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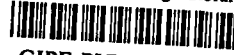
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INDIAN CENTRAL COTTON COMMITTEE.

STUDIES IN THE PHYSIOLOGY OF THE BROACH COTTON PLANT

BY

K. V. JOSHI, M.Ag.,

R. B. GODE, M.Sc.,

and

A. K. SHAH, B.Ag.

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PREFACE.

The object in writing this detailed report is to place on record all the data collected during a period of nine years on the problem of bud and boll shedding in cotton. The research developed into diverse branches and was carried out by a number of workers under the direction of the senior author who was in charge of the investigation throughout the whole period.

Mr. S. B. Ranade, B.A., M.Sc., worked as the first senior assistant for a period of six months. In 1924, Mr. B. M. Dabral, M.Sc., took the place of Mr. Ranade and continued till 1927. Thereafter, he left this work to enable him to take charge of a similar investigation in Sind. His place was subsequently filled by Mr. S. V. Godbole, B.Ag., M.Sc. The late Mr. N. M. Nitimargi, M.Ag., worked from 1923 to 1929. In 1929, he proceeded to England for prosecuting higher studies. He was succeeded by Mr. G. B. Patel, B.Ag., who was later transferred as Cotton Breeder and placed in charge of the Cotton Wilt Research Scheme at Broach. Mr. S. S. Sirur, B.Ag., worked during the years 1930 and 1931.

Mr. A. K. Shah, B.Ag., had been working all along since the commencement of the project till its completion and rendered substantial help in the preparation of this publication. Mr. R. B. Gode, M.Sc., joined the investigation in 1926 and continued to assist till the completion of the work. He shares with the senior author the responsibility of writing this report.

In addition to these regular assistants, two research scholars, Mr. M. A. Shama Iyengar, B.Ag., and Mr. R. N. Gidwani, B.Ag., also worked—the former during 1926 to 1929 and the latter for a short period in 1928.

To all these workers the senior author offers his most sincere thanks for their loyal co-operation and willing help, without which the investigation could not have been brought to a successful termination.

We are also obliged to Mr. R. S. Kasargode, L.Ag., and Mr. B. P. Deshpande, who were in charge of the Entomological Research Scheme on Cotton Boll-Worm at Surat for their being accessible for occasional consultation and for willing co-operation from time to time.

We have also to thank the authorities in charge of the Agricultural Station, Surat, for their assistance in various ways during the course of this investigation.

We take this opportunity to express our deep sense of gratitude to Dr. H. H. Mann, D.Sc., ex-Director of Agriculture, Bombay, but for whose ardent love of scientific research and masterly guidance of the investigation, especially during the first five years, the work would not have progressed in a satisfactory manner. His annual visits to the station, characterised as they were with much critical and synthetic discussion, helped in no small measure the progress of the entire project, besides being a source of perennial inspiration for the workers concerned in their respective branches of research converging on the main problem of investigation.

After the retirement of Dr. Mann, the heavy responsibility of guiding this research in all its ramifications fell on Dr. W. Burns, D.Sc., the Economic Botanist to the Government and at present Director of Agriculture, Bombay. His solicitude for the progress of the work and his sympathetic understanding of all problems connected therewith have enabled the authors of this report to record the enormous mass of data obtained during a sufficiently long period of nine years.

Our thanks are also due to Mr. T. F. Main, B.Sc., O.B.E., who succeeded Dr. Mann as Director of Agriculture, for his sympathetic attitude in continuing this research during his regime.

The authors are equally grateful to Mr. B. C. Burt, B.Sc., C.I.E., M.B.E., the first Secretary of the Indian Central Cotton Committee. The present investigations are mainly the result of his conviction about the necessity and usefulness of agricultural research. He took a very great interest in this project during his Secretaryship of the Indian Central Cotton Committee for a period of nine years.

The present work has benefited immensely by the advice and criticism of Mr. N. V. Kanitkar, M.Ag., B.Sc., Soil Physicist to the Government; Rao Bahadur D. L. Sahasrabuddhe, M.Ag., M.Sc., Agricultural Chemist to the Government; and Principal V. G. Gokhale, L.Ag., Professor of Agriculture, all of whom made it convenient to pay occasional visits to the Research Station during the whole period of the investigation. They deserve our warmest thanks for this labour of love and especially for the troubles taken by them in going through the manuscript of the present report very critically at great personal inconvenience.

Our thanks are also due to Dr. L. A. Ramdas and Dr. R. J. Kalamkar of the Indian Meteorological Department for their help in statistical work and interpretation of the meteorological data connected with this report.

Finally, we have to acknowledge very gratefully our deep sense of obligation to the Indian Central Cotton Committee who provided the sinews of all the research imbedded in the present report and but for whose scientific attitude towards agricultural research and unstinted financial support the present Scheme would not have come to fruition.

K. V. JOSHI,
Senior Author.

POONA,
Dated 31st July, 1933.

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CHAPTER I.

INTRODUCTION.

It is a fact commonly observed by cotton growers that the cotton plant sheds a large number of its flower-buds and bolls before they attain to maturity. Since the quantity of the cotton crop is directly dependent on the number of bolls maturing on the plant, a belief is prevalent in cotton-growing territories throughout the world that this loss of buds and bolls must be directly responsible for a proportionate reduction in the yield of the crop. Shedding of buds and bolls is, therefore, viewed with great concern by the cultivators and as a result a good deal of research has been carried on for more than two decades in the two important cotton-growing countries, *viz.*, Egypt and the United States of America.

In India, however, the problem had not received as much attention as it deserved. It was mainly through the efforts of Dr. H. H. Mann, D.Sc., the ex-Director of Agriculture, Bombay Presidency, that the Indian Central Cotton Committee was persuaded to give their immediate attention to this problem. They accordingly expressed their readiness to finance a research scheme for the investigation of (1) the factors governing the shedding of buds and bolls, (2) the exact relation of the shedding to the yield and (3) to suggest measures which should keep effectually the shedding under control. Such a scheme was accordingly formulated and started in 1923. Research work under this scheme was carried on at Surat, an important centre of the Broach Cotton Tract, for a period of nine years. The data collected during this period are recorded and interpreted in the present volume.

The non-development or the shedding of reproductive organs before maturity is a phenomenon of wide occurrence in the plant world. In the majority of cases, it is a result of sterility ; in some, it is caused by diseases or insect pests ; while in others it is an expression of nutritional disturbances. The initial years were, therefore, devoted to the study of the nature and extent of shedding of both the buds and bolls, and to the investigation of the probable causes indicated by external signs of the shed forms. These causes were eliminated, after a preliminary inquiry as either not existing or not explaining the bulk of the huge shedding. In the absence of any extraneous cause, the trouble was considered to be of internal origin pertaining to the physiology of the plant.

Physiological investigations, like the one under study, present peculiar difficulties as the factors concerned have to be discovered before their working can be properly understood. This involves a simultaneous study of as many factors as possible to ascertain their direct influence and the limitations caused by their interplay. The work in the early years, therefore, has to be necessarily diffused and spread over a large field until by a process of elimination it gets narrowed down. In this way, once it was established that the shedding was a result of nutritional deficiency and that it was a dynamic process involved in the adjustment of growth commensurate with the quality and quantity of nutrition in the plant, what was important from practical considerations was to find out how this deficiency of nutrition could be remedied and how the same plant could be made to give more bolls. Further work was, therefore, directed to achieve this end under conditions of crop production.

The presentation of the data begins with a description of the general conditions of crop production as obtain in the Broach cotton tract. This is followed by a detailed account of the growth and development of the plant under field conditions. As the crop is damaged by the spotted boll-worm which feeds on shoots, flower-buds and bolls, the performance of the plant under non-boll-worm conditions is then given to assess the toll taken by the insect. After this, the dry-matter growth of the plant, its chemical conditions at different stages of growth, the influence of environment in causing growth and shedding variations, the course of events as clarified by this research that lead to shedding of buds and bolls are described and discussed. Finally, the influence of shedding on the yield of the crop, and the factors of successful boll production under conditions of crop production are dealt with.

REVIEW OF LITERATURE.

A review of literature on the subject of bud and boll shedding was taken in the first year of the investigation (1923-24) and the same is reproduced below with some additions which gives an idea of the nature of the problem. Literature that came to our hand during the progress of work has been cited at suitable places while discussing the respective aspects.

Ewing (1918) studied the behaviour of boll shedding in several varieties of cotton and concluded that the rate of shedding differed in different varieties grown under similar conditions. Bryan and Pressley (1924) also support Ewing's view and maintain that the character of shedding is varietal. The only effort to determine the inheritance of shedding was made by Kearney (1926 and 1927) who crossed two species differing widely in their rate of boll shedding (Pima Egyptian and Acala Upland) and studied the behaviour of the progenies. From the studies of the hybrid, he concludes that shedding is partly controlled by genetic factors which segregate after hybridization and recombine although no definite Mendelian ratio is observed. "There can be little doubt," he asserts, "that there is a tendency for plants which shed many of their flower-buds to shed also many of their young bolls."

Cook (1921) agrees with others when he observes that shedding is genetic, but he is still inclined to feel that it has both morphological and physiological aspects. He says, "The primary causes, those that determine whether abortion (shedding) is to take place, are genetic and physiological, but the method of shedding has a morphological aspect that needs to be considered. Abscission has a definite position occurring always in the sockets of the pedicels which are bounded and bordered by the stipular ring. That the sockets are too large for the pedicel bases, becomes apparent since a gap is formed at once between the separating tissues of the pedicel and the socket, indicating a release of tension. In such cases, enlargement of the sockets rather than shrinkage of pedicels would seem to be the mechanical stimulus of shedding. Checking the growth of the flower-buds or the young-bolls, while the vegetative frame work of the plant is developing rapidly, would explain why the sockets may become too large for the pedicels."

Cook's (1911) morphological studies of the cotton plant, both of the local and the newly introduced types in the United States of America, led him to the conclusion that the shedding of the flower-buds and bolls was a result of the dimorphic nature of branching, the vigorously growing vegetative branches suppressing the fruit growth. He writes that "if the fruiting branches are of a normal, slender and horizontal form, the chances of the buds being retained are very much greater.

If on the other hand, the fruiting branches become more robust and take an oblique and upright direction and thus resemble the vegetative branches or limbs, the buds almost invariably fall off whilst very young." His observations on sterility and abnormalities of organs in cotton, led him to think that the shedding was a sort of sterility induced by the failure of proper suppression of the vegetative character of the plant. He noticed with Meade (1911) various intermediate stages of sterility in foreign cottons in the process of acclimatization in the United States of America. Cook has been quoted at length, because his outlook on shedding differs materially from most of the other workers on cotton. Nevertheless, it is an important view that needs to be considered.

Another case of abnormality leading to shedding of bolls is suggested by the work of Trought (1928) in the Punjab. This is the non-dehiscence of anthers at certain times of the year. Another possibility leading to shedding is indicated by the work of Jivanrao (1922) in Madras who considers that it is brought about by the low osmotic strength of the sap in their growing tissues.

Boll shedding has been ascribed by others to pathological conditions caused by internal and external rot. Atkinson, as quoted by Edgerton (1912), studied boll rot for three years in Alabama and has described many of the fungi and bacteria which are responsible for it. Edgerton observes that the actual loss from all kinds of boll rot varies from 5 to 10 per cent. and in wet years, he feels, it is even more. He attributed the rot mainly to *Glomerella gossypii*, commonly known as Anthracnose, *Bacterium malvacearum*, *Diplodia Malvacearum* and *Fusarium* sp. Nowell (1916-17) worked in the West Indies on internal boll diseases and traced four different species of fungi, which he termed as A, B, C & D, attacking the internal parts of the cotton bolls. Harland (1920) classifies the chief sources of loss of the cotton crop, amongst which are the internal boll diseases due to *Bacterium malvacearum* and soft rot or phytophthora diseases. Ballard and Norris (1923) have isolated another type of bacterium in rotting bolls. Shedding of fruits in plants other than cotton has been observed to be caused by various parasitic fungi. Butler (1918) reports the dropping of fruits in plants and in some other cases by the attack of phytophthora. Coit and Hodgston (1919) have found two important causes of the June drop of young Washington Naval oranges, one of which is a parasitic fungus, *Alternaria citri*.

Insect attacks on flower-buds, flowers and bolls have been found to be among the serious causes leading to shedding. The ravages of the boll weevil in the United States of America, resulting in heavy shedding, are too well known. Another insect of an equally serious importance is the spotted boll-worm observed by Fletcher and Misra (1921) which is responsible for a large part of the shedding. In California, McGregor (1927) reports the presence of tarnished bug (*Lygus elisus* Van Duzee) which punctures the squares, blooms and young bolls of cotton as a result of which these forms are soon shed.

The majority of workers on cotton, however, attribute shedding to physiological disturbance in the plant in response to soil and climatic environments. Balls (1912) studied shedding in Egypt two decades back and found that the main factor of shedding was water deficiency in the plant. This, he thinks, may be due to soil desiccation, excessive transpiration or root asphyxiation consequent upon the rise of the subsoil water. Lloyd (1920) in Alabama supports Balls and remarks that shedding under field conditions is attributable to soil-water conditions. According to him, the shedding referable to soil water, "proceeds in minor waves,

superimposed on a larger wave, the crest of which follows the gradual depletion of moisture in the deeper reaches of the soil." He further observes that a probable factor which intrudes itself more effectively into boll shedding in general is competition amongst bolls for water, similar to that observed by him in *Juglans* (Lloyd 1919), resulting in the shedding of fruits. King (1922) worked in Arizona on the water stress behaviour of Pima cotton and thinks that the shedding of squares and bolls is not always induced by a lack of available moisture in the soil, but may be due to a water stress in the plant caused by a more rapid reduction of moisture in the portion of the soil immediately surrounding the roots than can be restored by capillarity to meet excessive transpiration. The investigation of Coit and Hodgston (1919) on the Washington orange brings out that these abnormal water relations furnish stimulus to shedding. According to these workers, a contributing factor to water deficit lies in the fact that under stress of the tremendous atmospheric pull for water, the leaves actually appropriate water from the young shoots. This strain on the plant is not localised but extends throughout the tree. Water tensions developed by exterior foliage are transmitted quickly to interior fruits and even to distant roots as was shown by several experiments.

Another school of investigators working on the problem, attributes the shedding to competition and a deficiency of the elaborated plant-food. Mason (1922), who carried out studies on growth and abscission in Sea Island Cotton, observes that any slight obstacle in the functioning of assimilating processes is enough to disturb the growth balance which ultimately results in the shedding of forms. He says that the proportion of shedding over any given period is the resultant of two opposing factors, the rate at which food is synthesised by the plant and the rate at which it is utilised in the maturation of the fruits, and that any check in the former augments the rate of bud-shedding. Ewing (1918) from his flower pruning experiments and from his studies of different varieties, concludes that the cotton plant naturally produces a surplus of flowers, many more than it can mature into fruits, suggesting shortage of food in the plant.

According to Kraus and Kraybill (1918), the balance between carbohydrates and nitrogen in the plant, determines the kind of growth that occurs. They point out that a lower ratio of carbohydrates to nitrogen in the plant stimulates vegetative growth and checks the reproductive growth. Correlative influences of growth in the plant are also suggested by other workers as a possible cause leading to shedding of fruit. Conditions stimulating the vegetative growth of plants suppress the fruiting growth and *vice versa*. Mason (1922) attributes both the cessation of growth in the main axis and the augmented susceptibility to shedding to a correlation factor, which tends to deflect the supply of the elaborated food from the apical part of the plant to the developing organs on the basal fruiting branches. Murneek's work (1926) on Tomato brings out very prominently the inhibitive influence of the growing fruits on the vegetative growth. Some of the environmental factors like the day time rain, clouds, heavy winds, etc., have also been observed to augment shedding of buds and fruits.

CHAPTER II.

CONDITIONS OF CROP PRODUCTION.

The Broach cotton tract is situated on the west coast of India, beginning from about 120 miles north of Bombay and extending over about 120 miles further north, with a breadth which varies from twenty to fifty miles. It is divided into two more or less equal parts—the north and the south—by the river Nerbudda. The cotton grown in the northern part has deteriorated owing to extensive substitution of a short-staple variety; in the southern part, however, the renowned long-stapled, Broach cotton is grown almost in a pure state. Surat forms the centre of this tract and the studies embodied in this volume have been carried out at this place. Its eastern longitude is $70^{\circ}52'$; north latitude, $21^{\circ}12'$; and elevation, not much above the sea level.

CLIMATIC FACTORS.

RAINFALL.

Rainfall as a climatic factor is by far the most important as the cotton crop in this region has not the advantage of irrigation and is, therefore, dependent upon rain for its moisture supply. This tract is most favourably situated for rains, the average annual precipitation amounting to not less than forty inches. Almost the whole of this quantity is received during the period of four months, from mid-June to mid-October (Table Nos. 1A & 1B in the Appendix). Normally, there is no effective rainfall in the remaining eight months though spells of cloudy weather sometimes terminating in small amounts of rain are of common occurrence during November, December and January. The average monthly rainfall for two periods, the one of 32 years from 1877 to 1908 and the other of 23 years from 1909 to 1932, is given in the following table.*

TABLE NO. 1.
Average monthly rainfall in inches.

	Sow- ing.	Active growth.										Boll development.		Prepa- ratory tillage.	Total
		Slow growth.				Flowering.						Harvest.			
		June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	April.	May.		
Average of 32 years, 1877-1908.	7.49	17.04	7.37	6.07	1.61	0.11	0.04	0.07	0.08	0.02	0.05	0.10	40.05		
Average of 23 years, 1909-1931.	8.56	16.26	7.11	5.51	1.92	0.37	0.07	0.23	0.03	0.01	0.00	0.32	40.39		

Rains during the months of June to about the middle of September, are caused by the currents of the south-west monsoon; those in the latter half of September and during October, are mostly derived from those of the north-east monsoon. These currents are generally weak in June but later they rapidly strengthen and give rise to heavy and frequent rains in July, the sky being heavily clouded during all this

* The former data are taken from the records of the Indian Meteorological Station, and the latter from the Agricultural station, both the stations being located at Surat with a distance of two miles between the two.

time. The precipitation in August is similar to that in the preceding months but is only of a light nature. The sky, however, continues to remain cloudy. Rains become less frequent in September but whenever received, they come in sharp and heavy showers. The sky then begins to get clear and there is repeated sunshine. These characteristics will be evident from the weekly figures of average rainfall (Table No. 2 in the Appendix), shown in the following graph and from the average number of rainy days set out in Table No. 2.

GRAPH NO. 1.

Weekly rainfall in inches—Averages of 23 years (1909 to 1931).

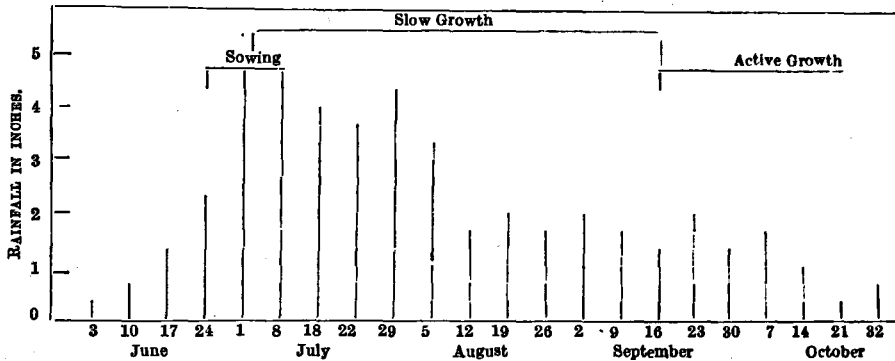


TABLE NO. 2.

Number of rainy days per week—average of 23 years.

	June.			July.				August.				September.			October.							
	3	10	17	24	1	8	15	22	29	5	12	19	26	2	9	16	23	30	7	14	21	28
Average number of rainy days.	0.57	1.26	3.17	2.91	3.35	4.57	4.87	4.87	5.39	5.23	4.09	4.04	4.22	3.91	3.22	2.61	2.79	1.57	1.22	0.61	0.30	0.30

Although the average annual rainfall is 40 inches, it varies widely from year to year (Table No. 3). Similarly, the monthly precipitation during the rainy season departs considerably from the average monthly figures given above. Patel (1924) worked out the co-efficient of variability of rainfall as 76.7% in June, 50.9% in July, 68.9% in August and 91.3% in September. This gives an average of 71.9% and shows the extreme variability of the monthly rainfall.

TABLE NO. 3.

Frequency distribution of years, according to rainfall during 23 years.

Rainfall in inches.	16-20.	21-25.	26-30.	31-35.	36-40.	41-45.	46-50.	51-55.	56-60.	61-65.
Frequency of years.	2	1	4	3	1	3	2	3	2	2

A critical study of weekly distribution of rainfall and yield over a period of 23 years at the Agricultural Station, Surat, indicates that a considerable amount of rain is superfluous, as a normal crop can be grown with even half the average quantity. As about 10 inches of concentrated rainfall has been observed to be generally sufficient to wet the soil to a depth of three to five feet and as this quantity is generally assured in July, the tract is practically free from a complete failure of the crop. Rains in the month of July are therefore of immense value to the cultivator and form practically the backbone of the cotton crop.

The common experience in this tract is that although rains sufficient for growing the cotton crop successfully are assured, the nature and the distribution of rainfall often inhibit the establishment and earlier growth of the plants.

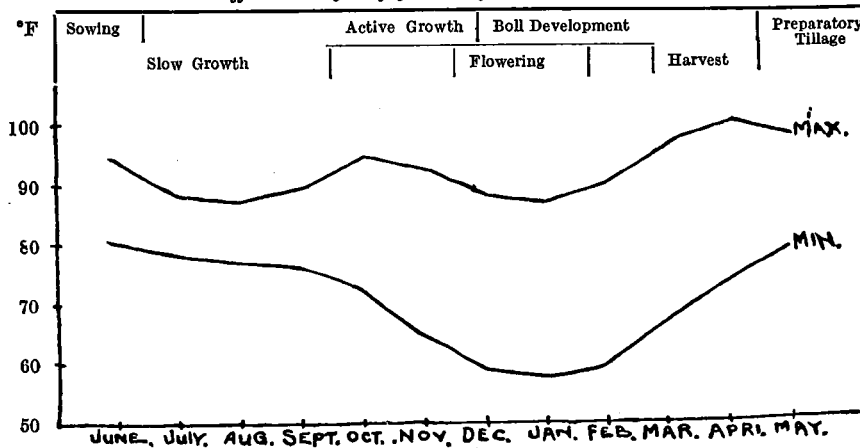
AIR TEMPERATURE.

In addition to rainfall, another factor which is no less important and which influences the climate of any place or locality, is with respect to the air temperature. Variations in humidity, the formation of winds and other atmospheric phenomena, are all governed in no small measure by air temperature. Air temperature also affects the soil environment and regulates the attendant chemical reactions both in the soil and in the plant.

A large quantity of data has now accumulated as a result of the labours of the Indian Meteorological Station at Surat, on the factors relating to atmospheric phenomena. From these data, we reproduce below graphically (Graph No. 2)

GRAPH NO. 2.

The mean monthly maximum and minimum temperatures (Average of 54 years from 1878 to 1931), recorded by the Indian Meteorological Station at Surat, and the different stages of growth of the cotton crop.



the mean monthly maximum and minimum temperatures as the average of 54 years from 1878 to 1931 (Table No. 3 in the Appendix). In the same graph, are shown the different stages of plant growth, from the date of sowing to the time of crop maturity. The temperatures are shown in this graph from June to May of the following year, as the cotton crop in this tract is sown towards the end of June

and harvested in March of the next year. This arrangement is most suitable and gives an idea of temperature conditions at different stages of crop growth.

It will be clear from this graph that for over two months after sowing, both the maximum and the minimum temperatures do not vary to a marked extent (Maximum, 87° F. to 88° F. Minimum 76° F. to 78° F). During this time which corresponds to the major part of the rainy season, growth of the cotton crop is very slow. Thereafter while the maximum temperature steadily rises and records in October the highest mean maximum temperature (93° F.) during the whole of the crop season, the minimum instead of showing a similar rise gradually declines. The plant now sets on its growth which rises rapidly during October. Then follows a period in which both the maximum and the minimum temperatures descend together until they reach, in January, a level not exceeding the mean value of 86·5° F. for the former and 57° F. for the latter which is the lowest minimum of the year. In this interval, the reproductive growth of the plant takes place. From this time onwards, both the temperatures continue to ascend until the highest maximum of the year is reached in April and the highest minimum in June. The maturing of the crop generally occurs in March and at a time when both the maximum and the minimum temperatures are rising.

It is important to note further that the commencement of the divergence between the daily minimum and maximum temperatures synchronises with that of the active growth of the crop and that the divergence is the greatest during the flowering and the bolling period as will be evident from Table No. 4. (Table No. 3 in the Appendix.)

Trought and Mohmad Afzal (1930), who compared the temperatures of the various cotton tracts in India, observe that unlike in other tracts, the maximum temperature at Surat, rises in the first half of the growing season and falls in the latter half and rises again during the picking season, the minimum temperature following more or less the maximum. The peculiarity of the Surat tract in comparison with the other tracts is that both at the time of planting and of harvesting, Surat records the highest minimum temperature which never rises in effect of the spell of hot weather during the middle of the growing season, and which on the contrary shows a tendency to decline.

TABLE NO. 4.

Difference between the maximum and the minimum temperatures as the average of 54 years from 1878 to 1931 and the stage of plant growth.

Crop phase.	Sowing.	Active growth.										Preparatory tillage.
		Slow growth.			Flowering.		Boll-development.		Harvest.			
Months.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	April.	May.
Difference between maximum and minimum.	13·3	9·6	9·6	12·8	21·7	27·0	28·5	28·9	29·6	29·2	25·9	18·6

Although the mean monthly value of the maximum temperature has not gone beyond 99·5° F. and that of the minimum lower than 57·6° F., the absolute readings

have varied widely from the mean. Taking the last ten years, the highest maximum temperature recorded was 111.2° F. in 1925, and the range between the lowest and highest values of the maximum temperature was 68° F. to 111.2° F. The absolute values of the minimum temperature also vary likewise from that of the mean, the range being from 40.3° F. to 84.4° F. against the mean 57.6° F. The following table gives, year by year, the range of the maximum and the minimum temperatures for ten years.

TABLE NO. 5.

Range of maximum and minimum temperatures at Surat for ten years from 1921 to 1930 (From the records of the Indian Meteorological Department).

Year.	Maximum temperature (°F.)	Year.	Minimum temperature (°F.)
1921	75.2 to 110.4	1921	49.6 to 83.6
1922	77.1 to 109.6	1922	49.2 to 84.4
1923	77.4 to 107.7	1923	51.6 to 84.2
1924	77.3 to 108.2	1924	52.2 to 84.2
1925	71.3 to 111.2	1925	46.4 to 82.8
1926	80.2 to 109.4	1926	53.2 to 84.4
1927	73.3 to 106.1	1927	50.0 to 83.4
1928	72.9 to 108.5	1928	48.2 to 83.2
1929	68.0 to 107.3	1929	40.3 to 84.3
1930	74.0 to 110.0	1930	48.0 to 83.0

The minimum temperature does not generally lower to the freezing point so as to dry up the crop by frost. The Broach cotton tract is not much liable to frost, though this phenomenon is not quite unknown to the people here. Joshi (1931) observes that during the last two decades frost did not occur more than three times. The frost in 1911 and in 1929 was of a widespread nature and caused considerable damage to all standing crops including cotton; that in 1925 was neither severe nor widespread.

The diurnal variation of temperature at four different times of the crop season—July, October, December and February—is shown in Figure Nos. 1, 2, 3 and 4. The time of the day when the temperature reaches the maximum in these four periods is between thirteen to sixteen hours, fourteen to fifteen hours, at fifteen hours, and fourteen to fifteen hours respectively and the time when it reaches the minimum is between four to seven hours, five to seven hours, six to eight hours and seven to eight hours respectively in the morning.

HUMIDITY.

Another important factor affecting climatic conditions is the relative humidity of the atmosphere. As a regulator of transpiration and indirectly of vital processes going on within the plant, its value cannot be exaggerated. We give, in the following graph, the mean monthly relative humidity and the vapour tension of 43 years and indicate the corresponding stages of crop growth.

GRAPH NO. 3.

The mean monthly humidity and the vapour tension (Appendix Table No. 3) recorded at 8 a.m. by the Indian Meteorological Station at Surat as an average of 43 years.

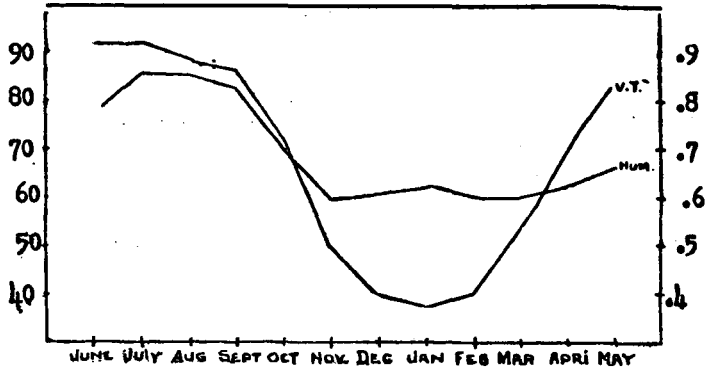
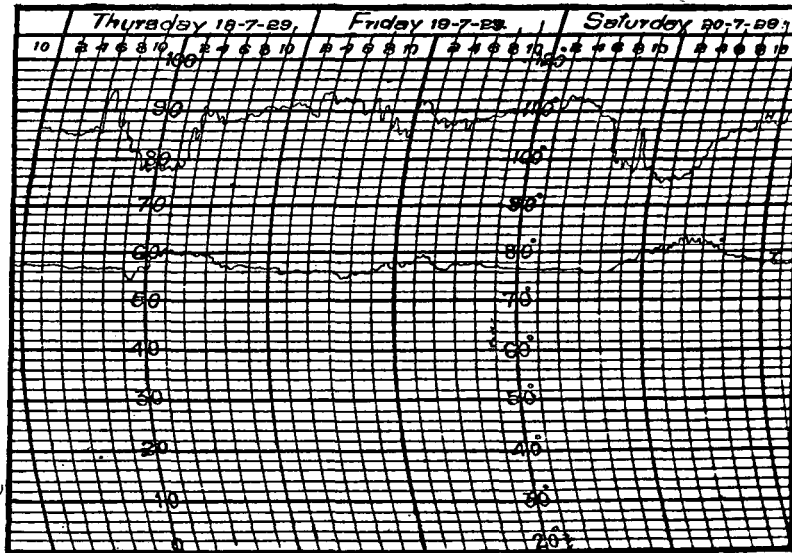


FIGURE NO. 1.

Diurnal variation of temperature and humidity in July.



T = Temperature curve.

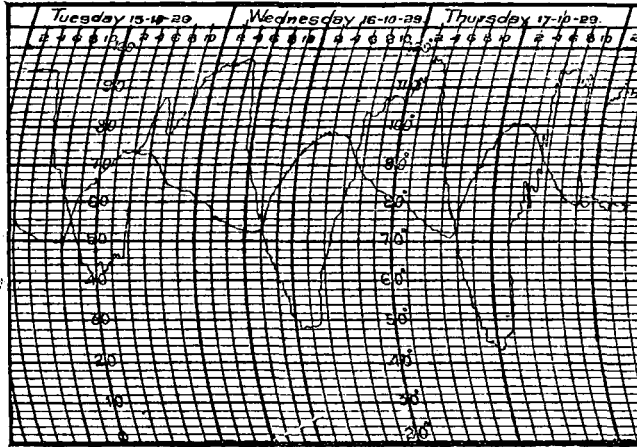
H = Humidity curve.

The temperature time is fast by two hours and the humidity time is correct.

Add twenty to the temperature curve to get the correct value of the temperature for a given time.

FIGURE NO. 2.

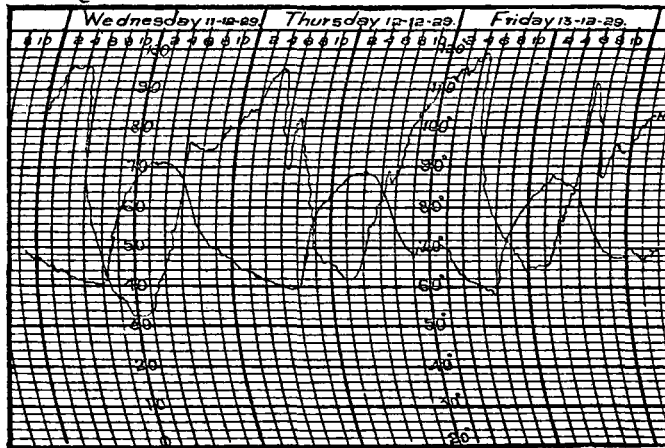
Diurnal variation of temperature and humidity in the month of October.



1. Add twenty to the temperature curve to get the correct reading for a given time.
 2. The temperature time is correct and the humidity timing is fast by three hours.
- T = Temperature curve. H = Humidity curve.

FIGURE NO. 3.

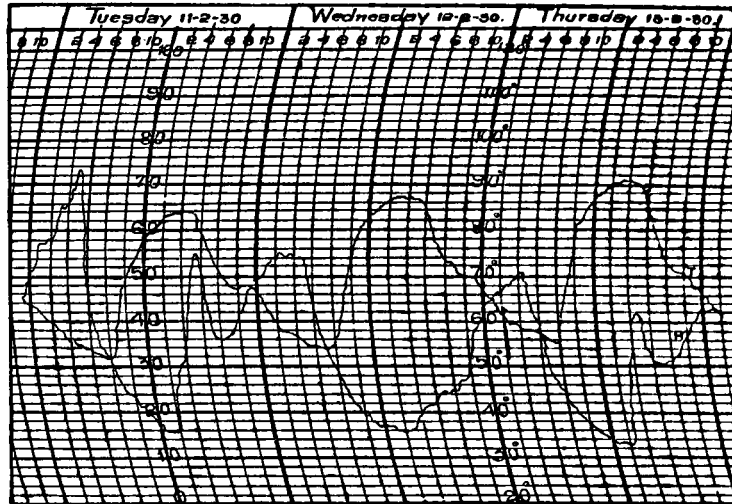
Diurnal variation in temperature and humidity in the month of December.



- T = Temperature. H = Humidity.
1. Add 20 to the reading of the temperature curve to get the correct temperature for a given time.
 2. The temperature time is correct and the humidity time is faster by three hours.

FIGURE NO. 4.

Diurnal variation in temperature and humidity in the month of February.



T = Temperature.

H = Humidity.

1. Add twenty to the temperature reading to get the correct temperature at a given time.
2. The temperature timing is correct and the humidity timing is faster by three hours.

Humidity is very high during the rainy months from July to September (period of slow growth) and falls at a very rapid rate during October and November (period of rapid growth). It remains practically constant at this level till April (periods of flowering and boll development) of the following year and begins to rise in May.

The times of the day when the maximum and the minimum humidities occur during the months of July, October, December and February will be seen from the Figure Nos. 1, 2, 3 and 4. These are 4 to 8, 5 to 6, 6 to 7 and 5 to 7 o'clock in the morning and 1 to 2, 1 to 3, 1 to 4 and 2 to 4 o'clock in the afternoon respectively.

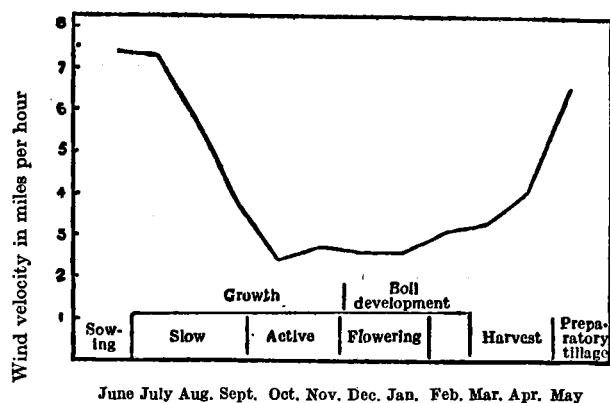
The vapour tension, during the rainy months from June to September, is high and like the humidity it declines sharply in October and November, reaching the lowest value in January as in the case of the air temperature. The rise in March, April and May is as abrupt as the preceding fall. Unlike the humidity, it is not constant from November to May.

WIND VELOCITY.

Intimately connected with the climatic factors so far presented, is the velocity of the winds. The mean monthly velocity of the winds (Table No. 3 in Appendix) is graphically represented below. The stages of crop growth are also shown in the same graph.

GRAPH NO. 4.

Monthly mean wind velocity in miles per hour, as recorded by the Indian Meteorological Department at Surat. (Average of 40 years.)



During June and July winds blow heavily, the range of variation in the absolute values being from 1 to 16 miles per hour during the last eight years. The velocity falls in August and September from 7.4 miles to 2.4 and from October onwards it is more or less constant until March, when it again begins to rise at a sharp rate. Patel (1924) in this connection mentions the cold north winds locally called *himalu*, occurring from the latter part of December to the early part of February, which are believed to affect the flowering and boll-development adversely.

Winds thus blow heavily prior to sowing and continue to do so for over two months after the operation. They are one of the factors that affect the growth of the seedlings adversely. Plants protected from winds have been observed to grow faster. These winds, however, are in a way useful as they dry up the surface soil pretty fast during intervals of rains and make the fields accessible for weeding and interculturing operations. Further, it is important to point out that the relation that the velocity of wind bears to humidity is closer than the relation it bears to other atmospheric factors.

SOIL AND SOME OF ITS PROPERTIES.

GENERAL DESCRIPTION.

The Broach cotton tract is a plain and its soil is formed of alluvium brought down from long distances by various rivers, chief among which are the Tapti and the Nerbudda. "The soil seems to be the result of the decomposition and recomposition of trappean material" (Imperial Gazetteer Vol. III). "Being derived from the Deccan trap, it has all the essential characteristics of the black cotton soil of western India" (Patel—1924). It is black in colour and varies in depth from three to five feet. Owing to this depth of the soil and also due to its clay and colloidal content, it expands on wetting and contracts and cracks deep and wide on drying.

For the same reason again, water enters and drains so slowly from these soils that during periods of heavy and continuous rain, conditions of water-logging are presented. These conditions obtain for a longer time in low-lying areas which are large and numerous in the northern and central parts of this tract.

The sub-stratum differs from the soil proper in respect of colour, texture and composition. The top-foot of this layer consists of fine yellowish-brown sandy loam with a large admixture of kankar (lime nodules). Below this layer, it passes into fine sand and further down becomes coarse sand. No rock is generally discovered when wells are dug out to the water level, which is generally at a depth of about 25 feet.

A. Homogeneity of the soil.

The mechanical analysis* given below points to the fact that the distribution of earthy matter, varying in fineness from coarse sand to the finest silt, is uniform in different layers of the soil.

TABLE NO. 6.
Composition of the soil at different depths.

Components.	1st layer.	2nd layer.	3rd layer.	4th layer.	5th layer.	6th layer.
	0-15 cms. %	15-30 cms. %	30-45 cms. %	45-60 cms. %	60-75 cms. %	75-90 cms. %
Finest silt	8.84	6.78	8.72	6.13	6.15	8.71
Fine silt	9.26	8.58	9.58	9.46	8.60	10.44
Medium silt	3.90	3.44	4.20	4.21	4.20	6.73
Coarse silt	10.00	7.34	11.00	9.02	8.70	13.06
Fine sand	67.38	73.30	65.90	70.54	71.71	60.48
Coarse sand	00.62	00.56	00.60	00.64	00.64	0.58

Analogous results were obtained in regard to the moisture holding capacity of the soil, determined by the Hilgard's Cylinder method. The determinations carried out with this method in the first four layers of 22.5 cms. each, have shown that the value attained by every layer for this capacity was about sixty-eight. The moisture equivalent (Briggs and McLane—1910) of the soil in all the layers up to 90 cms. mentioned above, did not vary to a marked extent, the actual values being 40.74, 37.22, 35.79 and 35.58 respectively.†

* The mechanical analysis was done by the Agricultural Chemist to the Government of Bombay.

† Determined by the Soil Physicist to the Government of Bombay.

By means of altogether different experiments conducted to ascertain the extent of availability of the soil-water to the plant, it has been possible to record the observation that the colloids which are supposed to retain water and which on this account, offer resistance to root suction are uniformly distributed in all the layers of the soil (Table Nos. 4 and 5 in the Appendix).

These considerations ultimately lead to the conclusion that the soil in its several layers is not only uniform with regard to its physical structure but also in respect of such important properties as the moisture equivalent, moisture holding capacity and colloidal matter.

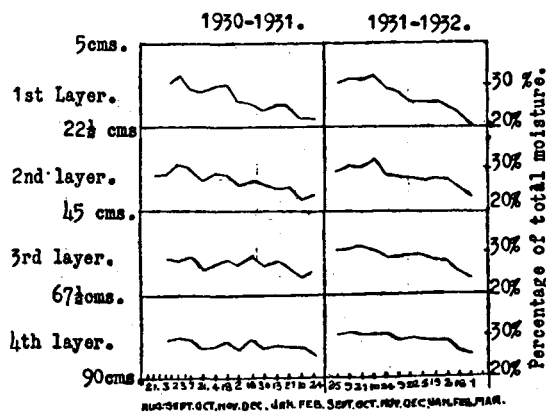
B. SOIL MOISTURE.

In the months of June to September and occasionally even up to the middle of October the soil receives from time to time large quantities of rain water. This is generally more than sufficient to wet the soil thoroughly and to replenish the loss that occurs at intervals between rains. The soil, therefore, remains fully wet, all these months, containing from 30 to 35 per cent. moisture as calculated on oven-dry basis. The upper layers hold somewhat more moisture owing to bad drainage. When the rains are over, the upper layers gradually decline in moisture while the lower ones remain unaffected and show relatively a higher content.

The behaviour of moisture in different layers of the soil, after this period till about the end of January, is of particular interest (Graph No. 5). For over six weeks after the cessation of rains the soil retains practically all its moisture. From this time onwards, the upper layers begin to lose moisture while the lower ones remain pretty steady throughout the crop season, i.e., till about the end of January, the

GRAPH NO. 5.

Per cent. moisture in different layers of an uncropped plot under cultural operations identical with those of the surrounding plots where cotton-crop was grown.



rate of loss decreasing with increasing depth. The extent of depletion in the several layers is well seen in Table Nos. 6 to 8 in the Appendix. As the surface layer is directly exposed to the action of the sun it suffers the greatest loss. When the land

TABLE NO. 7.

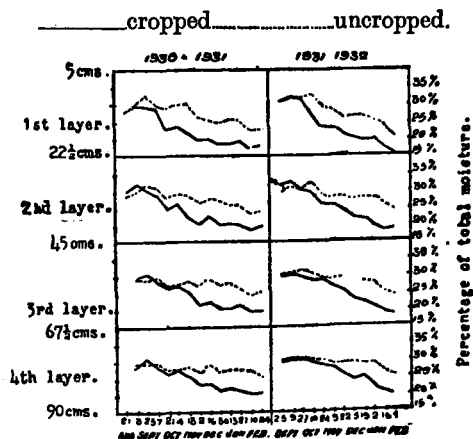
Percentage of moisture in four layers of the soil at the close of the monsoon and at the end of the crop season—results expressed on oven-dry matter.

Soil layers. cms.	1930-31.		1931-32.	
	7-10-1930.	27-1-1931.	10-11-1931.	2-2-1932.
First 22.5 cms.	29.7	25.3	32.4	25.1
Second 22.5 cms.	30.9	25.9	32.3	27.2
Third 22.5 cms.	29.2	26.4	30.9	28.04
Fourth 22.5 cms.	29.2	27.8	30.2	29.0

begins to crack, the lower layers gradually lose moisture. Thus, the rate of fall in moisture is governed in these soils both by the intensity of the sun's heat and the extent of its cracking. In addition to the mere evaporation of water under fallow conditions, large quantities of water are also lost by the physiological process of transpiration. The extent of depletion on this account as well as under the influence of physical forces may be compared (Graph No. 6).

GRAPH NO. 6.

Comparison between the moisture contents of uncropped and cropped lands, in four layers of 22.5 cms. each, for years 1930-31 and 1931-32.



During the rainy season, the moisture content in both the cropped and the uncropped land does not differ to any extent. This is, however, obvious. The growth of plants at this time is extremely slow and the losses incurred are also made good by additional showers of rain. Striking differences are, however, noticed after this period when the plants become extremely active and build up their vegetative matter.

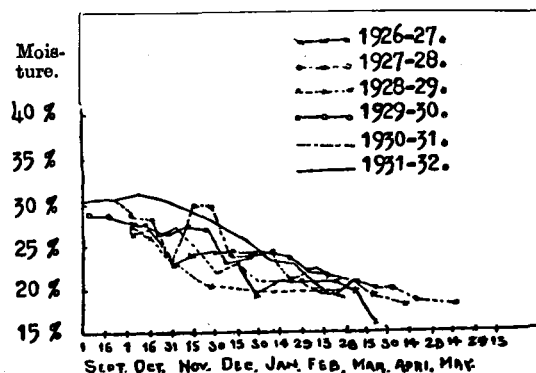
In the cropped area, the soil loses more moisture than it does under the influence of the physical forces alone. Again, while the mere evaporation of water takes a longer time to affect the soil moisture, the effect of root absorption is felt even much earlier. The depletion steadily proceeds from layer to layer as the roots descend to lower depths (Table Nos. 9 to 14 in the Appendix).

It is important to emphasize that once the roots enter a particular zone, indicated by the commencement of fall in moisture, they continue to absorb water till such time when the moisture content of the zone is reduced to about twenty to twenty-one per cent. Hence, it is inferred that the force of root suction is not able to overcome the united forces in the soil, at this level of moisture.

What is said with regard to the behaviour of soil moisture under cropped conditions in one year, can be repeated with regard to other years as well (Graph No. 7).

GRAPH No. 7.

Percentage moisture on oven-dry basis, as the average of the lower three layers (excluding the surface layer) of 22.5 cms. each, under cropped conditions.



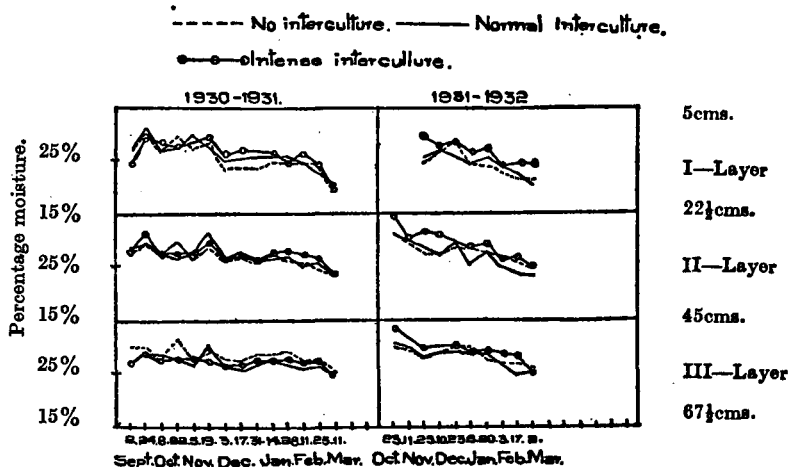
(a) *Capillary movement.*

We have seen that under uncropped conditions, it is only the surface layer that loses moisture, being directly subjected to action of the sun. The lower layers are only affected when the land is furrowed with cracks. Hence, it appears to be more than certain that the loss of water caused by evaporation in the upper layers is not made good to an appreciable extent by capillary movement of water from the lower reaches of the soil. This is, further, supported by the results of experiments (Graph No. 8 and Table Nos. 15 to 20 in the Appendix) carried out for studying the effects of no-mulch in three different plots. In 1930, they clearly showed that the percentage moisture from layer to layer in the plots under study had been the same. In 1931-32, there was a slight difference in favour of the normally inter-cultured plot but this was not corroborated by the intensely-mulched plot in which the moisture contents for the several layers were the same as those in the non-intercultured. It is to be noted that all the three plots in these two years were left uncropped so as to have only one factor varying.

Similar data were collected in the year 1928-29 but the samples were drawn from cropped plots (Table Nos. 21 to 23 in the Appendix). The results of these

GRAPH NO. 8.

Percentage of total moisture in several layers of the soil expressed on oven-dry basis in the uncropped area receiving normal interculturing, no interculturing, and intense interculturing during 1930-31 and 1931-32.



experiments together with those referred to above afford perhaps the most convincing evidence of the fact that mulching as a means of conserving moisture proves to be of no avail.

(b) Water delivering power of the soil.

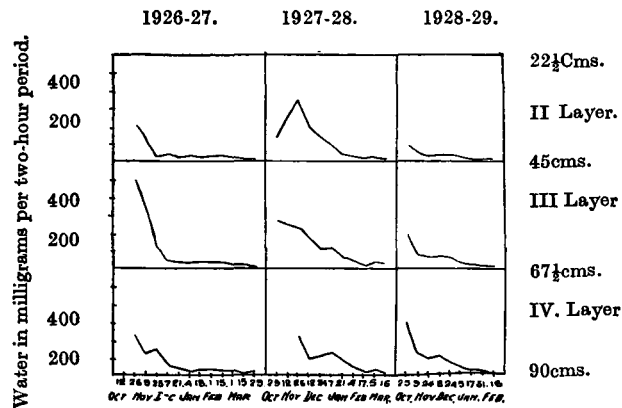
The percentage moisture discussed so far, it may be pointed out, represents only the total water content of the soil; it gives no idea whatever about the readiness or the ease with which the soil parts with its water. "Water is held by tiny particles of the soil, partly on their surfaces by absorption and partly, in the case of colloids, as water of imbibition; water is also held between the particles of the soil by capillarity (Maximov—1929)." All these forces directly resist a free absorption of water by the roots. On this account, the question of the water delivering or water supplying power of the soil rises into importance.

It was once believed that the capillary water was all available to the plant. But the researches of Briggs and Shantz (1912) have shown that this is not so. Livingstone and Koketsu (1920) devised, therefore, a method for determining the water supplying power of the soil, in which what they call the "soil points" were used.

Our experiments (1926-27, 1927-28, 1928-29) with this method show that the soil varies in its capacity of delivering water not only in the same season but also from season to season (Graph No. 9 and Table Nos. 24, 25 and 26 in the Appendix). They further show that the lower layers always deliver large amounts of water than

GRAPH No. 9.

Water delivering power of the soil per two hour-period (three layers of 22.5 cms. each surface layer being excluded).



the upper ones. The differences between the water supplying power of the upper and the lower layers gradually become less intense as the season advances. In all the three years, this power of the soil very rapidly declined after the close of the monsoon but later no marked differences could be found in the different layers.

Water supplying power of the soil appears to be a function of the total water content. (Compare the figures for total moisture content in Table Nos. 9, 10 and 11 in the Appendix.) In 1927-28, the unusual precipitation of nearly three inches of rain in November, increased both the moisture content and the delivering power. It varied, in fact, in the three years with the moisture content of the soil.

Another factor which affects this power is the concentration of the soil solution (Table No. 27 in the Appendix). This increases with the advance in season while the delivering power decreases. The inverse relation of the water supplying power to concentration of the soil solution is but natural. The osmotic pressure of the solution rises with the increasing concentration and exerts a retarding influence on the rate of water delivery.

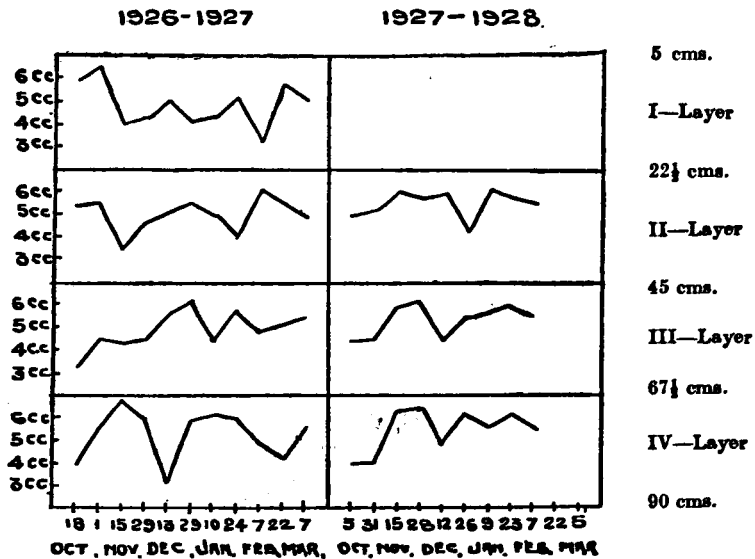
It may be stated that although the water delivering power of the soil varies with the total moisture content, the variation is by no means proportional. Again, the fact that the delivering power is reduced to a minimum even when the soil contains water to the extent of 20 per cent out of 30 at the close of the monsoon, shows in no uncertain manner that the soil is highly retentive and is capable of withstanding for a considerable period the desiccating effect of the climatic complex.

(c) *Unfree water.*

The retentive capacity of the soil is influenced, in a high measure, by its colloidal matter. Although no experiments have been made at this station to ascertain the quantity of colloids present in these soils, determinations made with the idea of finding out whether a large amount of moisture in the soil is held unfree and as such not available to the plants, have yielded very interesting information (Graph No. 10 and Table Nos. 4 and 5 in the Appendix). These determinations were carried out by the dilatometric method (Bouyoucos 1917). They show that the amount of added water, held unfree by the soil, is more or less constant throughout the season and for all layers of the soil. The average figure is 5 cc. out of 10 cc. of water added. This character is neither affected by seasonal influences nor does it appear to vary even in a given season.

GRAPH NO. 10.

Amount of water held unfree out of 10 c.c. of added water, in several layers of the soil, in the cropped area during 1926-27 and 1927-28.



It is, therefore, inferred that the colloids, which are supposed to be the agents for holding a certain amount of the added water unfree, do not vary in their quantity or at least in their influence either in the different seasons or in the different parts of the same season.

On the strength of the evidence cited above, we are in a position to say that owing to their great depth, fine texture, homogeneity, retentive capacity and other properties, these soils are able to absorb large quantities of water during the rainy season and conserve them for several months without much loss. On this account, they are most suitable for agricultural purposes especially for deep-rooted crops like cotton which entirely depend on the supply of soil moisture in this tract.

C. PLANT FOOD IN THE SOIL.

The chemical composition of the black cotton soil in this tract is shown below. As the roots sometimes penetrate the sub-soil, its analysis is also included. From these results, it will be clear that the soil is fairly good in organic matter and lime, good in phosphoric acid and rich in potash. Iron and alumina are sufficiently high.

TABLE NO. 8.

Chemical composition of the soil and the sub-soil at the Agricultural Station, Surat.

Constituents.	Black soil layers.		Sub-soil.
	15 to 22.5 cms. %	60 to 75 cms. %	110 to 125 cms. %
Stones .. .. .	..	.. on fine matter.	37.03
Moisture	5.73	6.21	6.66
Organic matter (loss on ignition excluding moisture).	6.50	6.35	4.62
Iron and aluminium oxides	11.54	13.80	10.52
Lime (CaCO ₃)	1.76	1.97	13.90
Nitrogen	0.044	0.039	0.027
Phosphoric Acid. (P ₂ O ₅)	0.065	0.055	0.044
Potash	0.174	0.212	0.123

The variation in respect of chemical composition even at widely different depths of the soil is not appreciable. The sub-soil on the other hand has a large admixture of lime nodules and therefore its lime content is outstandingly high but it is comparatively poor in the other constituents.

The Imperial Gazetteer of India (Vol. III—Articles on Agriculture) records the following with regard to these soils. "The percentage of soluble silicates, iron and alumina which the soil (in the Broach tract) contains are fairly constant. Lime varies in amount and also in the form in which it is found. It occurs usually both as carbonate and as silicate. Magnesia is always present in high proportion. The quantity of potash varies considerably, but it is not usually defective. The amount of phosphoric acid, nitrogen and organic matter is usually or frequently low."

Of the various plant food ingredients of the soil mentioned above, nitrogen is by far the most important and particularly so under Indian soil conditions, where the dry decay of organic matter continuously reduces the same under the influence of the hot sun during a large part of the year. This does not mean that

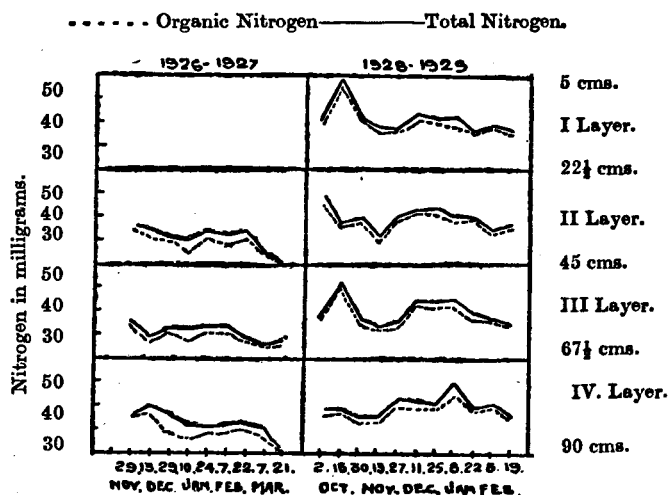
the other constituents are of less importance. Any of them may become limiting and disturb the normal growth behaviour of the plant. The nitrogen of the soil was, therefore, studied in detail in four layers to a depth of 90 cms. up to which the cotton plant mostly feeds.

(a) *Total and organic nitrogen.*

The following graph represents the periodical quantities of organic and total nitrogen found in these soils after the close of the monsoon. It shows the probable variation in the nitrogen content in two areas in which determinations were made for two years. (Table Nos. 28 to 31 in the Appendix.)

GRAPH No. 11.

Total and organic nitrogen in milligrammes per 100 grammes of oven-dry soil.



The figures of both the years indicate that total soil nitrogen does not remain constant throughout the year but fluctuates within a certain range. These results corroborate the findings of Sahasrabuddhe and Kanitkar (1932).

The data for the season of 1928-29 are more complete, as during that season all the four layers from the surface to a depth of 90 cms. were examined for the nitrogen changes. All the curves show periodical fluctuations typical of the dry tract of Western India as shown by Sahasrabuddhe and Kanitkar (1932). The average total nitrogen of the four layers varies only within a limited range during the period of these determinations from 34 to 45 milligrammes per hundred grammes of oven-dry soil. If the maximum value is taken as 100, it goes down to the lowest level of 76. But the individual layers show much wider variations during the same period. The surface layer which receives additions of farm yard manure in cotton years and also the dried stalks and leaves of the crop plants, shows the widest range, varying from 37 to 58 milligrammes. The second layer follows the first in this respect. The variations in the third and the fourth layer are more or less of the same order.

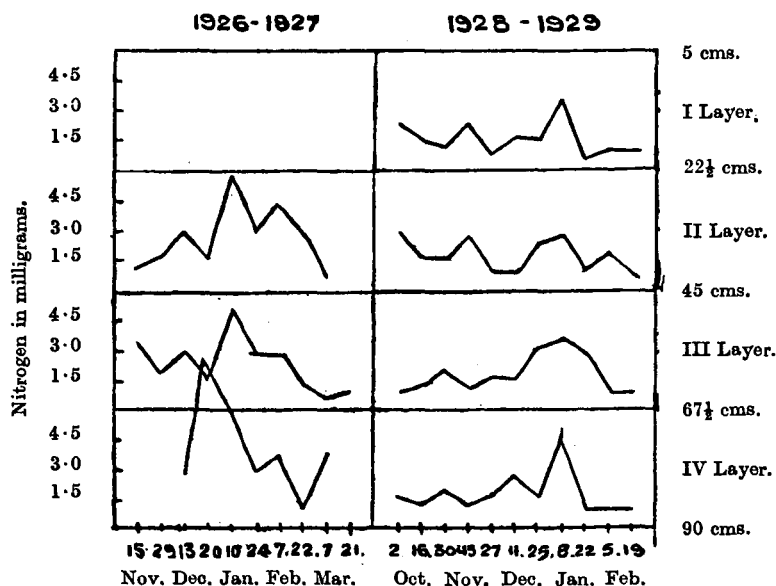
Of the total nitrogen, a little more than ninety-five per cent. is of the organic nature. It will be further seen that 4.3 per cent. is in the ammoniacal form and the remaining balance of less than half a per cent. only is made up of nitrous and nitric forms. These proportions remain practically the same in all the four layers of the soil, i.e., up to a depth of 90 cms.

(b) *Ammoniacal nitrogen.*

Periodical quantities of nitrogen in the ammoniacal form, for the same years are shown in Graph No. 12 (Table Nos. 32 and 33 in the Appendix).

GRAPH No. 12.

Periodical nitrogen in the ammoniacal form in different layers of the soil, expressed in milligrammes.



Nitrogen in this form shows wider fluctuations in the same season than the total or the organic nitrogen. In both years, its quantities have increased during December and January. This synchronises with the flowering period of the cotton plant in this tract.

The quantity of this form of nitrogen in the soil is about two to three milligrammes in the majority of determinations in both the years, and it is found fairly evenly distributed in all the four layers up to 90 cms.

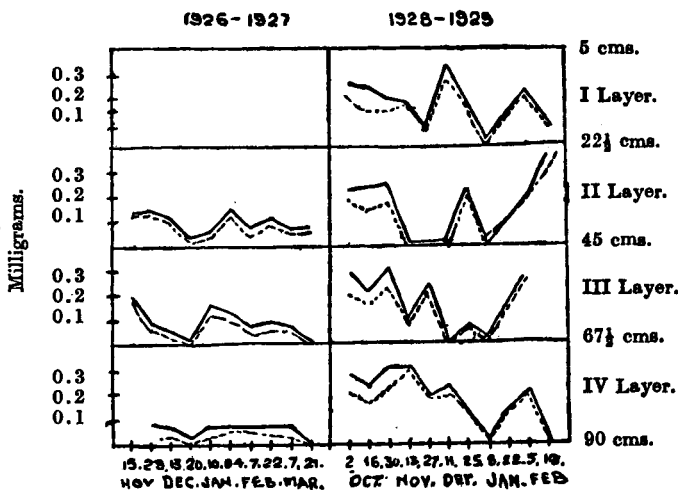
(c) *Nitrous and nitric nitrogen.*

The quantities of nitrogen in these forms are represented graphically in Graph No. 13 (Table Nos. 34 to 39 in the Appendix).

GRAPH NO. 13.

Nitrous and nitric nitrogen in milligrammes per 100 grammes of oven-dry soil.

----- Nitrous nitrogen. ————— Nitric nitrogen.



The curves show two crests, one in November and the other during January and February, indicating two periods of active nitrification. Of the two forms—nitrous and nitric—the nitric is directly utilised by the plant. It is, therefore, very important though the amount present is only a fraction of a milligramme. Being the final product of oxidation of the organic nitrogen, its quantity, therefore, depends upon the organic matter in the soil and upon the biotic and physical conditions including moisture and aeration. The nitrous nitrogen is an intermediate product in the processes of nitrification and denitrification and hence much value cannot be attached to its quantities present on any occasion. Besides, the curves clearly show that the quantities of nitrous nitrogen are very insignificant, the nitric nitrogen being by far the largest.

It will be seen from what has been discussed so far that the black cotton soils do not show unusual deficiency of any of the ingredients of plant-food normally present in soils. The organic matter and consequently the resulting nitric nitrogen are small as compared with the more fertile types of soil. We shall have occasion to consider in a later chapter whether any of the more important ingredients like nitrogen, phosphoric acid, potash and lime become limiting at any stage of development of the plant.

D. SOIL TEMPERATURE.

Of the environmental factors which control the bio-chemical phenomena in the soil, is undoubtedly its temperature. We have collected some data on the question of soil temperature but before they are presented, mention must be made of the nature of instruments and the way in which they were used in acquiring the data.

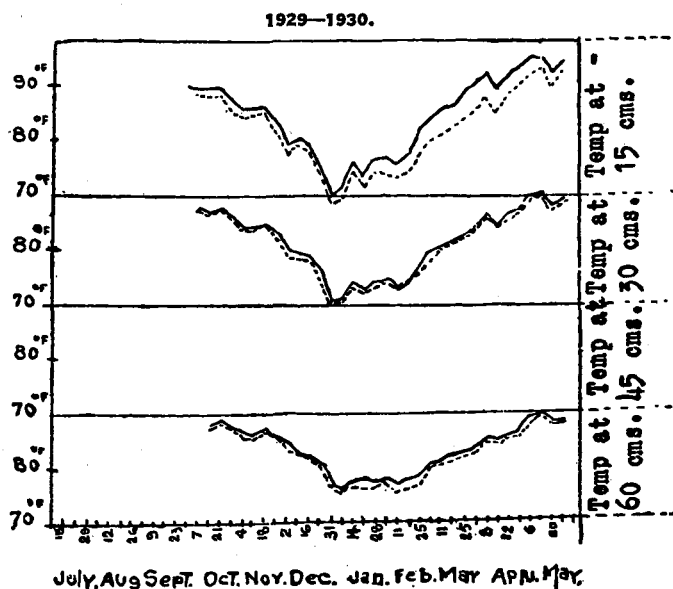
Two distance-thermometers, manufactured by Messrs. Negretti and Zambra, London, were employed. One of them was a dial-thermometer which consisted of a bulb connected to the dial with a capillary tube surrounded by an insulated covering; the other was a thermograph. It carried two bulbs connected to a self-recording arrangement with a capillary tubing, similarly encased. The self-recording clock-drum, set in a metallic container, was housed in a large wooden box specially made for the purpose.

These instruments were placed in a portion of the plot used for the study of the cotton crop. The dial-thermometer was used for recording temperature at a depth of fifteen cms., and the thermograph, for depths of thirty and sixty cms. The thermometers were always checked before use every year and were kept horizontally in the soil at the required depths.

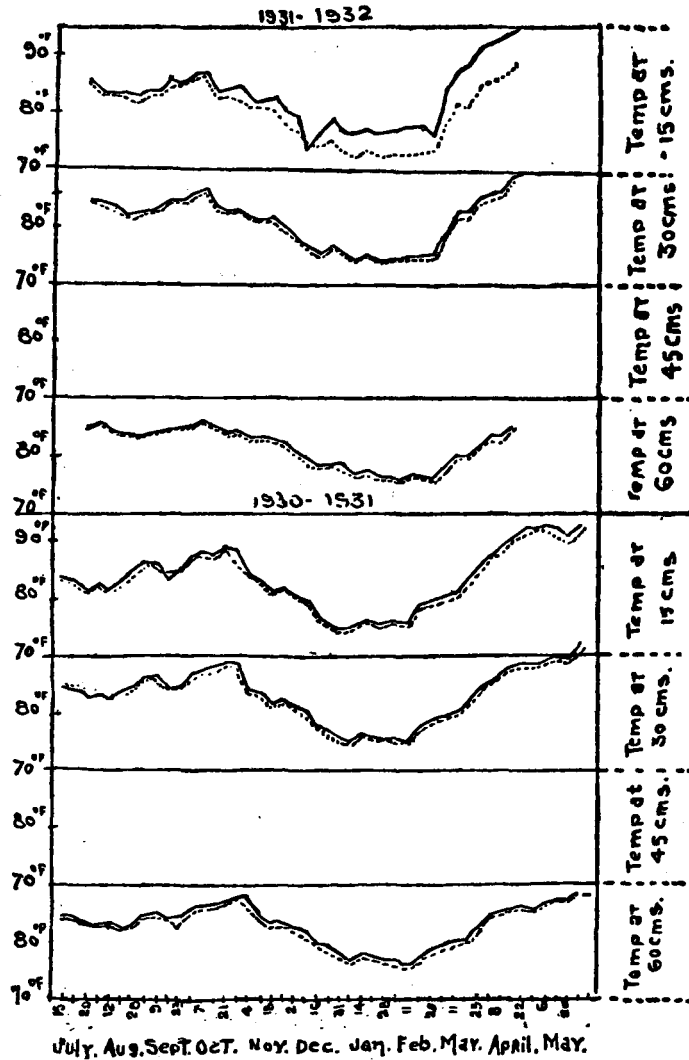
In this way, records of the soil temperatures were maintained for a period of three years. In the following graph are shown weekly means of the maximum and minimum temperatures of the soil at the depths of thirty and sixty cms. only. It was not possible to get these temperatures at the depth of fifteen cms., as in this case, the instrument used for this depth was an eye reading one. However, out of the four readings noted daily, one taken at 8 a.m. and another at 5-30 p.m. have been reproduced in the graph, as weekly means (Table Nos. 40, 40A and 41 in the Appendix). These, therefore, show the maximum temperatures within the limits of the time indicated.

GRAPH No. 14.

Weekly mean maximum and minimum temperatures of the soil at depths of 30 and 60, cms. and the weekly mean temperatures at 8 a.m. and 5-30 p.m. at depth of 15 cms.



GRAPH No. 14—(contd.)



From these graphs, certain facts become at once evident. The behaviour of soil temperatures, in the layers under observation is similar in all the years and that the difference between the maximum and the minimum temperatures is generally of a very small order, which becomes still less with increase in depth. Further, the lower layers of the soil always indicate a higher temperature and are liable to less fluctuations.

Bearing these facts in mind, we find that the cotton crop in this tract experiences a wide range of soil temperature during its career on the land. Soon after sowing, the soil warmed up (90° F.) by the hot weather of April and May, gets cooler (82° F.) owing to rains and remains in this condition during the period of July and August which coincides with the seedling stage. From this time onwards, the temperature steadily ascends (86° F.) till the third week of October, during which time the growth of the plant gets accelerated and represents, roughly speaking, the first half of the period of active vegetative growth. The temperature now declines at a rate which varies in different years, while the plant is still growing vigorously and producing and developing flower buds at a high rate. During flowering and in the early half of the period of boll development, lowest temperatures of the year prevail (74° F.) The temperature then slightly rises again (75·5° F.) over a period in which complete development of bolls takes place. Maturation of the boll occurs when the temperature rapidly rises. During harvesting, the soil temperature is comparatively high. The temperature of the soil in relation to the different stages of the plant growth is well illustrated in the following table.

TABLE No. 9.
Soil temperature at different stages of plant growth.

Crop phase.	Average temperature in Fahrenheit.		
	1929-30.	1930-31.	1931-32.
Seedling .. .. .	..	84	82
First half of active vegetative growth ..	87	87	85
Latter half of vegetative growth	81	80	78
Flowering and first half of bolling period ..	73	75	74
Second half of bolling period	75	76	75
Harvest	81	81	82

Mckenzie Taylor (1927) studied soil temperatures in connection with cotton grown in Egypt and found that during the period of germination and increase in height of the plant, the soil temperature was rising. This observation is supported by the results of our studies also. In the Broach cotton tract, as we have seen, the temperature of the soil at sowing is high and the period of active vegetative growth of the plant also synchronises with the period in which the soil temperature steadily rises. He further states that "during the flowering period the shading effect of the plant increases so that the maximum soil temperatures are characterised by a continuous decline to an almost constant value." This agrees with the conditions of the maximum soil temperatures experienced in the Broach tract as noted in the preceding paragraph. Comparing the minimum soil temperature during the periods of branching and flowering in the two countries, it is noticed that the temperature is constant in Egypt, while in this country it declines for over two months before becoming constant. Similarly, whereas the maximum and minimum temperatures during the boll-maturation period are constant in Egypt, they are rising in our tract. The nature of the soil temperature conditions in the two countries is thus not quite similar at every phase of plant growth.

Influence of air temperature on soil temperature.

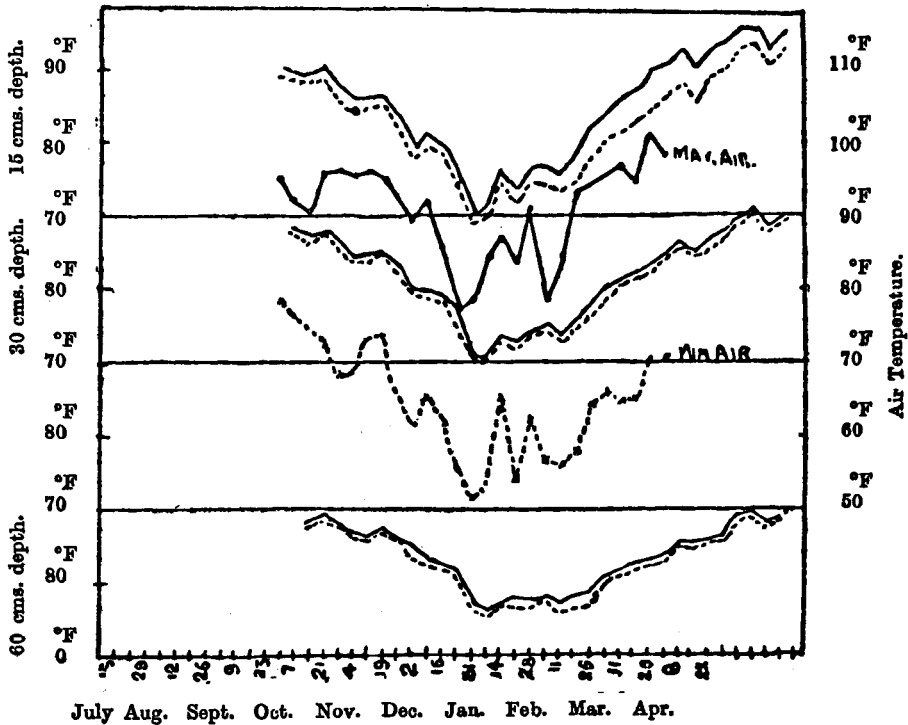
The chief source of heat governing the soil temperature at the depths occupied by the roots, is the sun. On this account, there is a close resemblance between the temperatures of the air and of the soil (Graph No. 15). Till the end of October, the soil temperature (whether maximum or minimum, as there is very small difference between the two) moves in accordance with the maximum air temperature. Hereafter till the end of February, it descends like the air minimum. This difference arises chiefly on account of the fact that during this period, the soil surface is protected from the heat of the sun by the foliage leaves of the cotton crop.

GRAPH No. 15.

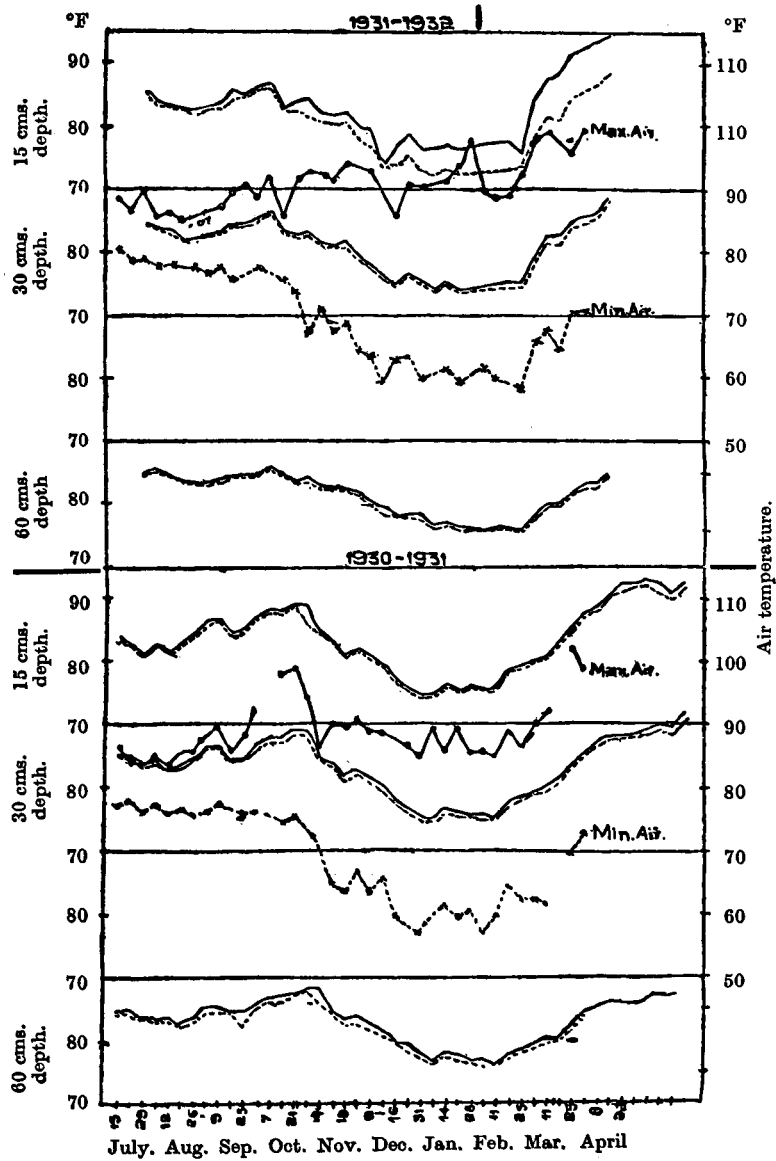
Comparison between the soil and air temperatures.

o—o—o Max. Air Temperature x—x—x Min. Air Temperature
 ——— Max. Soil Temperature Min. Soil Temperature.

1929-30.



GRAPH No. 15—(contd.)



Of greater interest, however, is the important fact that the soil temperature is found to be always lower than the maximum air temperature and always higher

than the air minimum. Keen and Russel (1921) observe that this is due to the remarkable property of the soil, by virtue of which the soil warms up more rapidly than it cools.

Whatever causes affect the air temperatures, they also affect the soil temperatures as well. Thus amongst the climatic factors, the effect of rainfall and the absence of sunshine deserve special mention. As a result of the rains and the accompanying phenomena of clouds, the temperatures of both the air and the soil are affected. In April and May, the soil acquires a temperature which is not less than 90° F. This is brought down to about 82° F., chiefly on account of the rains and the absence of sunshine during the rainy season. As the rains become scanty and the sunshine more frequent, both the air and the soil temperatures tend to rise during the months of September and October. In 1930, it rained from 10th to 15th September. This affected the rising soil temperature. Similarly, in 1931 the depressions in the weeks ending 23rd September and the 14th October were due to rains in those weeks. On account of these late rains for over 10 days after the 4th of October, the rise in temperature usually seen at this time of the year, was arrested in the midst of its career and the period of high temperature was, in effect, laterally shifted.

The cooling effect of rain on the temperature of the soil is, however, not as great as may be expected. We have seen that the soil attains as high a temperature as 90° F. in the months of April and May and this is brought down during the rainy season to a temperature not below 82° F. This is due, in the main, to the fact that the soil is badly drained and once thoroughly wetted, additional rain water passes down with great difficulty. Thus, whatever quantity of water gets in towards the beginning of the rainy season, it exerts a cooling influence to the extent indicated. Hence, however heavy and continuous the rain hereafter, the temperature of the soil remains almost unaffected.

The fluctuations in the maximum temperature after this period, have their reflex effect upon the temperatures of the soil as well. The rapid rise in the soil temperature which occurs from March onwards is mainly the response to those of the maximum air temperature.

It may now be asked how it is that the lower layers of the soil are at a higher level in regard to temperature. Keen and Russel (1921) point out that "the soil surface becomes hotter than the air but at a depth of six inches the temperature wave is so damped down that the maximum temperature of the soil is usually almost that of the air." For this reason, more than anything else, it would get still damped down at lower depths. The effect due to any change, in fact, occurring at the surface would get less intense before it is communicated to lower depths. Secondly, there would be some delay before it is exhibited by the lower layers.

To sum up, we may state that the soil temperatures are closely related to those of the air and they, in their turn, are related to different phases of plant growth. Further, the early half of the vegetative period which falls soon after the cessation of rains and which determines both the nature and the magnitude of growth of the cotton plant, is characterised by higher soil temperatures.

METHOD OF RAISING THE COTTON CROP.

The cotton now grown in this tract—1027 A.L.F.—is a monopodial type of *Gossypium herbaceum*. It is derived as recently mentioned by Burns (1931) from a hybrid, the original parents of which in the cross made by Gammie were

Goghari, a high-ginning short stapled variety of *G. herbaceum* and Kumpta—the *G. herbaceum* of the Southern Mahratta Country and was named 1027. By further selection, two types were evolved and were called 1027A long and coarse and 1027A long and fine. The final work was done by Patel, Cotton Breeder at the Agricultural Station, Surat, from the year 1917. Since 1919-20, three selections have been grown pure by selfing and one of these selections, the sub-type 1027 A.L.F., is now being extensively grown. The purity of this cotton is maintained by an organisation which provides for the supply of pure seed from the Agricultural Station, Surat, and by prohibiting the entry of cotton from outside the tract by legislative measures.

The cotton crop is grown in rotation with the cereal crop of jowar (*Andropogon sorghum*); the latter is grown either singly or with a sprinkling of *tur* (*Cajanus indicus*), a pulse crop of India. In certain localities and particularly in low lying areas, wheat is grown in the cold season, and in few cases, sesamum replaces jowar in the rotation. Jowar stubble which is unusually tall, being about 2 to 2½ feet in height, is removed and the land is harrowed once or twice in April and May as a preparatory tillage before rains. Farm yard manure is applied, according to its availability, in the cotton year. Usually from five to ten cartloads (about 2½ to 5 tons) of this manure are given per acre. The manure is carted to the field and dumped in heaps at convenient distances and is then broadcast as evenly as possible.

Sowing of cotton is generally done in the last week of June or early in July, when sufficient rain to form a good seedbed has fallen.

Being covered with fuzz and short hairs, cotton seeds get entangled. They are, therefore, required to be treated before sowing so that the fuzz and the linters are either removed or glued down to the seed. The local practice is to dip the seed in a mixture of cowdung and water and then rub it against coir mattress of a country cot and pass seed through it. The seeds thus get perfectly separated and they no longer cling together.

In sowing, the seed is dropped into the soil through a two coultered drill of twenty-four inches width and covered over by a plank harrow. From ten to fifteen lbs. of seed is required per acre. Of late, however, there has been a tendency of wider sowing and also of dibbling the seed by hand. The rows are spaced about four feet apart and if dibbled, the spacing given is three feet all round. At the Agricultural Station, Surat, the practice is to sow the seed in dibbles spaced three feet both ways. About eight to ten seeds are dibbled per hole and the seedlings are steadily thinned, leaving finally a single stalk to grow per hill.

The seed germinates and the shoot shows itself above ground after three or four days, depending on its position in the soil. Due to its hard coat and fuzzy surface, the cotton seed must be surrounded with enough moisture for germination. If this happens to be lacking either due to inadequate rains after sowing, or to the quick drying of the soil by the commonly prevalent heavy winds or to the seed lying shallow in the soil, a number of seeds fail to germinate. One of the reasons of using more seeds per hill is to provide for such mishaps. Excess of moisture is also harmful and if sowing is followed by heavy rains, germination fails owing to rotting of the seed and the fields are then required to be resown. In years of abnormally heavy and continuous rainfall, sowing even for the third time becomes necessary. In low-lying areas, sowing is for this reason often delayed up to August and in some years even up to September.

After successful germination, the young seedlings have to pass through a period of adverse conditions. If overtaken by continuous and heavy rains, many of them succumb to water stagnation. The high winds of July and part of August prove another adverse factor arresting the growth of seedlings. Young seedlings are also often damaged by insects like the cricket. The result is that in spite of sowing a large number of seeds per dibble, a number of gaps are still noticed. In the south Broach tract, the most critical part in raising of the cotton crop, is the germination of seed and the establishment of the seedlings. Progressive farmers are steadily following the lead given by the Agricultural Station, Surat, in respect of dibbling the seed on small ridges to overcome the effects of water stagnation.

During August, when rains become lighter, it becomes possible to commence interculturing operations and one or two hoeings with bullock-drawn blade hoes are given. The fields are also hand-weeded once. In normal years the surface of the soil dries up quickly under the influence of the blowing winds, making it possible to interculture the fields with bullock-drawn implements, even during small intervals of four or six days between two rainy periods.

In September, interculturing is repeated two to four times, the last one being carried out with a heavy type of blade harrow which penetrates the soil to a depth of about 3 to 4 inches. The fields are again hand-weeded in this month. The small ridges are now broken in cross intertillage. In years of continued late rains, the September operations are delayed and are finished at the earliest opportunity in October. Interculturing is completed for the season by running a small wooden plough between the rows which penetrates to a depth of about four to five inches. The crop needs no further cultivation or attention till the time of harvest.

On account of the adverse conditions both of the soil and the weather, caused by wet-conditions, high winds and absence of sunshine, the growth of the seedlings is arrested during July and August. Growth gets accelerated some time in September or even as late as October and then the plant grows rapidly and produces the bulk of its total expanse during the months of October, November and the first half of December. It is about the first week of September, when the plant is still progressing slowly in its development, that the first fruiting branch arrives on the main-stem. Flowerbud production continues and attains high magnitudes as the plant expands during October to December. These begin to bloom into flowers from mid-November, reaching the maximum rate of flowering some time in December. Flowering ceases by about the end of January. Bolls develop during December to February and the crop becomes ready for harvest in March. Cotton is generally picked in three lots at intervals of about a fortnight each. About sixty per cent. of the crop is removed in the first picking. The produce of the last lot is generally of a poor quality comprising the late and under-developed bolls.

PESTS AND DISEASES.

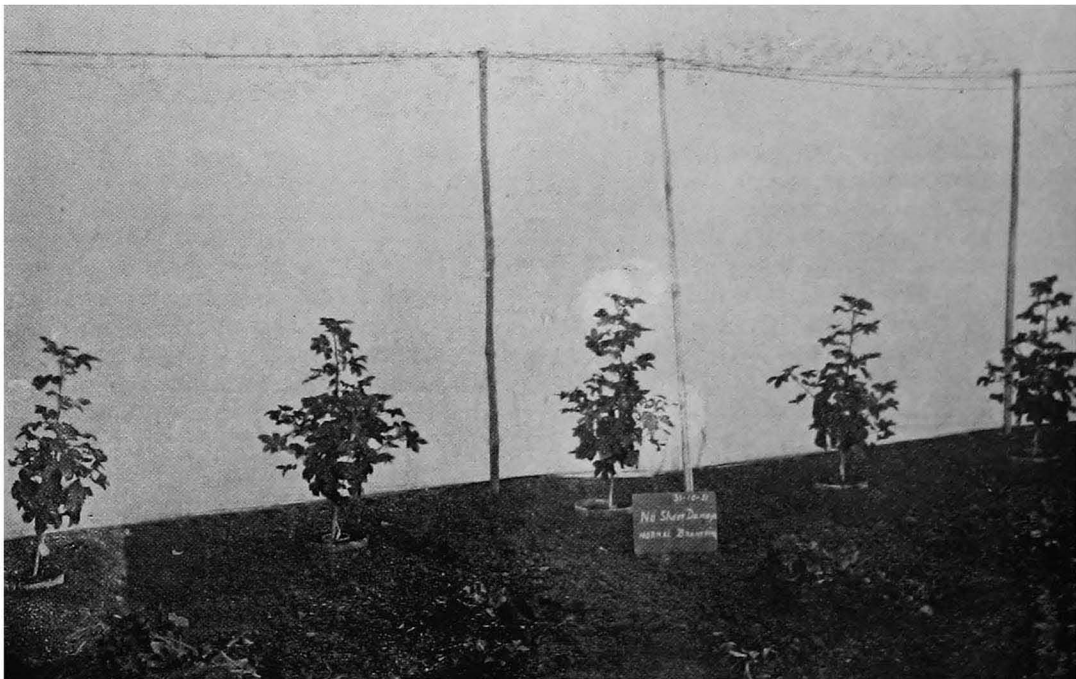
The normal growth behaviour of the plant in this tract is, however, greatly disturbed by the damage of an insect which is a contemporary organism associated with the cotton plant. It is popularly known as the Spotted Boll-Worm and is identified as *Earias fabia* and *Earias insulana*. This insect begins to grow in its population as more food becomes available. In its early broods, it mainly feeds on the tender shoots both on the main stem as well as on the branches. As flower-buds become available it transfers itself to those organs. Ultimately with the

PLATE NO. 1.

Plants damaged by the spotted boll-worm.



Plants not damaged by the spotted boll-worm



availability of flowers and young bolls they are also attacked. The spotted boll-worm is an important environment of the cotton plant in this locality and has called for considerable attention in regard to the effects of its damage to shoots, flower-buds, flowers and bolls in parts to follow.

The result of the damage by this pest is not destructive to the plant as a whole as happens in the cases of the stem-borer and wilt. Damage to shoots deforms the plant scaffolding and causes variation in the manner of branching and final form. (Plate No. 1.) Damage to flower-buds results in their shedding and thereby prolonging plant-growth and delaying flowering and harvest of the crop. Bolls injured by the caterpillars of the pest also shed in young stage. Older bolls when damaged, are retained on the plant but the injury results in destroying the produce of one or more loculi of the affected boll. The total effect of the damage by this insect is to lower the yield of the crop varying from twenty to fifty per cent, depending on the degree of infestation and the period of its activity. Normally, the population of the insect rapidly declines from mid-December, either owing to severe cold that sets in or, as is believed, to the attack of some parasites.

There is another boll-worm that is almost of annual occurrence. This is popularly known as the pink boll-worm (*Platyedra gossypiella*-Saund). The pest appears late in the season when bolls are forming and feeds on the seeds and is responsible for staining the lint yellow.

The shoot roller (*Phycita infusella*-Meyr) is another insect, which prevails from July to September. The insect rolls up the leaves of the shoot and destroys the young growing bud. The result is that the main axis of the plant gets pruned at this point.

Other insects that are prevalent on cotton in this tract are the aphides, dusky cotton bug (*Oxyceraenus laetus*, Kirby), red cotton bug (*Dysdercus cingulatus*, Fabr), woolly mite (*Eriophyes gossypii*) and the stem-borer (*Spenoptera gossypii*). All these do some amount of damage but their incidence is not high. The aphides are generally kept under control by their natural enemy, the lady-bird beetle. The dusky cotton bug appears on bolls that open prematurely and sucks up the contents of the seed. The red cotton bug feeds generally on the green and ripe bolls by sucking out the juice. The woolly mite prevails from August to December and the leaves of the affected plants become ashy white in appearance. (Thakar and Desai—1929.) On this account the pest is locally known by the vernacular name of "Chhasio" meaning thereby, white as butter-milk. The stem-borer is found in the stem at the level of the soil and the whole plant wilts as a result of its damage. The number of plants that fall victim to this insect is generally insignificant.

Among diseases, wilt (*Fusarium* spp) is by far the most severe but its ravages are restricted to the Broach tract, north of the river Nerbudda. It is not a serious trouble in the Surat tract. Dwarfing of leaves is another disease that is noticed here and there in cotton fields but its incidence is negligible.

SUMMARY.

This chapter gives a brief history of the origin of the cotton plant under study and describes the soil, aërial and biological environment in which it is grown and the method of raising the crop. Ample evidence is cited to show that the soils in the Broach cotton tract have a fine texture and are deep, homogeneous and retentive of moisture. It is suggested that they are most suited for deep-rooted crops like cotton which depend entirely on moisture reserves of the soil. A short account of the agricultural chemistry of these soils is given to show that they manifest no unusual deficiency of any of the mineral ingredients required by the plant except the organic matter and the resulting nitric nitrogen.

Data on soil temperatures and on climatic factors such as air temperature, humidity, wind velocity and the desiccating power of the atmosphere are presented.

Insects which grow contemporaneously with the plant and feed upon it are mentioned and a short description of each is given. Among these insects, the spotted boll-worm is the most serious and damage done by it to shoots, flower-buds and bolls is emphasised.

CHAPTER III.

DEVELOPMENT OF THE COTTON PLANT UNDER CROP CONDITIONS.

It may be recalled that cotton is sown towards the end of June or early in July when the soil becomes sufficiently moist to form a good seed-bed and that about ten seeds are dibbled per hill. Within four to five days from sowing, shoots come above ground and when the seedlings get a firm footing in the soil, they are thinned from time to time. Thinning operations, though often delayed owing to wet conditions of the soil, normally extend over the months of July and August. In some years, however, the last thinning is required to be postponed to even as late a period as the end of September. The first thinning is done when the seedling produces about three leaves at which stage four to five plants are retained per hole. When from five to six leaves are produced, the second thinning is carried out leaving about three seedlings per hole. The third thinning is generally the final and this is done when the growth extends to about ten nodes on the main axis. This time, only one plant is left per hole.

In this way, out of a number of seedlings, only the best and the most promising happens to be ultimately retained and allowed to carry on further growth till the time of crop maturity. It is on these plants that the studies incorporated in this volume have been carried out. The dates of sowing and thinning for a period of eight years are embodied in the following table.

TABLE NO. 10.
Dates of sowing and thinning for a period of eight years.

Year.	Date of sowing.	Date of thinning.			
		I.	II.	III.	IV.
1924 ..	28th June.	21st July.	4th September.	..	..
1925 ..	3rd July.	26th July.	6th August.	27th August.	..
1926 ..	4th July.	2nd August.	21st August.	24th September.	..
1927 ..	2nd July.	12th July.	20th July.	17th August.	27th August.
1928 ..	7th July.	23rd July.	9th August.	18th August.	23rd August.
1929 ..	15th July.*	31st July.	12th August.	26th August.	..
1930 ..	26th June.	18th July.	2nd August.	26th August.	..
1931 ..	2nd July.	23rd July.	22nd August.	1st September.	10th September.

* Resowing was required to be done owing to heavy rains that followed the first sowing done on 25th June.

The dates chosen for the commencement of our studies entirely depended on the last date of the thinning and the accessibility of the fields. On this account, the data on the growth of the cotton plant during the interval between the time of germination and the commencement of our studies in September to October, are wanting. Nevertheless, it will be evident from the records maintained after this period that the amount of growth put forth by the seedlings in this interval is extremely small,

A. DEVELOPMENT OF THE ROOT SYSTEM.

The study of the root system presents many difficulties. In the first place, it cannot be confined to the same plant throughout the season, as in the process of excavation the plant is destroyed. This involves a frequent change of plants under study. Error due to variations in sampling, therefore, usually occurs which could only be minimised by taking a large number of plants for excavation every time. This is, however, not possible as the task of exposing the entire root system of a plant like the Broach cotton, which spreads its roots deep and wide, is very laborious and time-taking. Secondly, it is exceedingly difficult if not impossible to secure all the finer roots which take part in the physiological process of absorption.

In view of these difficulties, present methods of excavation are anything but perfect, and give only a qualitative knowledge of root growth during the crop season. Our studies in this field have, therefore, suffered a good deal under these handicaps; nevertheless, they have enabled us to understand the inter-relation existing between the growth of the root and shoot.

(a) Method of sampling.

About 100 plants were ear-marked in a comparatively big plot for purposes of root study. These plants were situated at a distance of fifteen feet from one another. This distance was maintained in all years to avoid the undesirable effect of water used for facilitating root excavation, on the neighbouring plants meant for this study. A specimen arrangement of these plants is shown in the following diagram :—

DIAGRAM NO. 1.

Specimen arrangement of plants earmarked for root study.

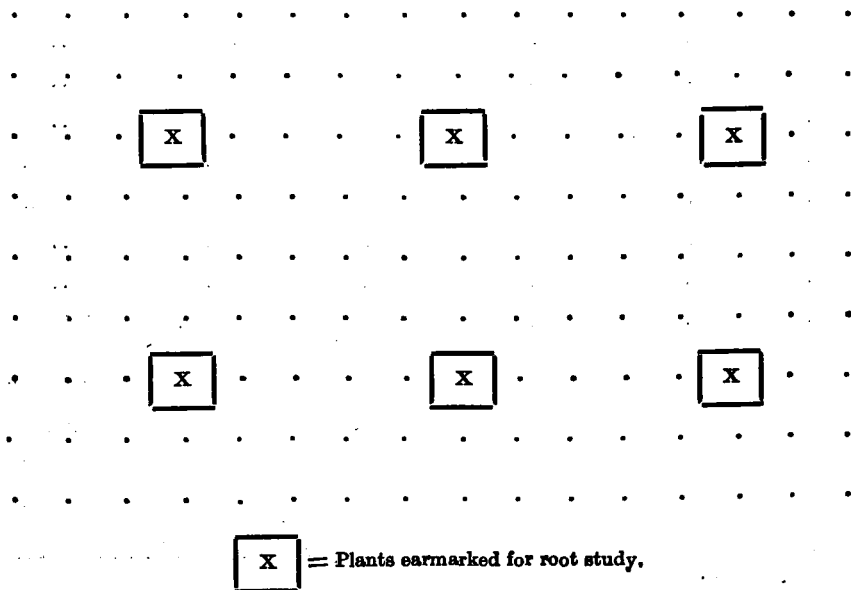


PLATE NO. 2.

Method of tracing a root-lateral.



It has been our experience in earlier years that in the selection of representative plants for this study or any study in fact, errors due to personal factor are invariably introduced. These were, however, reduced to a minimum value by the process of randomising. This was effected by numbering the plants set aside for this work from which plants for root excavation were taken by lot-drawing. Sometimes, either a very poor or a vigorous plant may appear in this selection. In such cases, it has been our practice to reject it altogether and select another immediately in its neighbourhood.

(b) *Method of excavating the root system and of recording the root data.*

The method of exposing the root system by washing with a jet, followed by Howard (1925) and other earlier workers, is not suited to conditions of the soil in this tract, which is clayey and extremely sticky. It does not, therefore, easily yield to washing with a jet. The trench system recommended by Weaver (1926) is also not entirely applicable here, as it is difficult to estimate the distance between the plant and the trench. We have, therefore, modified these methods to suit our conditions.

After a number of trials, it was found that the best way of exposing the root system and of procuring the maximum number of finer roots, was to water the plant profusely about sixteen hours prior to excavation. This is done by scraping the soil into a ridge running round the plant with a radius of about four feet. Water is then poured into it, the previous evening and allowed to percolate into the soil till the next morning when the root excavation is started. This softens the soil and facilitates its easy removal both by hand and the hand-tools without much loss of finer roots.

The soft surface of the soil is first removed until about four to six laterals are struck. The uppermost branch is then carefully disentangled from the adhering earth and gradually traced to its extremity with the aid of hand-tools. During this process, measurements of its length, its depth of origin on tap-root, depth of its extremity, positions of the roots of higher orders arising from it, direction of growth, etc., are recorded from time to time in a register specially designed for the purpose. The different entries made in this regard are all shown in the two specimen pages reproduced in Table Nos. 42 and 43 in the Appendix. When all the details of any one branch are recorded, it is cut off from the tap-root (Plate No. 2). The next branch is then taken up and similarly traced. In this way, all the laterals are separately exposed and their details recorded. Finally, the tap-root is removed with as much care and patience as is exercised in the previous cases. It may be mentioned that breakages do occur during the process of excavation but broken parts are easily linked up by a practised hand. The roots removed from time to time are collected in a metallic container for recording their dry weight.

It is necessary to point out that in the latter part of the season many rootlets shrink and die and are, therefore, lost during excavation. On this account lower values are frequently obtained for progressive figures of the rootlets in this part of the season.

Such critical study of the root system is a task of no small magnitude. Even with trained hands, it is difficult to excavate more than one or two root systems per day during the earlier days of growth. Later, when the plant attains its full stature, increasing difficulties are encountered and only four systems can be removed

per week. The results of the week are then put together and their average values are recorded against the central date of that week.

These figures, therefore, give only a rough idea of periodical development of the roots and their downward movement in the lower reaches of the soil. Hence, they are the nearest approximation to the actual values and will have to be interpreted with sufficient caution.

(c) *General structure of the root system.*

With a spacing of three feet by three feet, the plant under study produces a fairly deep and extensive root system. It reaches the depth of about 150 cms. and spreads laterally over a distance varying between 100 to 150 cms. It consists of the tap-root and a number of primary, secondary, tertiary and quaternary branches which differ both in number and dimensions.

A large proportion of the primary branches arise on the tap-root within a comparatively short distance of about thirty cms. from the surface of the soil. After growing horizontally to varying distances, they bend obliquely and then descend vertically to varying depths. A few of these, however, penetrate the soil to a depth reached by the tap-root. As they grow, they give rise to branches of

FIGURE No. 5.

Tapering of the tap-root below the zone of the primary branches.

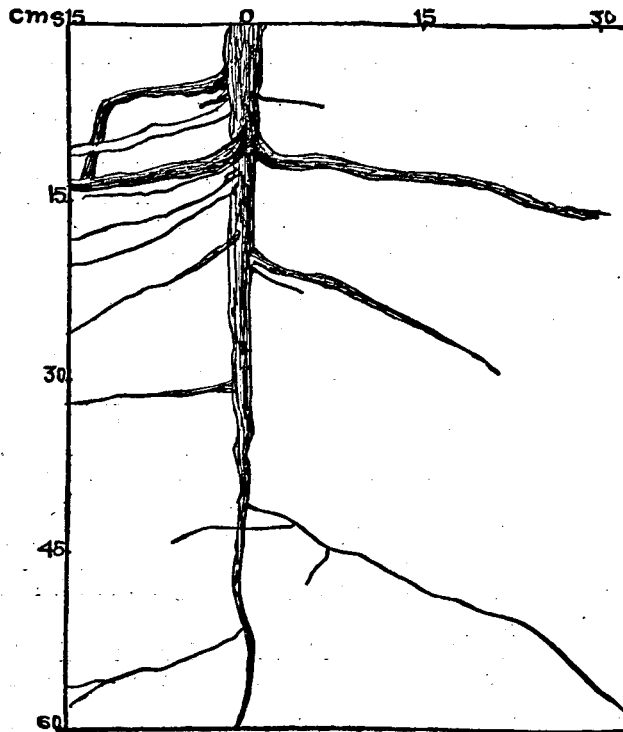


PLATE No. 3.

A typical root system exposed in situ.



the second order and they, in their turn, to branches of the third order and so forth. The newly formed roots spread in different directions and at different levels in the soil. Thus, the whole root system of the cotton plant occupies a very large volume of the soil. (Plate No. 3.)

(d) *Development of the tap-root.*

The tap-root, after penetrating the soil for some distance, gives rise to lateral branches which for the most part are crowded within the distance of about thirty cms. from the soil surface. On this account, it is comparatively very thick up to this depth. Just below this zone, it suddenly tapers and is then only as thick as some of the primary branches. (Figure No. 5.) Indeed, below this level, it could hardly be distinguished from the laterals unless by its central position. But even this distinction proves to be of no avail if one of the laterals gets as strong and runs parallel to it. (Figure No. 6.)

FIGURE NO. 6.

A root branch as strong as and running parallel to the tap-root.

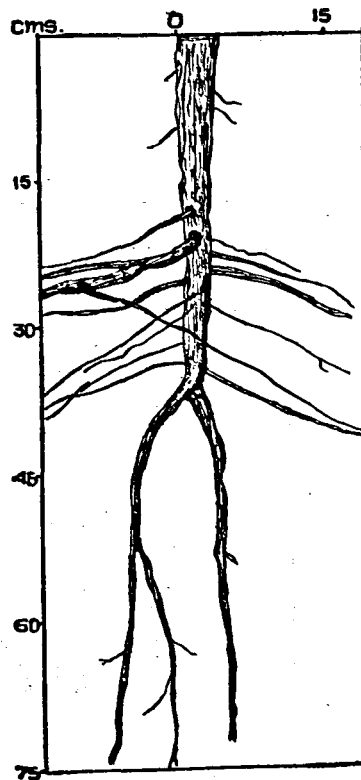


FIGURE No. 7.

The tap-root greatly diverted to one side.

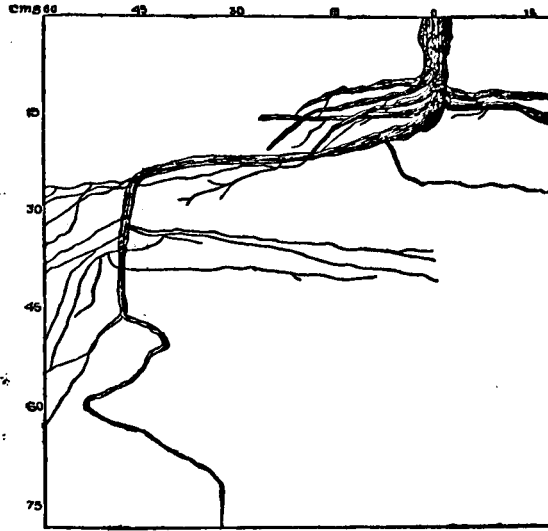
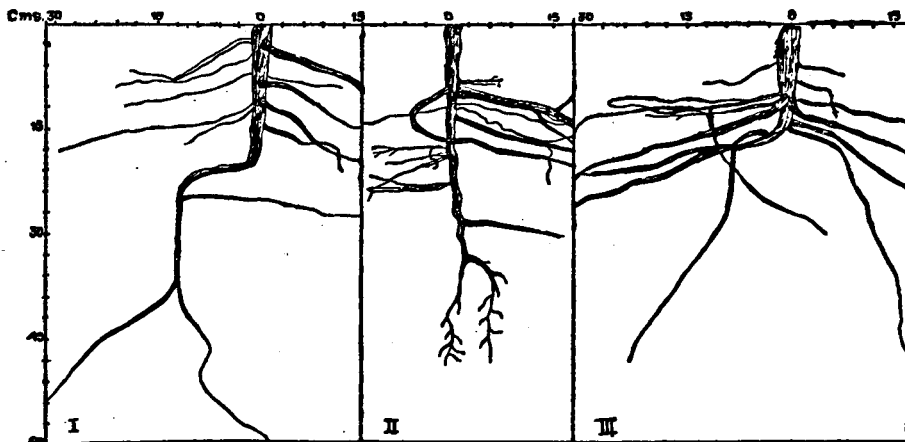


FIGURE No. 8. (I, II and III).

The tap-root and its branches.

(See the laterals on the tap-root, concentrated in the first 30 cms. depth.)



Diameter of the tap-root at the surface of the soil varies in different years from 1.2 to 1.8 cms. (Table No. 44 in the Appendix). This is its maximum diameter in the season and is attained towards the beginning of the flowering period.

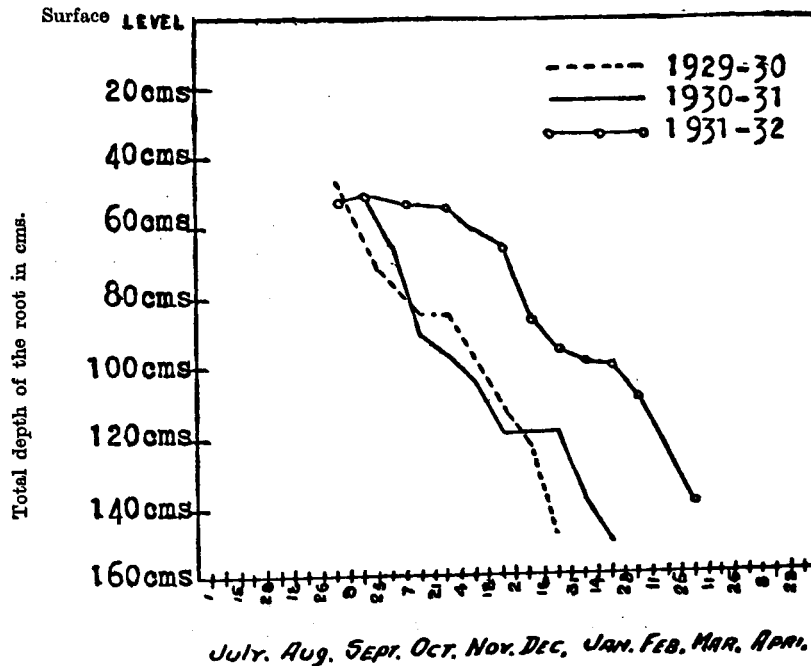
The downward movement of the tap-root is several times deflected, if any obstructing material happens to lie in its way. In such cases, it bends and again takes a vertically downward course. (Figure Nos. 7 and 8-I.) Occasionally, the bend is very sharp and the root gets deflected from its normal position (Figure No. 8-III). At times, it is damaged in its downward career and a lateral branch immediately above the point of damage grows in thickness and looks like the tap-root. In other cases, the tap-root shows a pseudobifurcation caused by the parallel development of the lowermost primary branch (Figure No. 8-II).

The rate of downward march of the tap-root differs in different years (Graph No. 16 and Table No. 45 in the Appendix). Till about the middle of September, it grows to a depth of forty-five to fifty cms. After this period, the rate of growth

GRAPH No. 16.

Depth in centimeters reached by the tap-root in different years.

(Average of 4 to 5 plants.)



varies considerably. The depth reached by it at the end of the season in different years, is about 150 cms. and varies within a narrow range of only eleven cms. In individual cases, sometimes, it has been found to penetrate the soil to a depth of 210 to 240 cms.

Root studies were also carried out in the years 1926-27 and 1928-29 in plots situated away from the area used for this purpose in the succeeding years. In 1926-27 the maximum depth reached by the tap-root was 187 cms. and in 1928-29 it was 127 cms. only.

The length of the tap-root always exceeds its depth (Table No. 46 in the Appendix). The reason is that the tap-root bends at several places during its downward course and thus increases in length.

(e) *Roots of the first order.*

Out of the fifty to sixty lateral branches which arise on the tap-root by about the end of October, about twenty grow (Table No. 11), and form the scaffolding of the root system. The rest of the branches do not elongate to an appreciable extent and do not therefore add much to the general frame-work of the root system.

TABLE No. 11.

Number of primary roots on the tap-root.

(Average of 4 to 5 plants.)

Period ending.	1929-30.			1930-31.			1931-32.		
	Large.	Small.	Total.	Large.	Small.	Total.	Large.	Small.	Total.
30th September	13	25	38	11	24	35	..	..	..
14th October	12	42	54	15	34	49	..	..	..
28th October	15	42	57	23	33	56	13	29	42
14th November	16	42	58	20	31	51	17	29	46
25th November	16	45	61	25	35	60	21	30	51
9th December	17	29	46	24	33	57	23	30	53

(For fuller details, see table No. 47 in the Appendix.)

Most of the large laterals originate within the depth of thirty cms. from the soil surface (Table No. 12). The density of the primary roots abruptly falls below this level.

TABLE No. 12.
Number of primary roots on the tap-root.
 (Average of 4 to 5 plants.)

Distance below the surface of the soil. cms.	1929-30.	1930-31.	1931-32.
	Count taken in December when the production of branches ceases.		
0 to 5	0.6	2.8	..
6 to 10	4.6	4.0	6.6
11 to 15	3.6	4.8	3.6
16 to 20	2.4	2.8	2.6
21 to 25	1.6	2.2	3.8
26 to 30	1.2	0.8	3.2
31 to 35	0.6	0.8	0.8
below 35	2.6	6.2	2.8
Total ..	17.2	24.4	23.4

The fully developed primary roots, especially those nearer the soil surface, grow horizontally to various distances on all sides of the plant. The expanse increases with advance of plant growth and after about the end of November very little lateral extension takes place (Table No. 13). The roots after the close of the monsoon bend obliquely and ultimately take to vertically downward course in the soil and thus put a limit to their horizontal spread.

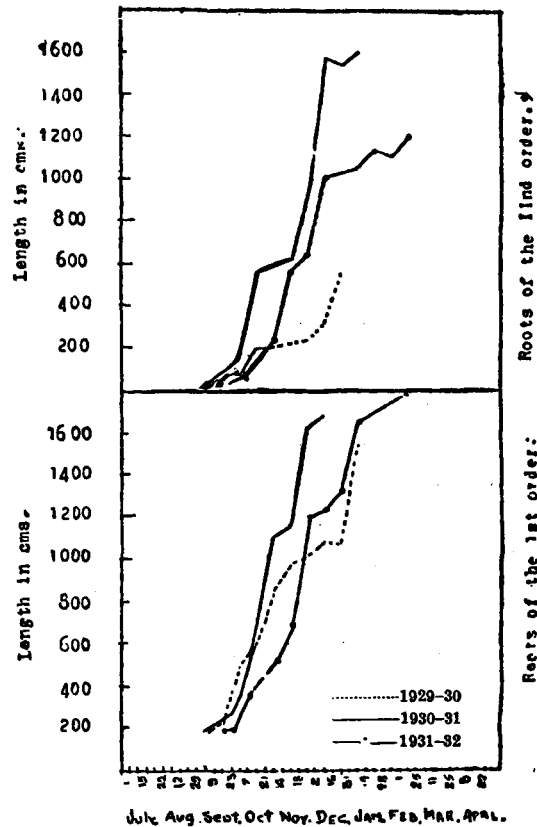
TABLE No. 13.
Horizontal spread of root-laterals.

Period.	1926-27. cms.	1928-29. cms.	1929-30. cms.
End of August .. .. .	..	55	..
End of September .. .. .	..	90	40
End of October	81	143	92
End of November	120	175	108
End of December	160	166	116

Although the production of roots of the first order practically ceases by about the end of October, their elongation and increase in thickness continue till about the end of December. This is evident from the periodical total length of all large

GRAPH No. 17.

Total length in cms. of large roots of the first and second orders.



roots belonging to this order (Graph No. 17 and Table No. 48 in the Appendix). Their total length during the course of development varies a good deal from season to season. Thus in 1931, their elongation was delayed. The same thing also happened this year in the case of the tap-root. The total length towards the end of the season, however, was fairly constant in all the years.

(f) *Roots of the second order.*

Roots of the first order give rise to those of the second order. Their total production varies widely from 350 to 500 in different years and remains in progress till as late as the end of December (Table No. 14 and Table No. 49 in the Appendix). Like the primary roots, all the roots of this order do not develop to the same extent. Only a few (from eleven to thirty-five) of these grow large enough and give rise to roots of the third order.

TABLE No. 14.
Number of the roots of the second order.

Period ending.	1929-30.		1930-31.		1931-32.	
	Large.	Small.	Large.	Small.	Large.	Small.
30th September.. ..	2	202	7	94	..	..
14th October	4	232	15	161	..	..
28th October	4	243	14	256	7	103
11th November	5	258	17	188	17	219
25th November	5	222	26	287	24	237
9th December	7	263	35	267	30	274
23rd December	11	282	32	316	29	241
6th January	6	468	..	..	34	316

The total length of large roots varies from 550 to 1,600 cms. (Graph No. 17 and Table No. 50 in the Appendix.) Their growth, both in length and thickness, practically ceases in the latter part of December.

The most important point to be noted in this order is the magnitude of production of small roots. Although they do not develop and produce further framework, they are nevertheless very important in as much as they have, at one time or another, assisted the plant in the process of absorption. Just as the roots of the first order build up the frame-work of the root system, roots of the second order constitute its absorbing surface.

(g) *Roots of the third order.*

Roots of the third order arise on the roots of the second. Their production continues till about the third week of January. (Table No. 15.*) Compared with the roots of the second order, the total number of these roots is very small though it considerably exceeds that of the first. The importance of these roots lies in

TABLE No. 15.
Average number of roots of the third order.
(Average of 4 to 5 plants.)

Period ending.	1929-30.		1930-31.		1931-32.	
	Large.	Small.	Large.	Small.	Large.	Small.
30th September.. ..	..	25	1	32	..	..
14th October .. ..	..	67	3	136	..	..
28th October .. ..	..	38	2	96	..	38
11th November .. ..	..	62	3	93	2	118
25th November .. ..	..	53	7	118	4	97
9th December .. ..	..	85	8	206	3	177
23th December	1	113	3	195	4	104
6th January .. ..	..	94	9	164	3	136
20th January	1	114	5	236	5	165

the fact that they are comparatively young and add materially to the absorbing surface specially during the later stages of boll development.

* For fuller details, see table No. 51 in the appendix. For lengths of the roots of the 3rd order see table No. 52 in the appendix.

Roots of the fourth order are generally very small in number (Table Nos. 53 and 54 in the Appendix). None of them ever grow large enough to give rise to roots of higher orders. Due to their late arrivals, they are of immense use to the plant.

(h) *Total number of roots of all orders.*

Although no data were collected during the seedling phase, the total number of roots of various orders produced till the end of September indicates that the root system is active during all this time and comprises 150 to 250 small and large branches. The production of these roots extends over a period of six months (Table No. 16 below and No. 55 in the Appendix). By about the end of December to the latter half of January, both their production and increase in their length (Appendix Table No. 56), practically ceases. Growth of the tap-root in regard to its length also stops by this time.

TABLE No. 16.
Total production of roots in different years.

Period ending.	1929-30.			1930-31.			1931-32.		
	Large.	Small.	Total.	Large.	Small.	Total.	Large.	Small.	Total.
30th Sep- tember ..	15	251	266	19	151	170	..	..	..
14th Octo- ber ..	16	344	360	33	353	386	..	..	..
28th Octo- ber ..	19	323	342	39	398	437	21	174	195
11th Novem- ber ..	22	361	383	40	319	359	35	376	411
25th Novem- ber ..	21	320	341	58	464	522	50	378	428
9th Decem- ber ..	24	380	404	68	529	597	57	499	556
23th Decem- ber ..	28	438	466	56	586	642	55	386	441
7th Janu- ary ..	27	617	644	61	480	541	65	492	557
21st January	30	584	614	59	613	672	59	501	560
3rd Febru- ary ..	32	638	670	52	581	633	50	409	459

The number of roots produced during the season oscillates between 550 to 650 and denotes to some extent the absorbing surface. Out of these, from thirty to sixty grow in length and thickness. On this account, they constitute both the frame-work and conducting channels of the root system. Their total length varies widely from 1,900 to 3,600 cms. (Graph No. 18). The rest of the roots are spread over all this length.

It appears, therefore, rather difficult to ascertain precisely the soil zone in which the majority of the roots feeds. It will, however, be evident from the figures of root-tips (Table No. 17) of the large laterals, that this zone lies between the depth of ten to forty cms.

GRAPH No. 18.

Total length of the large roots of all orders put together.

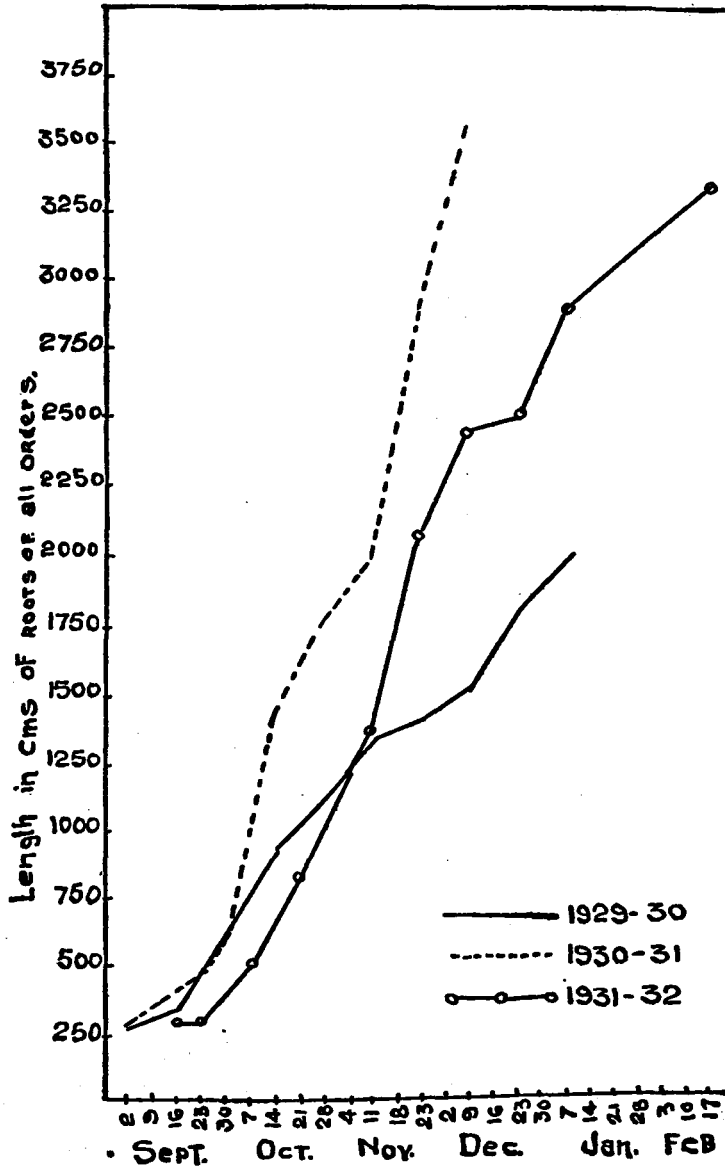


TABLE NO. 17.

Percentage of the total number of tips of large root branches found in different layers.

Soil layers in cms.	Percentage of the total number of root-tips of large branches.		
	1929-30.	1930-31.	1931-32.
0-10	2.8	3.3	2.3
11-20	20.5	25.9	17.5
21-30	23.8	18.5	20.0
31-40	15.5	10.0	14.9
41-50	9.3	6.8	10.1
51-60	6.2	6.4	7.5
61-70	5.1	5.3	7.0
71-80	3.0	4.1	6.1
81-90	3.1	4.7	5.4
91-100	3.8	5.8	4.6
101-110	1.9	3.2	2.2
111-120	2.8	2.3	1.6
Below 120	2.2	3.7	0.8

Below the depth of forty cms., the density appreciably dwindles. Thus, about sixty per cent. of large laterals of whatever order, are confined to a depth of forty cms., while the remaining forty per cent. are spread over the rest of the depth which exceeds 120 cms. As the small roots or rootlets originate from these roots over the whole of their length, the general distribution of the total roots formed becomes at once evident.

From the foregoing, it will be apparent that the root system of the cotton plant under normal conditions is deep and extensive and on this account occupies a very large volume of the soil. Further, the feeding zone of the greater part of roots lies within the shallow depth of forty cms.

B. DEVELOPMENT OF THE SHOOT.

The shoot grows monopodially and gives rise to leaves in acropetal order. It produces two kinds of branches, the monopodia or vegetative branches and the sympodia or fruiting branches. Monopodial branches arise from axillary position and the sympodia spring up from extra-axillary position.

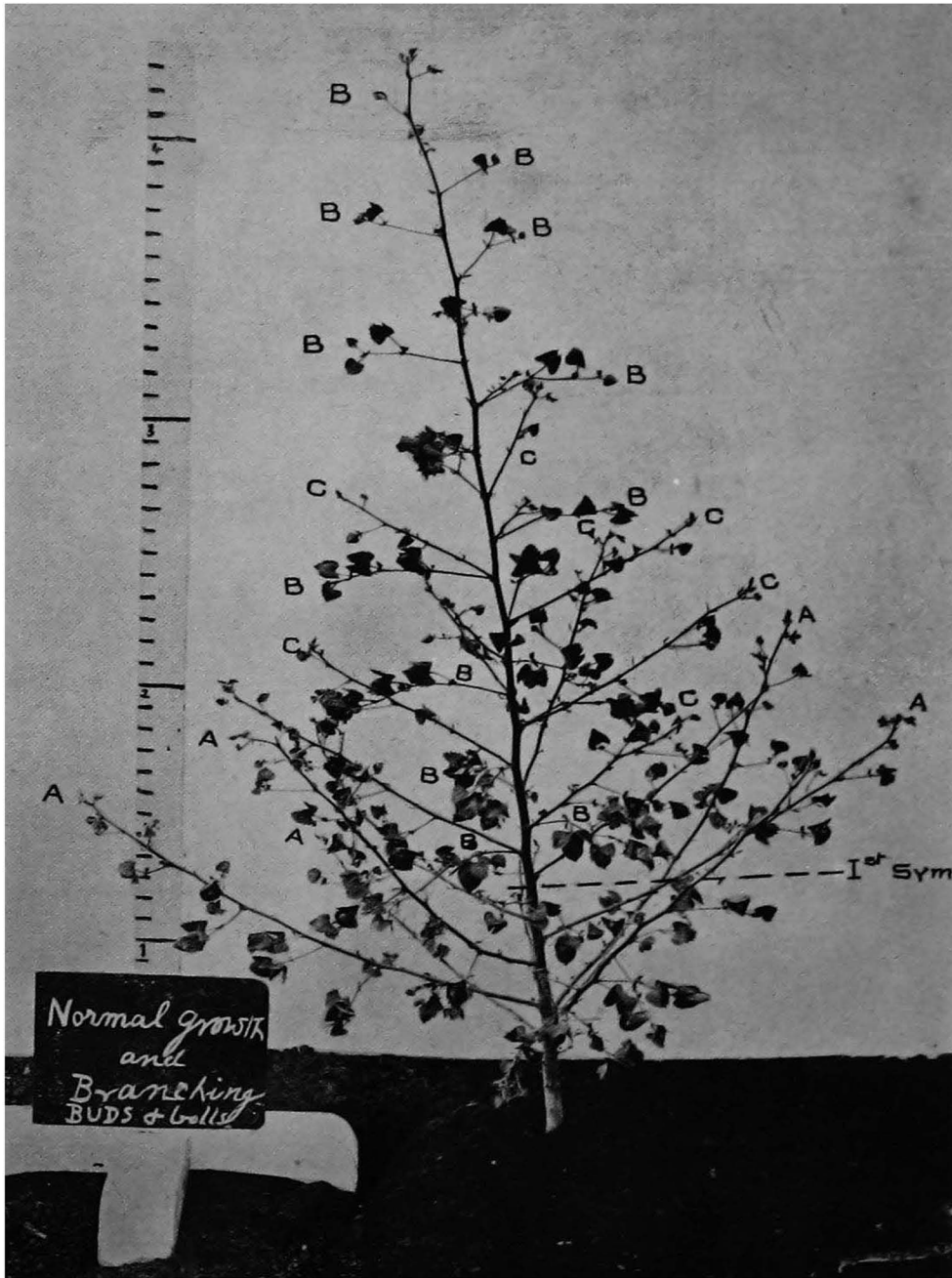
(a) *The stem and its system of branching.*

The first sympodial branch arises from a definite node on the main stem, which varies in different species. (Leake 1909.) Branches arising below this node always grow monopodially and are known as limbs. Once the sympodial branch arises, the

PLATE NO. 4.

BRANCHES IN COTTON.

The plant defoliated to show the three types of branching.
(The organs on the branches are buds and bolls.)



A. = Monopodia or limbs.
B. = Sympodia.
C. = Auxiliary branches.

system of branching is altered. Hereafter, all the successive nodes give rise to sympodial branches, though the production of monopodia continues to a few more nodes. The monopodial branches arising along with the sympodia from the same node are called auxiliary branches, in contrast to the limbs which are situated below the first fruiting branch (Plate No. 4).

Normally, one branch of one kind is produced at each node. Sometimes two branches of the same kind may arise from the same node. The second branch in that case is generally smaller and is called the accessory branch.

Monopodia just behave like the main stem, giving rise to secondary monopodia and to secondary sympodia. In this way, branches of higher orders are produced. The limbs are well developed and generally grow obliquely upwards to a length of about ten to sixteen nodes. The auxiliaries, as they appear later are comparatively small and have seven to nine nodes.

The sympodia on the main stem, grow horizontally to a length of about four to seven nodes, each of which gives rise to a flower-bud. The number of nodes steadily falls with increasing height until at last two to three sympodia at the top are reduced to only one node.

The total number of branches per plant varies over a wider range. In the majority of cases, however, it fluctuates between twenty-two and forty-two (Table No. 18). Plants having less than ten branches and more than fifty are not commonly met with.

TABLE No. 18.
Frequency of plants according to total number of branches.

1923-24.															
Class value of number of branches.	6.5	10.5	14.5	18.5	22.5	26.5	30.5	34.5	38.5	42.5	46.5	50.5	54.5	55.5	Total
Frequency ..	4	3	5	2	11	17	14	17	12	10	3	1	..	..	99
1924-25.															
Frequency ..	..	1	4	2	3	1	5	6	6	6	7	5	3	1	50
Year.	Mean.	S.E. of mean													
1923-24.	29.85	1.00													
1924-25.	36.9	1.75													

All the auxiliaries and the limbs are not effective* (in the sense of producing at least one flower-bud). The lowest one or two limbs are very small and hence not effective. It is only the upper limbs and the lower auxiliaries that generally give rise to flower-buds.

On an average, the plant produces seven effective limbs, seven effective auxiliaries and ten sympodia (Table No. 57 in the Appendix). The number of each of these branches varies considerably from season to season and also from species to species. Patel (1924) studied the behaviour of this character on this cotton from 1919 to 1921 and found the number of limbs per plant was six in the first year, seven in the second year and seven to eight in the third year. The fact that the number of effective limbs is constant from season to season, indicates that the damage done to the main shoot by the boll-worm generally occurs above the zone of the limbs. The number of the sympodia and auxiliaries, however, varies from plant to plant depending upon the height at which the main stem happens to be pruned. (Table Nos. 58 and 59 in the Appendix.)

It has been pointed out that the first sympodial branch arises from a definite node on the main axis, which varies within a small range of thirteen to eighteen from season to season and which has been found to be a hereditary character.

TABLE NO. 19.

Mean number of the node at which the first fruiting branch arose on the main stem in different years.

Years.	1923.	1924.	1925.	1926.	1927.	1928.	1929.	1930.	1931.
Number of plants under study.	93	58	8	10	19	18	17	18	11
Mean number of the node on the main stem at which the first sympodial branch appeared.	16.7	17.4	13.4	18.7	16.8	15.3	14.5	16.1	17.8

(Table No. 19). In the majority of cases, it oscillates between sixteen to eighteen. These observations substantiate the findings of Patel (1924) who fixes the range at fourteen to nineteen.

From this study it will be evident that the cotton plant is characterised by a di-morphic system of branching consisting of the monopodia and the sympodia which materially differ from each other in their respective functions as they do in their manner of growth. The monopodia represent the vegetative branches of the plant and give rise to flower-buds after the production of sympodia which directly produce the fruiting forms.

(b) *Growth of the main stem.*

It may be recalled that quite early in the season, when the plants are only fifteen to twenty cms. in height, the shoot-roller appears and feeds upon terminal buds. In so doing, it rolls up the uppermost two or three leaves of the shoot with the result that it withers and its further growth is stopped.

* The word "effective" will be used in this sense hereafter.

The insect continues the damage during August and September. While the shoot-roller is active, the population of the spotted boll-worm steadily increases. The caterpillar of the spotted boll-worm either feeds on young buds or bores its way into the stem through the axil of the second or the third leaf of the shoot and feeds inside. On this account, the portion of the shoot above the point of injury always withers and further growth of the main axis is arrested. The boll-worm is active on shoots of the stem and branches from mid-August to November. During this time most of the plants are attacked in their main axis at one time or another. Under crop conditions, therefore, only a few plants escape damage and grow to their normal height.

As the main stem happens to be damaged at different times in the season, its growth is arrested at different heights (Table No. 20) which vary over a very wide range from five to hundred-and-five cms. The majority of plants—nearly

TABLE NO. 20.
Frequency distribution of plants according to height of the main stem in centimeters, under crop conditions.

1923-24.

Class value. Height in cms.	5	15	25	35	45	55	65	75	85	95	105	115	125	Total.	Mean.	S. E.	
Number of plants	..	1	5	5	7	15	23	18	9	6	7	3	..	..	99	57.3	2.22
Per cent.	..	1.0	5.1	5.1	7.1	15.2	23.2	18.2	9.1	6.1	7.1	3.0	..	..	..	..	..

1924-25.

Number of plants	..	..	1	4	7	2	6	13	9	12	4	1	..	1	60	65.5	2.96
Per cent.	..	..	1.7	6.7	11.7	3.3	10.0	21.7	15.0	20.0	6.7	1.7	..	1.7	..	..	..

seventy per cent—are checked in the growth of their main stem by about the end of October, *i.e.*, within four months after the date of sowing (Table No. 21). The

TABLE NO. 21.
Age of plants in weeks at which the elongation of the stem is arrested.

1923-24.

Number of plants under count.	Weeks from sowing.													Mean.			
	8	9	10	11	12	13	14	15	16	17	18	19	20		21	22	23
99	3	1	5	4	11	20	12	30	7	6	16.6

S. E. of Mean. 0.23

1924-25.

60	1	5	6	5	7	4	9	13	7	1	1	..	1	16.3
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S. E. of Mean. 0.39.

mean height of the stem differs in different years and depends upon the earliness and intensity of the damage. (Table No. 22). In 1923-24, the mean height was 57.8 cms., while in the following year, it was 65.5 cms. In the latter year, the boll-worm appeared rather late and the attack was also less virulent. The mean height of the main stem during the last nine years has varied from 33.8 to 65.5 and the average for all these years works up to 51.6 cms.

TABLE No. 22.

Mean height of the main stem in different years.

Years.	1925-26.	1926-27.	1927-28.	1928-29.	1929-30.	1930-31.	1931-32.
Number of plants under growth study.	10	10	20	20	18	20	20
Mean height in cms. of the main stem.	34.4	58.7	52.3	57.0	52.3	52.5	33.8
Standard error of the mean..	2.03	9.28	2.89	4.44	3.83	3.69	3.12

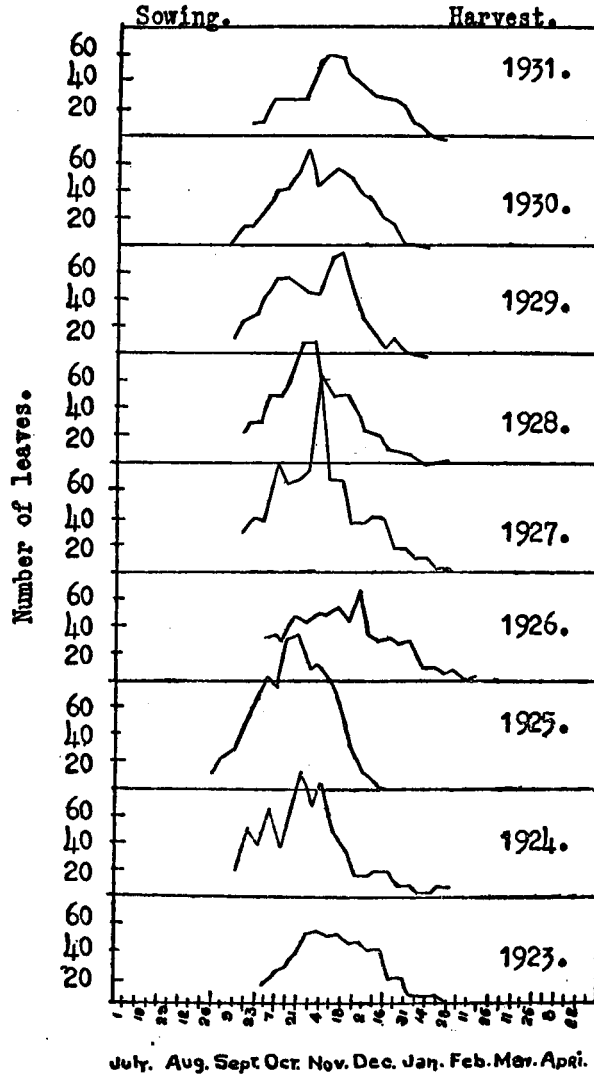
The damage done to the main shoot has its effect upon the production and growth of the later branches. These grow to different lengths depending upon the age at which the stem happens to be arrested in its growth. If attacked at an early stage, the limbs grow more vigorously and the plant presents a more or less truncated appearance; if later, the sympodial and monopodial branches show extra growth and the plant looks cylindrical; if damaged at an intermediate stage, a roundish form is attained. The plant thus assumes different shapes under varying degrees of stimulation (Plate No. 1).

(c) *Leaf production.*

It has already been stated that leaves are produced from the nodes of the stem and branches whether monopodial or sympodial. Their periodical average production per plant for nine years is shown in Graph No. 19 (Table No. 60 in the Appendix). Leaf production begins to rise some time in September and terminates by about the end of December. It is thus in progress for nearly six months from sowing. The most active production, however, occurs during October and November in which nearly seventy per cent. of the total number of leaves on the plant are produced (Table No. 23).

GRAPH No. 19.

The number of leaves produced periodically for nine years.



* During the years 1923-24 to 1927-28 (both inclusive) counts in the latter half of the season were taken fortnightly as due to increased size of the plant, weekly counts could not be coped with. In drawing the curves of those years, the fortnightly counts have been halved to get weekly figures. The same procedure has been followed with regard to the other characters.

TABLE No. 23.
Percentage of the total leaf production in different periods.

Year.	July-Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.
1923-24 ..	Negligible.	5.7	24.3	35.8	26.0	7.4	0.8
1924-25 ..	Do.	13.6	27.6	39.1	12.1	5.2	2.3
1925-26 ..	2.7	16.3	41.0	34.2	5.8	Nil.	Nil.
1926-27 ..	Negligible.	4.8	24.1	30.7	25.5	12.2	2.6
1927-28 ..	Do.	11.0	27.0	38.6	16.3	6.3	0.8
1928-29 ..	Do.	13.7	34.9	34.9	12.7	3.2	0.5
1929-30 ..	3.9	23.7	30.8	34.7	6.8	0.1	..
1930-31 ..	Negligible.	5.7	21.3	36.6	29.6	6.7	0.1
1931-32 ..	Do.	5.4	17.8	35.6	27.3	13.4	0.5
Average ..	0.8	11.6	28.6	35.7	16.9	5.6	0.8

The total number of leaves incepted per plant varies from year to year. (Table No. 24.) Out of the nine years, it is only in 1925-26 and 1927-28 that the record number of 940 per plant is reached. Normally, the total production never goes below 550.

TABLE No. 24.
The number of leaves incepted per plant in different years.

Years.	1923-24.	1924-25.	1925-26.	1926-27.	1927-28.	1928-29.	1929-30.	1930-31.	1931-32.
Number of plants under periodical growth counts.	99	50	10	10	20	20	18	20	20
Average number of leaves per plant.	568	735	945	642	940	734	668	622	575

A mere knowledge of the number of leaves incepted often fails to give a correct idea of the total leaf surface. This is because all the leaves do not grow to the same size. Those produced at different stages, in the same season, differ both in their size and life period. The leaves on the first half of the stem or on any branch, whether monopodial or sympodial, are as a rule larger than those on the second half. The size of the leaf is steadily reduced from the base of the sympodium to its tip.

A more detailed study of leaves incepted at different times was undertaken in the year 1931, in connection with their nitrogen content and its movement during their life period. Leaves of two days' growth situated at the top of the main stem were selected and ticketed on 1st September, 2nd October and 3rd November.

At suitable intervals, about five leaves were removed and their area measured with a planimeter. These measurements were carried out till the leaves came down from the plant. Their age and area, as recorded from time to time, are presented in the following table.

TABLE NO. 25.
Age and area of the leaves incepted at different periods.

Leaves ticketed on					
1st September.		2nd October.		3rd November.	
Age in days.	Sq. Cms.	Age in days.	Sq. Cms.	Age in days.	Sq. Cms.
9	36.50	9	33.98	11	24.90
14	43.27	16	66.45	16	28.31
19	51.98	21	53.30	22	36.55
24	55.08	25	66.98	28	34.40
30	68.56	31	70.90	..	..
35	71.43	35	70.00	35	35.28
40	88.68	43	65.10	40	34.66
47	72.35	50	67.20	47	34.89
..	..	58	76.60	54	35.00
..	..	67	70.00	—	..

These results are indeed very significant. They show that leaves produced towards the beginning of September and October grow more or less to the same size (70 sq. cms.) and are about twice as large as those produced towards the beginning of November (36.5 sq. cms.) Further, the days required for their expansion decrease with the advance in their inception period in season. Leaves of September origin attain their maximum surface extension within a period of thirty-three days; those of October require twenty-seven days. Leaves produced in November require a still shorter period. These develop to their full size in nineteen days.

Of greater interest, however, are the differences in the life periods of these leaves. Those appearing in September and November are short-lived. They grow old and begin to yellow within about fifty days. The October leaves, on the other hand, have a longer career and are evidently more useful to the plant. Their life extends over seventy days.

Similar measurements were made in the year 1930-31. But in their case, only the leaves incepted towards the beginning of October were studied. The maximum expansion attained by these leaves did not exceed fifty-eight sq. cms. This shows in a characteristic manner that the leaves produced even in the same month differ from year to year.

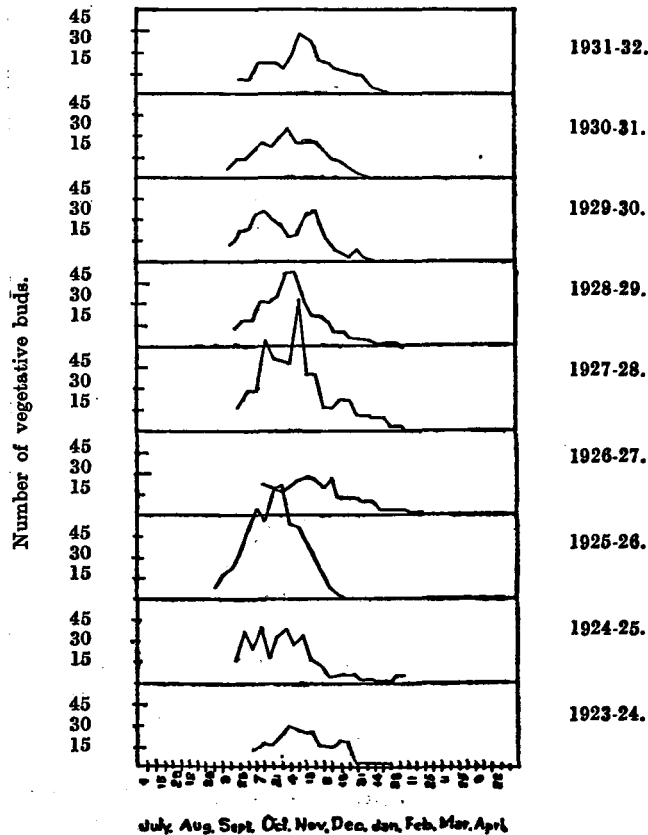
The life span of leaves incepted at different periods has a very important bearing upon the rate of leaf-fall. We have just seen that the October leaves remain on the plant for over eighty days while those in November begin to fall off within fifty days. This means that although the leaves incepted in November are younger, they fall off more or less at the same time as those in October. On this account, the rate of leaf-fall does not correspond with the sequence of leaf inception.

D. PRODUCTION OF VEGETATIVE BUDS.

It has already been stated that every leaf has a bud in its axil which is capable of growing into a vegetative shoot. These buds are therefore called "Vegetative Buds" and their number is represented by the number of leaves on the main stem and various monopodial branches of different orders.

GRAPH NO. 20.

Periodical production of vegetative buds.



Periodical counts were maintained on these buds for a period of nine years (Table No. 61 in the Appendix) and are graphically shown in Graph No. 20.

The nature of the production of vegetative buds is essentially the same as that observed in the case of the leaves. During the first two months from the date of sowing, the rate of inception is almost insignificant. It is, however, accelerated in the month of September and attains a maximum value from the end of October till the middle of November. The production then declines and practically ceases by the end of December, though in years of belated growth it may continue to the middle of January.

The number of vegetative buds give some idea about the expanse of the vegetative branches already studied.

E. PRODUCTION OF FLOWER-BUDS.

Within eight to ten weeks from sowing when the plant is twenty to twenty-five cms. in height, fruiting branches begin to appear on the main stem. Later, the monopodial branches also produce fruiting branches and these are called secondary sympodia. This process continues and branches of higher orders are produced in both the cases. The scaffolding of the plant thus gets steadily built up by the two classes of branches from stage to stage. As the sympodia, whatever their origin, continuously produce reproductive forms, the production of these organs forms a necessary concomitant of the general expansion of the plant. Thus the two phases of growth in cotton, namely, the vegetative and the reproductive, are not quite distinct and separate as is commonly the case in cereal crops.

Under field conditions, where the main stem happens to be subjected to damage by both the spotted boll-worm and the shoot-roller, the initiation of the reproductive phase as heralded by the appearance of flower-buds is determined by the height at which the main stem is attacked (Table No. 26). If the stem is knocked down below the first fruiting branch, the arrival of the flower-buds is postponed until secondary sympodia are formed on the lateral branches. If these have to appear on the limbs, the delay may extend to about seven days; if on the auxiliaries, more than twenty days are required.

TABLE NO. 26.

Approximate dates of the appearance of the flower-buds on the three types of branches 1923-24.

Average of 99 plants.

Kind of branch.	No. of cases.	Approximate date of bearing of flower-buds.
Primary sympodia	78	24- 9-1923.
Limbs	33	1-10-1923.
Auxiliaries	43	15-10-1923.

In addition to the spotted boll-worm, the effect of the environmental factors on the time of arrival of floral buds is appreciable. This will be discussed in a later chapter on a certain set of plants where the disturbance caused by insect agencies are altogether eliminated. For the present, the joint effect of the boll-worm and the seasonal influence on the time of initiation of the reproductive phase (Table No. 27) may be discussed. The time of inception of flower-buds varies a good deal from season to season. In 1925 and in 1929, floral buds appeared on the plant

as early as seven weeks from the date of sowing. In 1931 on the other hand, they appeared as late as the twelfth week. Broadly speaking, however, flower-buds

TABLE NO. 27.

Time of arrival of the flower-bud in different years.

	1923.	1924.	1925.	1926.	1927.	1928.	1929.	1930.	1931.	Average.
Week in which flower-buds began to emerge.	23rd Sep-tember	31st Aug-ust	22nd Aug-ust	24th Sep-tember	5th Sep-tember	30th Aug-ust	3rd Sep-tember	9th Sep-tember	21st Sep-tember	
By age in weeks from sowing.	11	9	7	11	9	8	7	11	12	9

begin to arise within about nine weeks, from the date of sowing. Under ordinary conditions, the plant (spaced 3' x 3') produces 293 flower-buds as the average of nine years (Table No. 28). With the exception of the year 1931, the production of these forms has not varied appreciably from year to year (Table No. 29).

TABLE NO. 28.

Average number of flower-buds produced per plant in different years.

Years.	1923.	1924.	1925.	1926.	1927.	1928.	1929.	1930.	1931.	Average.
Number of plants under count.	99	50	10	10	20	20	18	20	20	
Average number of flower-buds per plant.	275	344	298	313	313	303	298	293	294	293

Although the total bud-production has not varied widely every year, the individual variation is indeed enormous in spite of the fact that the plants under observation appeared to be almost identical in respect of growth at the time of flower-bud arrival. It has fluctuated from 70 to 675 flower-buds. Even if the extremes are left out, the variation still ranges from 175 to 375 (Table No. 29).

TABLE NO. 29.

Frequency distribution of plants according to the number of flower-buds produced.

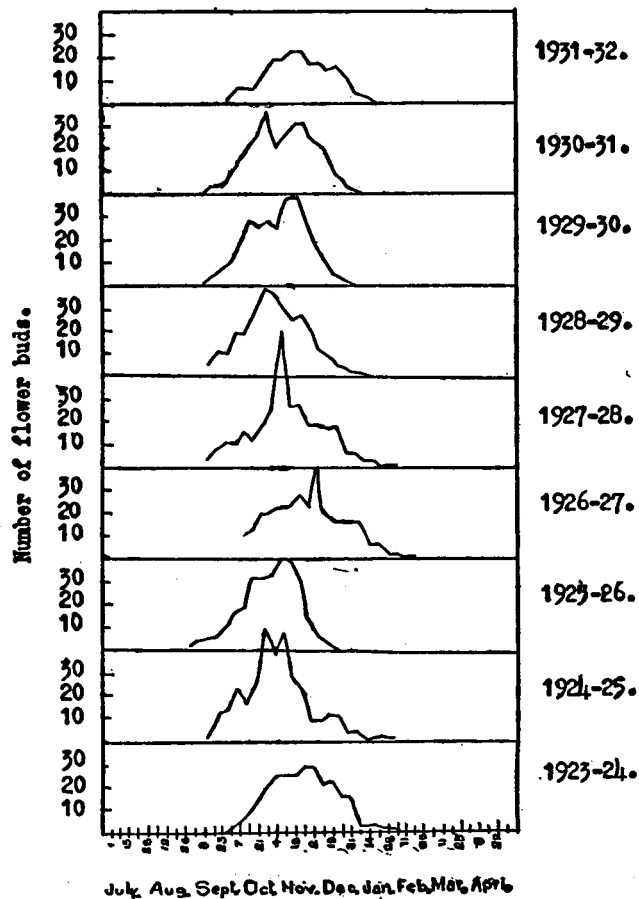
Class value of flower-buds on the plant.	75.5	125.5	175.5	225.5	275.5	325.5	375.5	425.5	475.5	525.5	575.5	625.5	675.5	Total.	Mean.	S. E. of mean.
	75.5	125.5	175.5	225.5	275.5	325.5	375.5	425.5	475.5	525.5	575.5	625.5	675.5			
1923-24.																
Frequency of plants.	3	10	13	17	15	14	18	4	3	..	1	1	..	99	276.51	10.96
1924-25.																
Frequency of plants.	..	..	7	8	9	9	11	9	3	2	1	..	1	60	335.5	14.11

Examining the data of all the nine years on flower-bud production (Graph No. 21), it will be evident that the rate of flower-bud formation is very slow in the initial stages. It then rises and after reaching a certain value the production continues for three to four weeks at that value or the rate is still further accelerated before the usual decline begins.

Nearly seventy per cent. of the production generally takes place during the twelfth to twentieth weeks after the date of sowing (Table No. 30). In the years

GRAPH No. 21.

Periodical production of flower-buds for a period of nine years.



(For figures, see table No. 62 in the Appendix.)

of belated growth as in 1926 and 1931, this period is shifted further by four weeks.

In regard to flower-bud production by each of the three types of branches, namely the limbs, auxiliaries and the primary sympodia, it may be expected that as the primary sympodia are the first to arise and as they are produced in succes-

TABLE No. 30.

Percentage of the total flower-bud production in different periods from the date of sowing.

Weeks.	0 to 8	9 to 12	13 to 16	17 to 20	21 to 22	23 to 24	25 to 26	27 to 28
Month.	July & Aug.	Sept.	Oct.	Nov.	December.	January.		
Years.								
1923-24 .. ..	..	0.9	17.9	38.5	18.5	13.4	6.7	4.1
1924-25 .. ..	..	5.5	24.1	47.5	9.2	6.3	4.8	2.6
1925-26	0.8	8.9	33.3	48.3	7.3	1.4	..	..
1926-27 .. ..	..	1.4	20.7	31.1	19.8	10.7	10.6	5.6
1927-28 .. ..	..	7.1	18.7	45.2	12.3	11.2	4.0	1.5
1928-29 .. ..	..	9.0	35.2	39.5	10.6	4.1	1.2	0.4
1929-30	0.4	13.8	36.7	41.9	5.6	1.5	0.1	..
1930-31 .. ..	..	1.3	16.5	37.0	21.1	15.8	7.4	0.9
1931-32 .. ..	..	0.4	10.5	35.9	19.9	15.6	13.4	4.3
Average	0.1	5.6	24.3	40.8	13.5	8.5	5.1	2.1

sion on the main stem they ought to contribute the largest quota. However, this is not so (Table No. 31). Under boll-worm conditions they are reduced to the third position. It is the limbs that are the most important to the plant. They get stimulated in consequence of the damage to the main shoot and give rise to a large portion of the total buds incepted. The auxiliaries play the second role.

The production of flower-buds by primary sympodia differs in different years (Table No. 31) depending upon the time of arrival of the boll-worm and the point

TABLE No. 31.

Percentage of the total production of flower-buds on the three types of branches.

Year.	Number of plants under growth study.	Percentage of total number of buds on		
		Monopodia.	Primary sympodia.	Auxiliaries.
1923-24	99	45.0	20.3	34.7
1924-25	50	48.2	22.5	29.3

at which it attacks the main shoot. Compared with the year 1923-24, the boll-worm arrived late in 1924-25 and was very mild. This resulted in the growth of a larger number of primary sympodia and consequently in larger production of flower-buds on them. The year 1923-24 was, however, more representative of the attack of the boll-worm in this tract, and hence the production of the flower-buds this year, may be taken as the normal performance of the three types of branches.

F. PROPORTION OF VEGETATIVE BUDS TO FLOWER-BUDS.

The ratio of vegetative buds to flower-buds is not the same every year. (Table No. 32.) It fluctuates from 1.06 to 2.17. In the majority of cases, it varies from 1 to 1.2; in some years it is nearly twice as great.

TABLE No. 32.
Ratio of vegetative buds to flower-buds.

Years.	1923.	1924.	1925.	1926.	1927.	1928.	1929.	1930.	1931.
Number of plants under growth study.	99	50	10	10	20	20	18	20	20
Total number of vegetative buds.	292	390	648	328	627	431	371	328	371
Total number of flower-buds.	275	344	298	313	313	303	298	293	204
Ratio $\frac{\text{Vegetative bud.}}{\text{Flower-bud.}}$	1.06	1.14	2.17	1.05	2.01	1.42	1.24	1.1	1.8

It may be pointed out that excepting the year 1931, the production of flower-buds hovered round 300 in all years. In the case of the vegetative buds, however, no such constancy was observed, the number ranging between 292 to 648. It may further be noted that the number of vegetative buds was always greater than that of flower-buds.

G. DEVELOPMENT OF REPRODUCTIVE ORGANS AND THEIR SHEDDING.

(a) Growth of flower-buds.

Flower-buds, like vegetative buds, emerge as tiny bodies subtended by leaves in the tufts of growing shoots and it requires some experience to differentiate the one from the other. Being hidden from view, it is difficult to ascertain with precision when these arise as distinct individuals on the tender shoot. But with the progressive elongation of the latter, the subtending leaves unfurl and the young reproductive forms become visible for the first time. When this happens, buds are said to be incepted or to have emerged. Buds appear in our counts from this time onwards.

The inner bud is cylindrical in shape and is encased by three bracts which present to the whole body a triangular appearance. It has two stipules; one of them is comparatively broad and serrated, while the other is long and irregular.

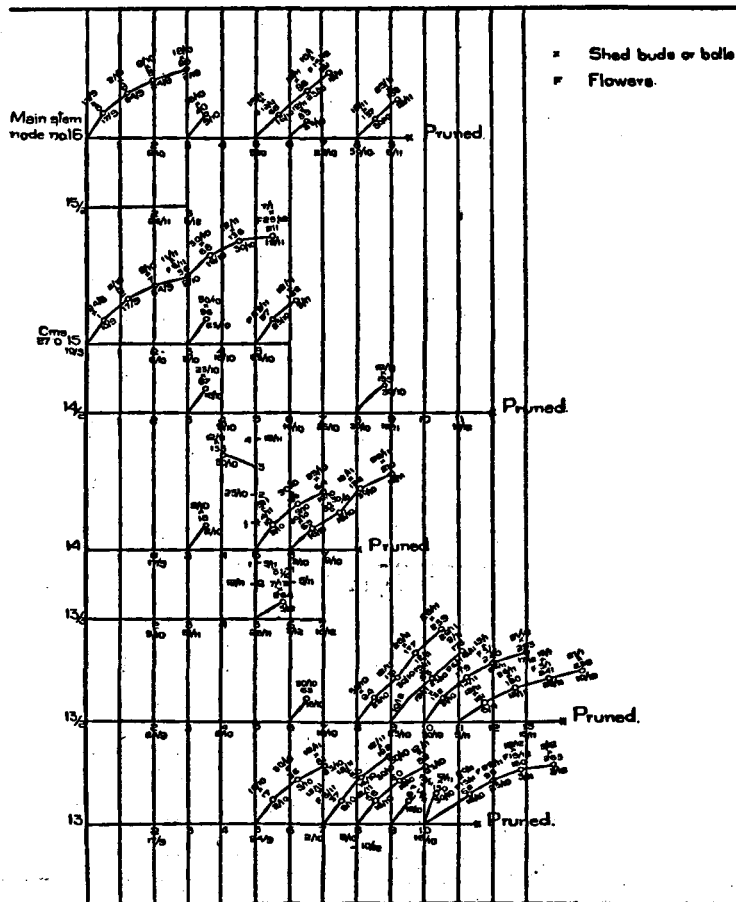
In order to understand the important events in its life such as the date of inceptation, time of flowering, the date of shedding either prior or subsequent to flowering as the case might be, the history of each bud incepted was regularly maintained every year on a set of ten to twenty plants. This was effected by sketching in large field registers the frame-work of the plant from period to period as it expanded. These registers were ruled in equal divisions vertically and horizontally. The starting vertical line on the left hand of the register represented the main stem and the points of the horizontal lines represented the branches and the points of crossing on these by the vertical lines, showed the nodes on the branch. Additional branches from the same node were drawn by hand. The position of each bud was shown in these drawings and the various buds arising in each period were numbered in consecutive order. The date of arrival of the bud and the dates

of shedding if it shed or of flowering and boll-shedding were recorded against each bud in the register (Graph No. 22 and Table No. 62A in the Appendix). Each page of the large field-register contained an account of branches on a set of two

GRAPH NO. 22.

Specimen page reproduced from the plant register for unpruned-plant no.13
of
1929-1930

Figures on the thick vertical line denote node numbers on the main stem. Horizontal lines denote the monopodial branches and the figures on these show their length in node numbers. Fruiting branches are shown by curved lines with a circle at each node bearing the number of the flower-bud, date of its inception, flowering and shedding. Secondary monopodial branches are shown by vertical straight lines with their lengths in node numbers.



to five nodes on the main stem and as such the history of the whole plant occupied about six pages of the register, the number depending upon the expanse of the various branches.

The entries from these sketches were then transferred to another register called the "bud-history register" which will be referred to from time to time.

In this way, bud-histories were kept up for a period of seven years from 1924 to 1931, the year 1927 being omitted. In the first year, counts were taken daily in the first half of the season until the plants grew large after which it was done on alternate days and finally once every three days. In the following year they were recorded for some time on alternate and subsequently every three days till the end of the season. During the next five years, only weekly counts were maintained.

It has been noted that the plant produces on an average 293 flower-buds. Out of these about seventy-six ever succeed in reaching the flower stage. (Table No. 36 on page 67.) Further, these successful buds are derived from those incepted in October and a part of November. (Graph No. 26 on page 77.) The rest of the buds drop down at one time or another throughout the season.

(b) *Age of buds at flowering.*

All the buds do not take the same time for flowering. In 1924-25, out of the 609 buds that flowered, seventy-two per cent. required forty-three to forty-eight days, the range of variation amongst individuals being from twenty-three to fifty-three days. (Table No. 33.) Next year out of the 874 buds seventy-two per cent. flowered at the age of thirty-one to thirty-five days. Individual variation this year ranged from nineteen to forty-seven with a S.D. of 4.01. It will thus be evident that the time required for flowering differs in different years.

TABLE NO. 33.
Frequency of the age of buds at flowering in the years 1924-25 and 1925-26.
1924-25.

Class value in days.	23	28	33	38	43	48	53	Total.	Mean.	S. E. of Mean.
Frequency of buds.	2	4	21	59	237	202	84	609	45.04	0.21

1925-26.

Class value in days.	19	23	27	31	35	39	43	47	Total.	Mean.	S. E. of Mean.
Frequency of buds.	1	11	95	374	258	104	28	3	874	33.02	0.14

According to period of inception, the range of variation in the age of buds at the time of flowering presents some interesting peculiarities (Table No. 34). In the first instance, the range widens with advance in the season. Thus, taking the extremes, it is found that in the year 1925-26 buds incepted in first week of October, flowered at ages varying between twenty-seven to thirty-four days; those incepted during the third week of November required from nineteen to forty-six days. Secondly, there is a tendency exhibited by the majority of buds to bloom at a higher age as the season advances.

Hilson, Ayyar and Pillai (1925) studied bud and boll-shedding at Coimbatore in 1922-23 and found that there was a very pronounced tendency for the age

TABLE No. 34.

Frequency of the age of buds at the time of flowering according to the time of inception in the season for the year 1925-26.

Days required for buds to flower.	Dates of inception.												Total.	
	September.			October.				November.						
	13	20	27	4	11	18	25	1	8	15	22	29		
19-20	1	..	..	..	1	..	1
21-22	1	..	..	1	1	..	3
23-24	1	1	2	3	1	..	8
25-26	1	10	11	4	4	..	30
27-28	1	1	2	8	26	19	7	1	..	..	65
29-30	1	1	7	10	21	42	64	18	5	1	170
31-32	2	1	4	13	31	40	62	47	4	..	204
33-34	1	1	2	3	14	26	29	29	37	10	..	152
35-36	7	24	17	19	21	11	7	106	
37-38	1	..	6	8	9	12	23	16	4	79
39-40	..	1	..	..	..	1	1	..	3	9	7	3	25	
41-42	1	1	2	..	7	5	2	18	
43-44	2	1	..	2	5	..	10	
45-46	2	1	..	3	
Total	..	1	1	4	6	15	54	125	177	221	181	72	17	874

of buds to shorten with the progress of season. This is not in accord with our first observation.

(c) *Flowering.*

Buds may be said to flower from the second week of November though stray flowers may appear from the last week of October (Graph No. 23 and Table No. 63 in the Appendix). Flowering comes into full swing generally in December. Hereafter, it declines and by about the end of January, practically ceases. In years of belated growth however the period of maximum flowering is shifted to January or even to the middle of February as in 1926.

The span as well as the magnitude of flower production, in the different seasons has varied a good deal. As we shall see later, the intensity of production depends in addition to seasonal influences upon the intensity and duration of attack, by the boll-worm. In the absence of this insect, the period of flowering is shortened and the intensity of production appreciably raised.

The relative merits of the different types of branches observed in regard to bud production, are maintained also in the case of flowers. The limbs give rise to the largest number of flowers, the auxiliaries come next in order while the primary sympodia stand last in this gradation (Table No. 35). Although in some years both the limbs and the auxiliaries may produce an equal number of flowers, owing to higher rate of bud-shedding on the former, the fact remains that under boll-worm conditions the sympodia are reduced to a third position in this regard.

GRAPH No. 23.

Rate of flowering in different years.

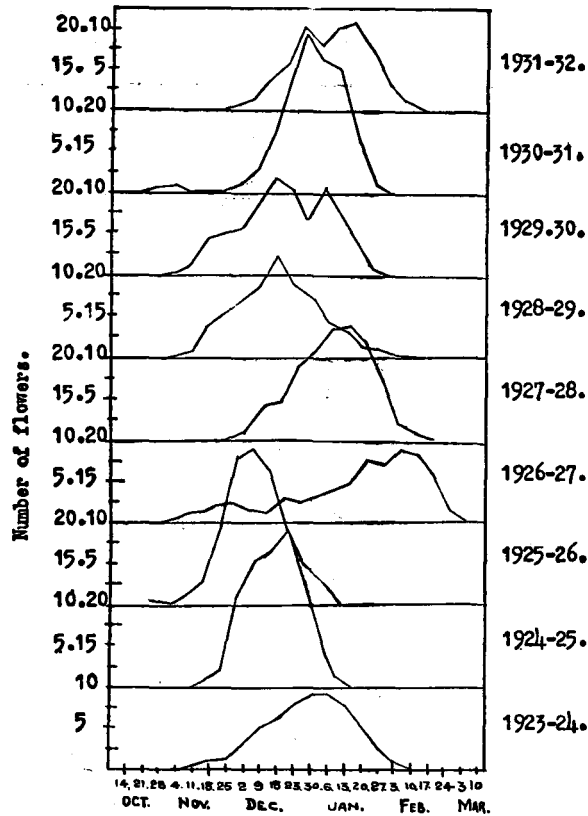


TABLE No. 35.

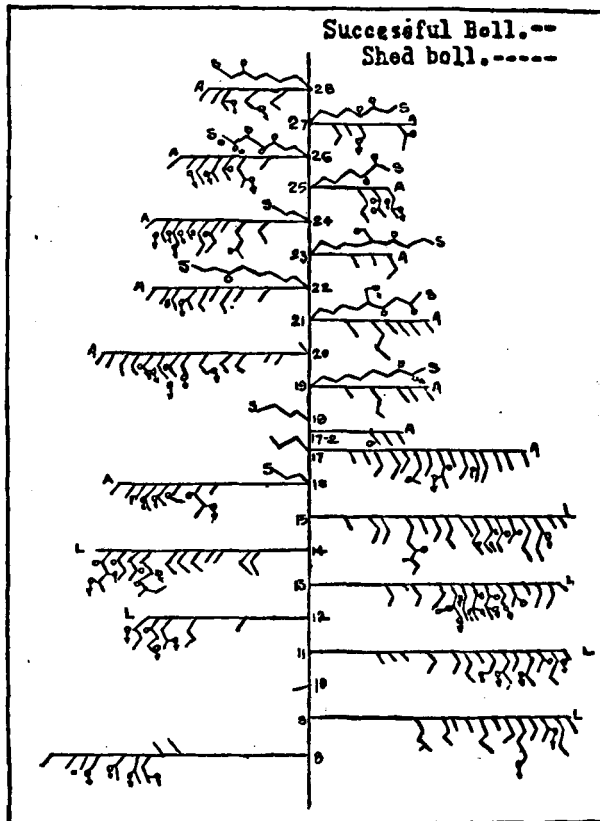
Production of flowers on the three types of branches in different years.

Year.	Plants under counts.	Number of flowers borne on			Total.
		Monopodia.	Sympodia.	Auxiliaries.	
1923-24	99	26.0	11.8	26.5	64.3
1924-25	50	37.2	16.0	34.1	87.3
1925-26	10	53.1	14.4	19.9	87.4

The position of flowers appearing on these branches is well illustrated in the following Graph No. 24. It need hardly be pointed out that the production of flowers is confined towards the periphery of the general scaffolding of the plant.

GRAPH No. 24.

Position of flowers on the three types of branches.



Explanation of the graph :—

1. The horizontal lines starting from the main axis are monopodial branches.
2. The zig-zag lines are the sympodial branches. Each terminal point on these represents a flower-bud.
3. The successful and shed bolls form in aggregate the flowers, and the position of flowers can thus be known.

(d) Development of bolls.

The average number of flowers per plant varies from sixty-five to eighty-seven (Table No. 36), the mean of nine years being seventy-six. All these do not, however, grow into mature bolls. It is only about thirty that ultimately reach the mature stage. The rest of the flowers shed as raw bolls.

PLATE No. 5.

Crop plant showing the extent of bud and boll-shedding and the number of mature bolls on the plant.



TABLE No. 36.
Flower and boll production in different years.

Year.	1923.	1924.	1925.	1926.	1927.	1928.	1929.	1930.	1931.	Average.
Number of plants under flower count.	99	50	10	10	20	20	18	20	20	..
Number of flowers opened.	64.3	87.3	87.4	69.6	81.8	68.65	77.7	87.0	64.8	76.5
Number of bolls matured.	29.6	35.8	30.0	25.8	32.0	24.15	27.0	28.25	30.35	29.2
Number of bolls shed.	34.7	51.5	57.4	43.8	40.8	44.50	50.7	58.75	34.45	47.3
Percentage boll shedding.	53.9	59.0	65.7	62.9	60.9	64.8	65.3	67.5	53.2	61.8

Thus, out of the 293 flower-buds, only ten per cent. succeed into mature bolls and represent the total yield of the plant. The remaining ninety per cent. shed either as buds or as bolls (Plate No. 5).

H. BEARING OF BOLLS BY BRANCHES.

With regard to boll bearing on the three types of branches, we have nothing more to add to what has been already stated under bud and flower production. The monopodia give rise to the largest number of bolls in some years, while in other years they produce more or less the same number of bolls as the auxiliaries (Table No. 37). The production of these forms, however, is very meagre in the case of the sympodia.

TABLE No. 37.
Boll bearing by branches.

Year.	Plants under counts.	Bolls on the three kinds of branches.			Total.
		Monopodia.	Sympodia.	Auxiliaries.	
1923-24	99	11.2	5.5	12.9	29.6
1924-25	50	13.7	7.5	14.6	35.8
1925-26	10	17.2	5.8	7.0	30.0

I. EXTENT OF BUD-SHEDDING.

When the subtending leaf unfurls, the flower-bud in its axil is generally found in a green condition. Occasionally semi-dried forms are also observed. The fate of the buds belonging to the latter class has been already determined and they shed sooner or later. Many buds of the former class though they continue to grow

to varying ages, ultimately shed at one time or another, either in the form of buds as such or later as immature bolls.

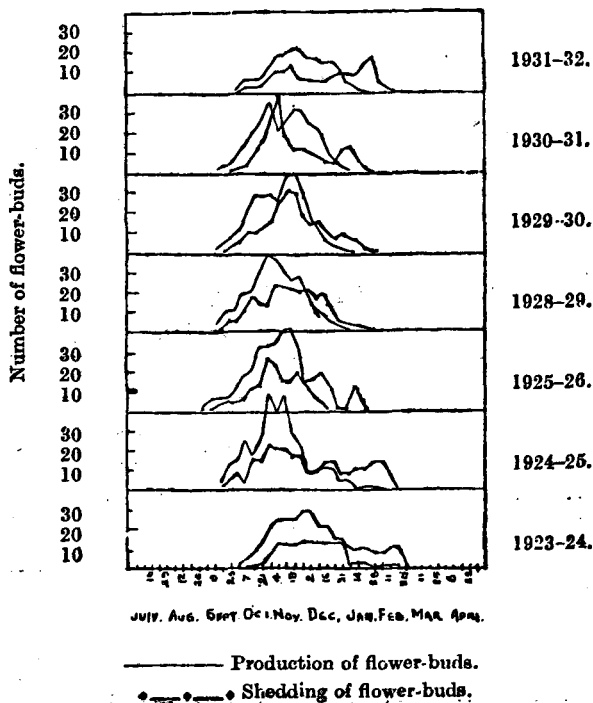
Shedding takes place by the formation of an abscission layer. When a bud or a boll drops, it leaves a scar at the point of its attachment on the branch. A count of these scars denotes the number of shed buds. Later on, however, when the bolls also begin to shed, the procedure adopted in determining this number is to take a regular count of all the scars on the plant and then subtract from it the number of bolls shed of which a separate count can easily be taken. This method has been found to be suitable and accurate enough especially when a direct count of the tiny shed forms is not possible, owing to considerable losses in their collections.

(a) *Time of bud-shedding.*

Buds have been found to shed at any stage of their life. It has been pointed out that when the subtending leaf unfurls, the bud is sometimes found in a semi-dried or a moribund condition. The growth of such buds has already been checked and they fall off sooner or later. Thus the two processes—production and shedding—proceed simultaneously (Graph No. 25 and Table No. 64 in the Appendix) throughout the season. Shedding is not restricted to any particular stage of the plant though it is enhanced in the latter part of the season.

GRAPH No. 25.

Periodical formation of buds and their shedding.



(b) *Total bud-shedding.*

Out of the large number of buds produced, as many as seventy-four per cent. are usually lost as buds (Table No. 38). This is the average of nine years. The percentage fluctuates from year to year between sixty-eight to seventy-eight, showing that the range of variation in the percentage of shedding is only ten.

TABLE No. 38.

Average number of buds incepted and shed.

Years.	1923.	1924.	1925.	1926.	1927.	1928.	1929.	1930.	1931.	Average.
Number of plants under counts.	99	50	10	10	20	20	18	20	20.	
Average number of flower-buds per plant.	275	344	298	313	313	303	298	293	204	293
Average number of buds shed.	211	257	211	243	231	234	220	206	139	217
Average number of buds developed into flowers.	64	87	87	70	82	69	78	87	65	76
Percentage flower bud-shedding.	76.7	74.6	70.7	77.7	73.8	77.4	73.9	70.3	68.2	74.1

In individual cases even in the same season, the variation extends from sixteen to eighteen (Table No. 39). In the majority of cases, however, it does not exceed eight.

TABLE No. 39.

Frequency of plants according to percentage shedding of flower-buds.

Class value of percentage shedding.	64	66	68	70	72	74	76	78	80	82	84	86	Total.	Mean.	S. E. of Mean.
Frequency of plants 1923-24.	5	9	15	26	18	17	3	3	3	99	76.81	0.36
Do. 1924-25	..	1	2	1	3	9	17	7	10	7	3	..	60	74.97	0.51

(c) *Size of shed buds.*

Out of the total number of buds produced per plant about twenty to forty-five per cent. were not available for examination as these generally belong to the class of buds which either die immediately after emergence or being very small are lost either in the mulch or in the crevices of the soil. As many shed buds as could be available were collected every day throughout the season and studied separately for their sizes.

Shed buds were classified roughly according as they were small, medium or large (Table No. 40). The small ones were usually below two mms. in diameter (the bud proper excluding the bracts) and completely enclosed by the bracts; the medium ones were between two to six mms. and fully exposed. At all stages of the plant growth, the bulk of the shed forms consisted of small ones. Buds medium in size, also shed in a fairly big number specially in November and December. Shedding of the large buds, however, is comparatively insignificant.

TABLE NO. 40.

Weekly classification of shed buds according to sizes.
1924-25.

Week ending	Small.	Medium.	Large.	Total.
21st September 1924	11	..	..	11
28th " 1924	192	6	..	198
5th October 1924	234	3	..	237
12th " 1924	353	..	..	353
19th " 1924	409	1	..	410
26th " 1924	441	13	..	454
2nd November 1924	401	37	1	439
9th " 1924	178	90	1	269
16th " 1924	224	140	4	368
23rd " 1924	131	113	6	250
30th " 1924	102	99	8	209
7th December 1924	201	99	9	309
14th " 1924	391	141	13	545
21st " 1924	288	244	29	541
28th " 1924	273	70	8	351
4th January 1925	78	54	5	137
11th " 1925	86	16	4	106
18th " 1925	57	6	..	63
25th " 1925	67	1	..	68
1st February 1925 :	66	..	..	66
Total ..	4,163	1,133	88	5,384
Per cent. ..	77.3	21.0	1.7	100

The data collected over a period of nine years on this subject show in a convincing manner that although the proportion of the shed buds in the three groups (Table No. 41) varies widely from year to year, most of these including the lost forms, are very small in their size and also in their age.

TABLE NO. 41.
Classification of shed buds according to sizes.

Year.	Number of plants under observation.	Total number of buds shed.	Total number of shed buds available for examination.	Shed buds.			
				Small.	Medium.	Large.	Total.
1923-24 ..	99	20,891	12,986	10,182	2,017	687	12,886
1924-25 ..	30	6,794	5,394	4,163	1,133	88	5,384
1925-26 ..	10	2,110	1,385	943	425	117	1,385
1926-27 ..	10	2,526	1,391	478	493	420	1,391
1927-28 ..			Data not available.				
1928-29 ..	10	1,912	1,374	625	418	331	1,374
1929-30 ..	10	1,404	1,157	473	278	406	1,157
1930-31 ..	10	2,005	1,635	978	482	175	1,635
1931-32 ..	10	1,395	865	559	215	91	865
Average ..	..	4,880	3,259	2,288	682	289	3,259

(d) Age of shed buds.

With regard to the age of shed buds it is observed that most of these forms are young as judged on the basis of their sizes. Bud histories maintained for recording, among other things, the age of buds at the time of their shedding show that in the year 1924-25, the shed forms varied in their age from three to fifty-three days (Table No. 42), although their mean age for the season did not exceed twenty-three with a S.D. 10.79. A large number of these buds, however, show a range

TABLE NO. 42.

Frequency of shed buds according to the interval between their appearance and shedding in days.

Class value of age in days.	3	8	13	18	23	28	33	38	43	48	53 and above.	Total.	Mean age at shedding.
Frequency of buds in 1924-25.	26	68	192	325	224	162	87	59	38	26	39	1,246	23.5
Do. 1925-26...	203	395	562	420	250	103	34	9	2	..	..	1,978	14.5

S. E. of Mean for 1924-25, 0.31; and S. E. of Mean for 1925-26, 0.16.

in their age from thirteen to twenty-eight. In the next year, their mean age was found to be only fourteen with a S.D. 7.29, the majority of the buds being between three to thirteen days in age. The data collected for the next five years (Table No. 43) indicate that the mean age of the shed buds varied from thirteen to sixteen days. It will, therefore, be at once evident that in spite of the varying differences in the different years, the ages of the shed forms could not be reconciled with their

TABLE No. 43.

Frequency of shed buds according to the interval between their appearance and shedding in weeks for different years.

Years.	Number of plants under study.	Class value of the interval in weeks.										Total.	Mean.	S. E. of mean.
		0	1	2	3	4	5	6	7	8				
1928-29 ..	20	200	1,137	1,368	838	350	203	42	5	..	4,143	2.19	0.02	
1929-30 ..	18	168	1,084	1,359	757	382	159	30	6	2	3,956	2.20	0.02	
1930-31 ..	20	375	1,461	1,263	603	268	94	48	9	1	4,122	1.87	0.02	
1931-32 ..	20	215	562	591	461	288	124	86	19	7	2,353	2.38	0.03	

small sizes. The bulk of shed buds consisted of small forms and these could not be expected to be as old as shown by their mean age at shedding.

In order to clarify this incompatibility, a study was undertaken in which a regular index of the sizes of growing buds according to their age, was first prepared (Table No. 44). This was effected by ticketing a large number of newly incepted buds on one and the same day (1-10-24). Out of these, five buds were removed every day and their age and diameter recorded.

A fresh lot of buds exceeding 200 was again ticketed. The shed forms out of this lot were collected every day and their ages determined by the use of the

TABLE No. 44.

Diameter in mm. of growing buds on successive days.

Days from the day the bud became visible.	1	2	3	4	5	6	7	8	9	10	11	12	13
Diameter with bracts.	Below two mm.	2.5	2.61	2.72	3.00	3.25	3.35	3.66	3.70	3.80	4.00	4.35	4.85
Diameter of the bud proper without bracts.	0.9	1.10	1.21	1.21	1.32	1.32	1.33	1.38	1.38	1.38	1.44	1.51	1.71

above table. The results (Table No. 45) so obtained show that a large number of shed buds are below the age of five days, the average age being nine days.

TABLE No. 45.

Age of shed buds as determined with the standard sizes of growing buds.

Class value of age in days.	1-5	6-10	11-15	16-20	21-25	26-30	31-35	36-40	41-45	46-50	Total.
Number of shed buds.	84	56	27	5	6	6	6	1	1	1	193

Mean days .. 9.19. S. E. of mean 0.70

According to bud histories, the mean age for this year was as high as twenty-three. It is, therefore, inferred that the bud continues to remain on the parent plant long after the arrest of its growth.

From these considerations, it will be seen that the bud is most susceptible to shedding while it is very young and that once it passes this critical period in its history, the chances for it to reach the flower-stage are fairly good.

(e) *Symptoms of shed buds.*

To get an insight into the causes of shedding, the shed buds collected from time to time were subjected to further examination. It was found that the larger buds had at times saffron coloured spots on them. Occasionally, they showed a bulging condition of their central portion. Sometimes, the margin of petals presented a drying appearance. Not infrequently, black rings at the base of the small buds, gave room to suspect the presence of micro-organisms. The most common symptom exhibited by the forms for a large part of season was, however, the bores made by the spotted boll-worm. In many cases, caterpillars were discovered feeding inside.

A study of the micro-organisms associated with the shed forms was made in the year 1924-25. The results obtained pointed to the improbability of these being concerned with the causes of shedding. This observation was further substantiated by the important fact that the commonest fungi obtained from the shed buds were saprophytic moulds of the type of *Microsporium* or *Alternaria*, *Fusarium* and *Helminthosporium*, and that none of them were constantly present. A complete study of all the organisms found on the shed organs, such as could have only been made in a specially equipped mycological or bacteriological laboratory was beyond our scope.

Symptoms other than the damage by the boll-worm were found to be merely the after-effects of shedding and were therefore of little use in elucidating the causal factors. Buds damaged or injured by the boll-worm invariably shed at one time or another. The extent of this damage under crop-conditions may now be studied.

Buds shed from day to day were collected and classified under two heads : those brought down by insect injury and those without the injury. The results of this study for the year 1923-24 and 1924-25 are given in the Table No. 46. In the first year, the classification was started rather late in the season. Nevertheless, it covered the four months from November to February during which time a large

TABLE NO. 46.

Periodical number of buds shed owing to spotted boll-worm damage and other causes.

Week ending.	1923-24. Total of 99 plants.			1924-25. Total of 30 plants.		
	Shed buds with injury.	Shed buds without injury.	Total.	Shed buds with injury.	Shed buds without injury.	Total.
21st September ..	..	..	..	5	6	11
28th „ ..	..	..	..	14	184	198
5th October ..	..	..	..	32	205	237
12th „ ..	..	..	..	50	303	353
19th „ ..	..	..	..	78	332	410
26th „ ..	..	..	..	81	373	454
2nd November ..	..	..	..	91	348	439
9th „ ..	794	91	885	105	164	269
16th „ ..	885	165	1050	145	223	368
23rd „ ..	745	160	905	111	139	250
30th „ ..	802	328	1130	91	118	209
7th December ..	787	409	1196	117	192	309
14th „ ..	1021	481	1502	142	403	545
21st „ ..	653	453	1106	113	428	541
28th „ ..	479	577	1056	38	313	351
4th January ..	260	872	1132	18	119	137
11th „ ..	196	1046	1242	10	96	106
18th „ ..	118	889	1007	2	61	63
25th „ ..	72	603	675	3	65	68
1st February ..	..	..	..	..	66	66
Total ..	6,812	6,074	12,886	1,246	4,138	5,384

part of the shedding takes place. Boll-worm was very severe this year and hence the proportion of buds shed by insect-injury to that by other injury has not only varied in aggregate but also from period to period. The figures in the above table bring out the significant fact that the attack of the insect sensibly declines from about the end of December.

Of the buds collected for examination, the percentage of those attacked by the insect varied widely from year to year (Table No. 47). The upper and lower limits of this variation appeared to be twenty-three and seventy, depending upon the intensity of attack. It need hardly be added that many of the tiny forms could

TABLE No. 47.

Percentage of buds affected by the spotted boll-worm in different years.

Year.	Number of plants under study.	Total number of shed buds.	Total shed buds available for examination.	Of the examined shed buds, those showing damage by the boll-worm.		Percentage of damaged buds on total shedding.
				No.	Per cent.	
1923-24 ..	99	20,891	12,886	6,812	52.9	32.6
1924-25 ..	30	6,794	5,384	1,246	23.1	18.3
1925-26 ..	10	2,110	1,385	551	39.8	26.1
1926-27 ..	10	2,526	1,391	856	61.5	33.9
1927-28 ..			Data not available.			
1928-29 ..	10	1,912	1,374	710	51.7	37.1
1929-30 ..	10	1,404	1,157	807	69.7	57.5
1930-31 ..	10	2,005	1,635	1,034	63.2	51.6
1931-32 ..	10	1,395	865	307	35.5	22.0
Total ..	..	39,037	26,077	12,323	47.3	31.6

not be collected as they were lost in the mulch and the crevices. It will, therefore, be seen that although the boll-worm is a serious cause of shedding for the greater part of the season, the number of buds shed without any apparent cause or symptoms is not inconsiderable.

Buds shed in different years owing to damage by the spotted boll-worm and by other causes have been further classified according to sizes under the three groups referred to above (Table No. 48). The figures in these groups illustrate in a characteristic manner the selective instinct of the insect. They show that the intensity of attack increases with the increase in growth of the buds. Thus, out of the total shed buds collected for any class the percentage attack increased in all the years, from the small buds to big ones, although the number of buds

TABLE No. 48.

Classification of shed buds by sizes and symptoms.

Year.	Plants under observation.	Shed buds showing injury by the spotted boll-worm.			Shed buds having no injury by the boll-worm.			Total number of buds examined.	Total number of shed buds lost as small forms.
		Small.	Medium.	Large.	Small.	Medium.	Large.		
1923-24	99	5,006	1,233	573	5,176	784	114	12,886	8,005
1924-25	30	986	196	64	3,919	195	24	5,384	1,410
1925-26	10	276	209	66	567	216	51	1,385	725
1926-27	10	126	428	302	352	65	118	1,391	1,135
1927-28				Data not available					
1928-29	10	103	300	307	522	118	24	1,374	538
1929-30	10	197	262	348	276	16	58	1,157	247
1930-31	10	584	330	120	394	152	55	1,635	370
1931-32	10	174	97	39	385	118	52	865	530

attacked ran in the inverse order, owing to the fact that the buds of higher ages were comparatively few at this time.

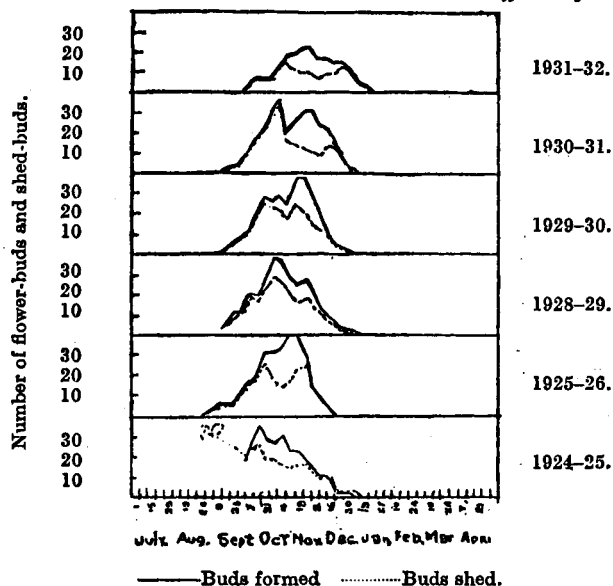
(f) *Relative bud-shedding.*

The term "relative bud-shedding" denotes the number of buds shed out of the total number incepted in a given period, no matter when they shed. The fate of buds incepted from time to time has been recorded in the bud histories from which the data on the relative shedding of buds is reproduced below.

It will be evident from Graph No. 26 (Table No. 65 in the Appendix) that the period of bud production can be divided into three sub-periods. In the first sub-period which extends from two to six weeks in different years, all the buds incepted practically shed. Then follows a period in which several buds escape shedding. The span of this period varies from six to eight weeks. Buds formed in the third period fail to grow and eventually shed.

GRAPH No. 26.

Periodical bud-shedding relative to bud formation in different years.



(g) BUD-SHEDDING ON DIFFERENT KINDS OF BRANCHES.

Percentage shedding of buds on three types of branches does not much vary. It is comparatively less in the case of buds produced on auxiliary branches (Table No. 49).

TABLE No. 49.

Percentage shedding of flower-buds incepted on different kinds of branches.

Year.	Number of plants under counts.	Percentage shedding of buds on		
		Limbs.	Primary sympodia.	Auxiliaries.
1923-24	99	79.0	79.0	72.3
1924-25	50	77.6	79.3	66.1
1925-26	10	70.8	76.1	64.5

(h) EXTENT OF BOLL-SHEDDING.

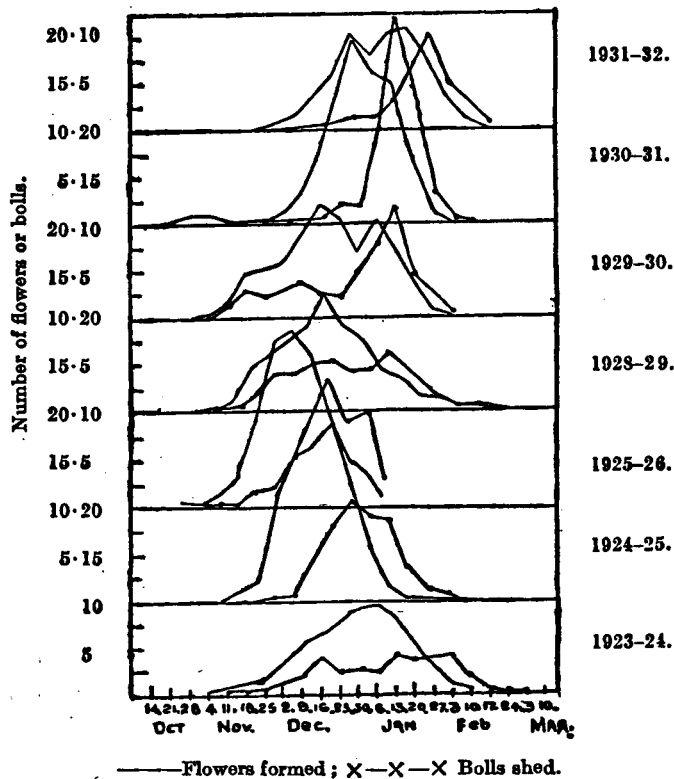
Shedding of flowers as such is seldom met with in cotton, at least in this tract. This is in complete agreement with the observations made by Hilson, Ayyar and Pillai (1925). Bolls are, however, very liable to shed. It has been noted that

the total number of buds which escape shedding and thus reach the flower stage, does not amount to more than seventy-six on an average of nine years. Out of these again as many as sixty-two per cent. generally shed as immature bolls (Table No. 36 on page 67).

Boll-shedding commences a few days after the start of flowering and continues throughout the bolling season with varying intensity (Graph No. 27 and Table

GRAPH No. 27.

Periodical flowering and boll-shedding in different years.

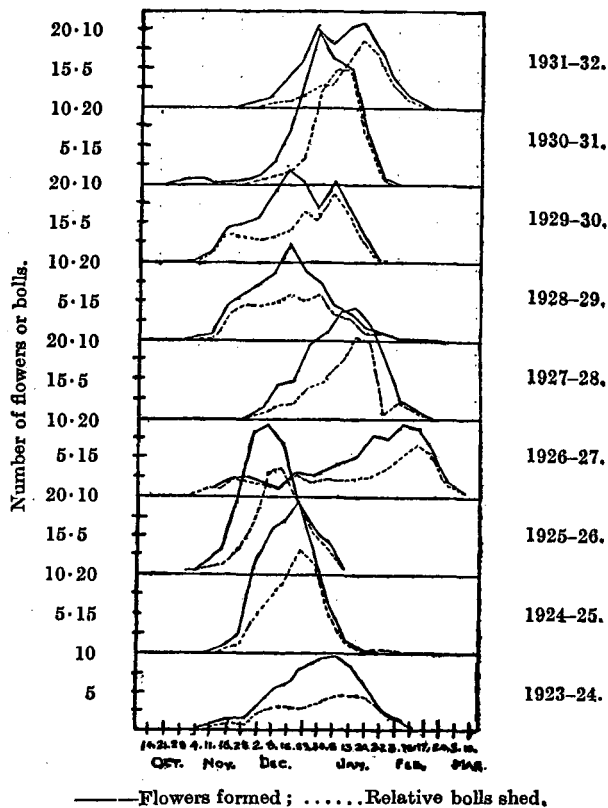


No. 66 in the Appendix). The rate of shedding in the early half of this period is comparatively low though it fluctuates a good deal from year to year, depending, to some extent, upon the virulence of boll-worm attack. In the latter half of the bolling period, it becomes more intense even when the presence of boll-worm is not so much felt at this time.

(a) *Boll-shedding relative to flower formation.*

Many flowers produced in the first half of the flowering season generally develop into mature bolls (Graph No. 28 and Table No. 67 in the Appendix). Bolls

GRAPH NO. 28.

Boll-shedding relative to flower formation.

from flowers appearing in the second half, shed in large numbers so much so that the flowers produced during the closing weeks always fail to develop into mature bolls.

(b) *Age of shed bolls.*

The age of shed bolls varies over a wide range from two to thirty-two days. (Table No. 50.) This range, however, is not constant from year to year. It may widen or shorten under seasonal influences. Nevertheless, the majority of shed bolls are between five to fourteen days old. The bolls that successfully dodge shedding for over a fortnight, generally succeed in reaching the mature stage.

Age of bolls at shedding increases with advance of the flowering season (Table Nos. 51 and 52 below). King (1922) makes the same observation in this regard. He states that in Pima cotton there is a tendency for the period between flowering and abscission to increase as the season advances.

TABLE No. 50.

Frequency of shed bolls according to age in different years.

98

Years.	Total plants.	Age in days.																	Total.		
		0	2	5	8	11	14	17	20	23	26	29	32	35	38	41	44	47		50	53
1923-24	366	319	1,668	2,449	2,000	1,074	547	291	142	198	..	..	..	..	..	..	..	..	..	..	8,688
1924-25	60	78	376	681	558	384	230	144	92	50	37	127*	..	..	..	..	..	..	..	..	2,757
1925-26	10	35	152	201	102	41	16	5	5	1	2	2	3	1	1	..	..	..	..	..	567
1926-27	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
1927-28	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
1928-29	10	1	62	137	124	93	47	23	8	5	6	3	0	1	0	1	0	1	0	2	514
1929-30	18	4	83	165	241	196	95	57	27	18	12	3	3	3	2	2	1	1	..	..	913
1930-31	20	39	373	373	220	88	40	18	9	3	6	2	2	..	1	1	..	..	..	..	1,175
1931-32	20	14	229	235	100	56	26	9	4	4	5	3	4	..	..	..	..	..	..	..	689

*33 and above.

Year.	1923-24.	1924-25.	1925-26.	1926-27.	1927-28.	1928-29.	1929-30.	1930-31.	1931-32.
Mean	10.26	12.46	8.73	..	..	9.18	10.12	8.76	8.91
S. E. of Mean	0.05	0.13	0.22	..	..	0.28	0.20	0.15	0.19

TABLE No. 51.
Frequency of shed bolls according to age.
1923-24.

Period ending	Class value of age in days.									Total.	Mean.	S. E. of mean.
	2	5	8	11	14	17	20	23	26 and above.			
19th Nov. 1923	34	142	83	23	4	4	..	..	..	290	6.27	0.16
4th Dec. 1923	53	233	196	110	66	41	23	7	9	738	8.84	0.18
19th Dec. 1923	137	502	454	208	111	41	34	10	33	1,530	8.32	0.12
3rd Jan. 1924	57	401	419	350	161	55	29	9	10	1,491	9.09	0.11
18th Jan. 1924	28	243	630	547	292	168	65	37	37	2,047	10.95	0.10
2nd Feb. 1924	10	147	667	762	440	238	140	79	109	2,592	12.40	0.10
Total ..	319	1,668	2,449	2,000	1,074	547	291	142	198	8,688	10.26	0.05

TABLE No. 52.
Frequency of shed bolls according to age.
1924-25.

Fortnight ending	Class value of age in days.											Total.	Mean.	S. E. of mean.
	2	5	8	11	14	17	20	23	26	29	32 and above.			
1st Dec. 1924	4	10	9	4	1	2	1	..	..	..	..	31	7.81	0.81
15th Dec. 1924	10	75	82	60	32	23	7	5	5	..	..	299	9.82	0.29
29th Dec. 1924	53	229	292	217	145	71	49	22	9	5	7	1,099	10.28	0.16
12th Jan. 1925	11	58	257	227	163	98	53	38	23	18	33	978	13.19	0.21
26th Jan. 1925	..	3	40	46	40	29	33	21	12	8	54	286	18.56	0.50
9th Feb. 1925	..	1	1	4	3	7	1	6	2	6	33	64	25.91	1.00
Total ..	78	376	681	558	384	230	144	92	50	37	127	2,757	12.46	0.13

Hilson, Ayyar and Pillai (1925), however, find that there is a tendency for this interval to shorten with the progress of the season. Similar observations have also been made by Ewing (1918) who says that the period between flowering and shedding is the longest when shedding first begins and shortest at the close. Lloyd (1920), however, maintains "that there is little evidence that the mean of frequencies of the bolls was reduced during the season but that there is evidence that the mean may recede or advance as a result of additive or subtractive effects such as the additive effect of rain upon that of the soil moisture which resulted in the recession of the mean three days."

(c) *Size of shed bolls.*

With regard to the size of shed bolls it is found that for the same age they are always smaller than those growing on the plant. Their size, however, corresponds

TABLE No. 53.

Comparison of the sizes of the growing and shed bolls on the basis of age.

Age in days.	Growing bolls (Average of 10).		Shed bolls.		No. shed.	Growing bolls (Average of 10).		Shed bolls.		No. shed.
	Length mms.	Breadth mms.	Length mms.	Breadth mms.		Length mms.	Breadth mms.	Length mms.	Breadth mms.	
	Results of 500 flowers ticketted on 21-1-24.					Results of 1502 flowers ticketted on 13th to 17-1-1925.				
1	7.42	5.06	..	..	..	6.95	4.95	..	..	..
2	8.10	5.06	7.0	5.0	1	7.25	5.25	..	..	..
3	8.65	5.98	7.66	4.60	2	7.55	5.45	..	..	..
4	8.20	6.21	7.55	5.42	4	8.55	6.15	..	..	..
5	9.67	7.18	7.91	5.10	17	9.25	6.45	7.55	5.22	3
6	10.33	7.82	..	..	..	9.25	6.75	7.22	4.75	9
7	10.71	8.39	8.02	5.58	50	9.55	7.35	7.41	5.14	14
8	11.42	8.82	8.88	6.30	55	9.55	7.35	7.67	5.09	25
9	13.95	9.61	9.40	6.62	44	..	..	8.26	5.30	64
10	14.20	10.10	9.56	6.77	30	10.45	7.75	8.37	5.52	120
11	15.25	11.65	10.57	7.56	19	10.95	8.55	8.85	5.87	143
12	16.60	12.47	10.66	8.36	6	11.95	9.45	9.17	6.22	133
13	..	..	..	..	..	12.33	9.85	9.89	6.61	109
14	18.40	13.95	12.25	7.66	6	12.65	10.35	10.42	7.18	89
15	19.85	15.70	13.66	8.91	6	13.75	10.75	10.69	7.33	50
16	21.70	16.20	13.66	10.50	3	14.95	11.65	11.16	7.51	46
17	23.35	18.02	..	..	..	15.65	12.05	11.44	8.11	18
18	24.70	19.10	..	..	..	15.95	12.67	11.63	8.05	23
19	24.60	19.34	..	..	..	17.77	13.44	12.74	8.55	16
20	..	..	..	..	..	20.05	15.05	12.49	8.79	17

to that of the growing bolls, five to six days younger (Table No. 53). This interval is not quite constant even in the same season. It increases with the age of shed bolls, although the range of five to six days generally stands for the majority of shed forms.

These results lead us to the conclusion that a stimulus to shedding is received by the bolls five or six days prior to shedding. This question will be discussed at some length when we come to the study of the nitrogen content and the dry matter of the shed bolls.

Mason (1922) studied growth rates of bolls and found that as a result of the activities on the flowering day, the growth rate of boll declines for four to five days after anthesis. This is, however, not corroborated by our results (Table Nos. 68 to 71 in the Appendix).

(d) *Symptoms of shed bolls.*

The most common symptom exhibited by shed bolls is the bore made by the caterpillar of the spotted boll-worm. It is further found that caterpillar generally enters the boll in the vicinity of the attachment of bracts, which is the softest part. In certain cases, it has also been observed to attack the boll higher up.

Out of the shed bolls, the percentage of those damaged by the insect varies a good deal from year to year as shown below (Table No. 54). Up to the end of

TABLE NO. 54.

Percentage of shed bolls with insect injury in different years.

Year.	1923-24.	1924-25.	1925-26.	1926-27.	1927-28.	1928-29.	1929-30.	1930-31.	1931-32.
Number of plants under observation.	99	60	10	10	..	10	10	10	10
Total number of bolls examined.	3,141	2,787	553	427	..	338	327	553	348
Total number of bolls showing injury by boll-worm.	1,633	1,158	105	193	..	186	174	69	19
Percentage injury by boll-worm.	52.0	41.5	19.0	45.2	..	55.0	53.2	12.5	5.5

December, most of the shed bolls bear insect injury (Table No. 55). Hereafter, though the virulence of attack appreciably declines, boll shedding proceeds even at a higher rate for over a month and then decreases till the end of the season. From these considerations it will be clear that, in addition to bollworm, there are other causes which are, in a large measure, responsible for the shedding of immature bolls.

TABLE No. 55.
Percentage of shed bolls with injury in the different periods.
 1923-24.
 (Average of 366 plants.)

Period ending	Shed bolls collected and examined.	Shed bolls with injury by boll-worm.	
		Number.	Percentage.
19th November, 1923	92	68	73.9
26th November, 1923	244	210	86.0
3rd December, 1923	447	392	87.7
10th December, 1923	573	536	93.5
17th December, 1923	804	739	91.5
24th December, 1923	725	670	92.4
31st December, 1923	668	590	88.3
7th January, 1924	752	494	65.6
14th January, 1924	1,001	512	51.1
21st January, 1924	1,056	354	33.5
28th January, 1924	982	164	16.7
4th February, 1924	1,374	149	10.8
11th February, 1924	613	100	16.3
18th February, 1924	338	72	21.3

Amongst the probable causes of shedding indicated by the external and internal symptoms of shed bolls, mention may be made of lack of fertilization of flowers and the presence of micro-organisms. The first of these was suggested by the fact that a large number of bolls contained ovules which were characterised by incomplete growth of their fuzz. In many cases even this growth did not take place (Table No. 56).

Our idea that lack of fertilization of flowers may be one of the possible causes of boll shedding, gathers strength from the researches of earlier workers prominent among whom are Lloyd (1920), Kearney (1923), Ewing (1918), etc. They all agree with the general view that the prevention of pollination causes the boll to shed. In India, Jivanrao (1922) ascribes boll shedding to ineffective fertilization or to its failure as the result of osmotic differences between the pollen grains and the stigmatic hairs, which retard the germination of pollen. Mead as quoted by this author regards inadequate pollination as a possible factor in shedding. Trought (1928) finds in the Punjab, that the non-dehiscence of anthers is primarily concerned in the failure of the earlier crop of flowers to set into bolls.

TABLE NO. 56.
External and internal study of shed bolls.
 1924-25.

External symptoms.	Internal symptoms.			
	Ovules sound and fuzzy.	Ovules shrivelled reddish, fuzz here and there.	Ovules sound without fuzz.	Ovules shrivelled without fuzz.
1. Light red patches and red at base.	347	49	99	13
2. Red all over	38	267	10	20
3. Dark red and hard shell.	5	86	0	27

During the early years of our investigation, we have devoted some attention to the study of fertilization of flowers in relation to boll shedding. This study indicates, in the main, that the different parts of the flower such as the pollen, stigma and ovules, associated with the process of fertilization are viable and the dehiscence of anthers is also quite normal. Again, additional pollination fails to improve the percentage success of bolls.

For the full and normal growth of the boll, it is not at all necessary that all the ovules in the ovary be fertilised. A boll may grow to maturity even if seventeen ovules are fertilised out of twenty-two usually found in the ovary. Indeed, Kearney (1923) who has made an exhaustive study of this aspect of the question observes that out of 633 bolls that matured from bagged flowers, 201 contained fewer than 10 seeds. In his other experiments, the success of bolls was achieved even with a much smaller number. He reported cases of mature bolls in which the number of seeds varied from three to one. The symptoms which led us into this investigation therefore were rather the after-effects of shedding than its causal factors.

More instructive, however, are the results of flower-pruning experiments which will be described later (page 245). They show that if the earlier flowers are removed, the later ones, which generally shed, are made to develop into mature bolls. This suggests that, in all likelihood, the heavy shedding of bolls usually witnessed in the latter part of the bolling period is intimately connected with nutritional deficiencies in the plant as a result of the earlier crop of bolls. This is possible, as Murneek (1926) suggests, that the lack of food supply in the plant may affect the fertilization of flowers and ultimately lead to the shedding of young bolls.

Another probable cause to which reference has been made is the presence of micro-organism. Suspicion with regard to this was entertained in that the walls of the ovary were found in a state of decomposition, particularly at the base and that they were marked by various shades of red patches. This suspicion was further strengthened by the results of some of the previous workers on the problem of bud and boll shedding. Amongst these may be included. Atkinson (1892), Edgerton

(1912), Nowell (1916-17), Harland (1920) and Ballard and Norris (1923). All these investigators ascribe the shedding of reproductive forms in cotton to the activity of micro-organisms as one of the causes. Butler (1918) reports the dropping of fruits in palms and in some other plants by the attack of *Phytophthora*. Coit and Hodgston (1919) have reached the same conclusion in regard to the June drop of naval oranges.

Our work on this subject entitles us to state that apart from the boll-worm, the causes of shedding of both buds and bolls in this tract are other than those related to fungal or bacterial attack. The decaying condition of the walls of the ovary, their discolouration and other symptoms presented by the shed forms were found to be only the after-effects of shedding.*

K. EFFICIENCY OF BUD AND BOLL RETENTION.

Before we come to the question of yield, we may discuss the percentage success of the different forms of reproductive organs on the basis of total formation. The percentage success of buds into flowers varies in different years from 22·3 to 31·8, the average of all the years being 26·1 (Table No. 57). In the case of the success of flowers into bolls, the percentage variation ranges from 32·5 to 46·8, the average percentage amounting to 38·2. The percentage fluctuates, in regard to the success of buds into bolls from 8·0 to 14·9, the average being only 10·0.

TABLE NO. 57.

The average performance of the plant in different years.

Year.	Plants under counts.	Leaves.	Vegetative buds.	Flower-buds.	Flowers.	Bolls.	Yield of seed cotton in gms.	Percentage success of		
								Bud into flower.	Flower into boll.	Bud into boll.
1923	99	567·6	292·3	275·3	64·3	29·6	..	23·3	46·1	10·8
1924	50	734·6	390·7	343·9	87·3	35·8	..	25·4	41·0	10·4
1925	10	945·2	646·8	298·4	87·4	30·0	1·75	29·3	34·3	10·1
1926	10	641·5	328·8	312·7	69·6	25·8	1·86	22·3	37·1	8·2
1927	20	939·5	626·9	312·6	81·8	32·0	1·83	26·2	39·1	10·2
1928	20	734·1	431·0	303·1	68·6	24·1	1·81	22·6	35·2	8·0
1929	18	668·3	370·8	297·5	77·7	27·0	2·00	26·1	34·7	9·1
1930	20	621·6	328·5	293·1	87·0	28·2	2·10	29·7	32·5	9·6
1931	20	575·2	371·4	203·8	64·8	30·3	1·74	31·8	46·8	14·9
Average	..	714·2	420·8	293·4	76·5	29·2	..	26·1	38·2	10·0

From the stand-point of the efficiency of the different classes of branches on the basis of percentage success of (1) buds into flowers (2) flowers into bolls and finally of (3) buds into mature bolls, the following data are presented (Table Nos. 58 to 60).

* The authors are indebted to Prof. S. L. Ajrekar of the Gujarat College, Ahmedabad, formerly Plant Pathologist to the Government of Bombay, for advice in connection with the conduct of studies on the micro-organisms associated with shed buds and bolls.

TABLE NO. 58.

Efficiency of bud and flower success on different kinds of branches.

Year.	Number of plants under counts.	Percentage success of buds into flowers on buds produced on each kind of the branch.		
		Limbs.	Sympodia.	Auxiliaries.
1923-24	99	21.0	21.0	27.7
1924-25	50	22.4	20.7	33.9
1925-26	10	29.2	23.9	35.5

TABLE NO. 59.

Percentage success of flowers into bolls on different kinds of branches.

Year.	Number of plants under counts.	Limbs.	Sympodia.	Auxiliaries.
1923-24	99	43.2	46.6	48.7
1924-25	50	35.8	46.9	42.8
1925-26	10	32.4	40.3	35.2

TABLE NO. 60.

Percentage success of buds into bolls on different kinds of branches.

Year.	Number of plants under counts.	Limbs.	Sympodia.	Auxiliaries.
1923-24	99	9.1	9.8	13.4
1924-25	50	8.3	9.7	14.5
1925-26	10	9.4	9.6	12.5

As regards the first of these tests, the auxiliaries occupy the foremost place in point of efficiency while the sympodia fall into the background as usual. With regard to the second test, the efficiency of the limbs is less than that of either the auxiliaries or the sympodia. We are more concerned, however, with the final efficiency of the different branches, that is the total production of mature bolls from the total buds incepted. Figures in Table No. 60 indicate that the auxiliaries show the greatest efficiency in this regard. The sympodia exhibit a higher efficiency than the limbs though the difference between the two is very small.

L. THE YIELD.

The yield of the cotton crop comprises seed-cotton locally known as Kapas. Ovules of the young ovary form the seed while the hairs on their surface develop into the lint. It is needless to say that the yield of seed-cotton per plant in a given variety, varies directly with the number of bolls in a given season. The yield per acre therefore is represented by the product of the number of plants grown and the number of bolls produced per plant.

The number of bolls per plant, however, does not depend entirely on the total buds incepted. It might even be asserted that the number of buds produced, has little relationship to the final crop of bolls, as will be evident from the data for years 1926 and 1931. (Table No. 57.) To develop into a mature boll, a bud requires on an average 100 days. During all this time, it has to pilot its course towards maturity under a variety of circumstances always threatening its elimination by shedding. The extent of their influence on the growth and development of the young forms, during the bud and boll stages, is indeed enormous and can be estimated in terms of the percentage success of buds opening into flowers, of flowers developing into mature bolls and of buds growing into bolls. The last case, we need scarcely point out, sums up the total effect of all the hostile forces. Thus, out of the large number of buds produced, only about ten per cent. ultimately reach the mature boll stage.

The yield of the plant, therefore, is essentially governed by the extent to which the hostile forces operate during the bud and the boll stages. If conditions are favourable for both the stages, the yield is considerably enhanced even when the bud production is very low as happened in 1931-32. If on the other hand, the conditions, whatever their nature, are less congenial, the yield is reduced in spite of a larger bud production as in 1928-29. It does frequently happen, however, that if the success of buds into flowers is increased that of flowers into bolls decreases and *vice versa*. In such cases, the number of bolls per plant remains almost the same.

SUMMARY.

This chapter deals with the study of production, growth and development of the different organs of the cotton plant under crop conditions in the Broach cotton tract.

The plant possesses a fairly large root system which reaches a depth of 150 cms. and spreads laterally over a distance of 100 to 150 cms. The root-system comprises the tap root and a number of primary, secondary, tertiary and quaternary branches, the total number amounting to more than 550. The number of large laterals is very small and varies within the limit of thirty to sixty. Their length oscillates between 1900 and 3600 cms.

After sowing early in July, till about the end of the rainy season (beginning of October), root activity is confined to the depth of forty to fifty cms. During this time, the primary branches spread more or less horizontally. Thereafter, they descend into lower depths and give rise, on their way, to branches of higher order. Growth of the root system, thus continues till about the end of December when the plant is in the midst of the flowering period.

The growth of the shoot is very slow during the first two months, owing to wet conditions. It gets accelerated hereafter till about the end of December. The scaffolding of the shoot is built up of the main stem and a fairly large number of lateral branches which grow either monopodially after the stem or sympodially.

The sympodia directly produce flower-buds which develop into bolls. The monopodia give rise to sympodia on them.

Under crop-conditions, the main stem never grows to its full height as it gets damaged, at one time or another, by the shoot-roller or the spotted boll-worm. The branch-shoots also are similarly damaged. On this account, the normal course of branching is seriously obstructed and the plant assumes various shapes and appears more or less bushy.

The magnitude of plant expansion varies widely from plant to plant and also from year to year. In terms of the number of leaves produced, it varies from 550 to 950, the mode being about 600 to 650. Nearly seventy per cent. of these are incepted during October and November, the total span of leaf production extending over about four months from September to December.

Leaves incepted at different times and on different parts of the plant vary both in their size and longevity. Those produced in the first half of the crop-season are larger. Leaves appearing in October live longer than those incepted in September or November.

Flower-buds begin to appear when the plant reaches the age of about nine weeks from the date of sowing. Their production continues over fifteen weeks. On an average, 300 buds are produced per plant. Of these, nearly seventy per cent. are incepted during the short period between the twelfth and twentieth weeks from sowing.

Out of the total production of flower-buds as many as ninety per cent. shed in the form of buds and bolls and only ten per cent. ultimately develop into mature bolls. These are generally derived from the lot of buds incepted during October and November.

Flower-buds take about thirty-five to forty-five days to open into flowers. From sixty-five to eighty-five flowers are produced per plant, the average of nine years being seventy-six. Of these again as many as forty-three shed as young bolls and only thirty grow into ripe bolls.

Shedding begins a few days after the commencement of bud formation and continues throughout the season. The age of the majority of shed buds varies from two to ten days. More than half the shed forms are apparently sound while the rest show signs of injury by the spotted boll-worm. Like bud shedding, boll shedding also continues during the whole of the flowering period. It assumes high proportions in the latter part of this period so much so that the flowers appearing in the closing weeks never develop into mature bolls. Most of the shed bolls are as young as the shed buds. Thus, both the bud and the boll are very susceptible to shedding while they are still young.

Though the spotted boll-worm is a serious cause of holl shedding, a large proportion of shed bolls bear apparently no injury. Neither lack of fertilization of flowers nor the presence of any parasitic micro-organism is responsible for this shedding.

The yield of bolls per plant does not entirely depend upon the number of buds incepted. It is also governed by conditions of environment during the different stages of their growth.

CHAPTER IV.

DEVELOPMENT OF THE COTTON PLANT IN THE ABSENCE OF THE SPOTTED BOLL-WORM.

The preceding chapter describes the studies on the development of the cotton plant under the spotted boll-worm conditions. They reveal, *inter alia*, that out of the average production of 300 flower-buds per plant only about thirty grow into mature bolls while the remaining 270 invariably shed as young buds and immature bolls. Further, of the total shed forms not less than thirty-three per cent. as the average of eight years, show injury by the spotted boll-worm. It was, therefore, hoped, at this stage of the investigation on the causes of bud and boll shedding, that if plants could be grown to the exclusion of this insect the loss caused by it would be saved.

I. CAGE PLANTS.

In the absence of any knowledge of control measures for the eradication of the spotted boll-worm, considerable difficulties were encountered in raising plants free from that insect. It was at the instance of Kasargode, who was investigating contemporaneously remedial measures against the spotted boll-worm at this station and to whom we owe most of our knowledge on the subject of this pest, that the first promising beginning was made in this direction. He suggested in 1924 the erection of a plant-house for purposes of warding off the insect, particularly its moth. His presence on the spot was of further assistance in combating thrips, and aphides which appeared in the plant-house.

Accordingly, before the break of monsoon in 1924, a plant-house (33 feet long, $10\frac{1}{2}$ feet broad and $7\frac{1}{2}$ feet high) sufficient to accommodate thirty plants, spaced three feet by three feet, was erected in the midst of a cotton field. This was enclosed, on all sides including the top, by two kinds of wire-netting. To keep out the caterpillar, a wire netting of the fineness of 20 meshes to a square inch was used all round the cage or the plant-house to a height of eighteen inches. The rest of the portion was covered up with wire netting of the fineness of 16 meshes only. The object in using the latter type was in the first instance to prevent the ingress of the moth and secondly to reduce as much as possible the otherwise undesirable effects of the cage.

Although the cage proved quite effective in keeping out the boll-worm, it had its own disadvantages such as high humidity, low intensity of light, etc. Besides, thrips which are not commonly found on plants grown in the open air, made their appearance. These were, however, immediately brought under control by the use of crude oil emulsion. Moreover, aphides increased owing to the keeping out of the predatory lady-bird beetles, usually found on plants outside the cage, but these also were checked by introducing every day some beetles collected from the field plants. Lastly, plants grown in the cage showed abnormal growth features resembling those grown under weak light.

For purposes of improving the light conditions, therefore, a new cage was constructed in the following year. This was done by enlarging its dimensions (65 feet long, 18 feet broad and $7\frac{1}{2}$ feet high) and by substituting glass panes for the walls of wire-meshing above the height of $4\frac{1}{2}$ feet. The remaining portion except the lowest $1\frac{1}{2}$ feet and the roof were enclosed with a wider meshing (10 to a square inch) to admit more light. The cage faced the south lengthwise with the roof sloping on two sides.

Before proceeding to the study of plants grown in the cage it is necessary to point out that in both the years (1924-25 and 1925-26) sowing had to be delayed owing to the comparatively wet condition of the soil inside the cage. In the first year, thirty plants were grown in three rows of ten plants each. Out of these only eight plants were studied, the border plants being left out as they had grown abnormally owing to the extra space. In the next year, out of the 100 plants raised in the new cage only ten in a row were used for the purpose of the developmental studies. The others, excluding the border rows, were reserved for experimental work which will be referred to later. In both the years, a set of ten plants outside the cage was maintained to serve as the control.

Under the cage conditions, the plants exhibited certain morphological characteristics which essentially differed from those of the outside plants. The stems were tall and slender and were marked by longer internodes. The branches were small and spread all over the stem. The leaves were never green as observed in the case of plants grown in the open. They were pale yellow and had elongated petioles and broader and thinner lamina. Flower-buds again manifested the same peculiarities as the leaves. Their bracts were thinner and paler and the pedicels were longer and thinner.

While the cage-plants in the two years did not materially differ in regard to the total production of the several organs, though the plants grown in 1925-26 were found to be a shade better, striking differences arise when comparisons are instituted between them and the control (Table No. 61). The plant to plant performances are reproduced in Table Nos. 72 and 73 in the Appendix.

Whereas in the first year the performance of plants in the cage was at least equal if not superior to that of the control, in the second year it was distinctly inferior.

TABLE No. 61.

Comparison between the average performance of plants inside and outside the cage.

Year.	1924-25.		1925-26.	
	Inside the cage 8 plants.	Outside the cage 10 plants.	Inside the cage 10 plants.	Outside the cage 10 plants.
Stem height in cms.	143.9	56.6	157.8	34.4
„ in node number	48	29	48	18
Number of leaves	723.6	608.7	742.5	945.2
„ of vegetative buds	359.6	319.7	400.7	646.8
„ of flowerbuds	364.0	289.3	341.8	298.4
Shed buds	302.5	225.4	276.9	211.0
Percentage bud shedding	83.1	77.9	81.0	70.7
Flowers	61.5	63.4	64.9	87.4
Shed bolls	34.6	37.8	36.0	57.4
Percentage boll shedding	56.3	59.2	55.5	65.7
Ripe bolls	26.9	26.1	28.9	30.0
Percentage total shedding	92.6	91.0	91.5	89.9
Percentage success of bolls from buds	7.4	9.0	8.5	10.1

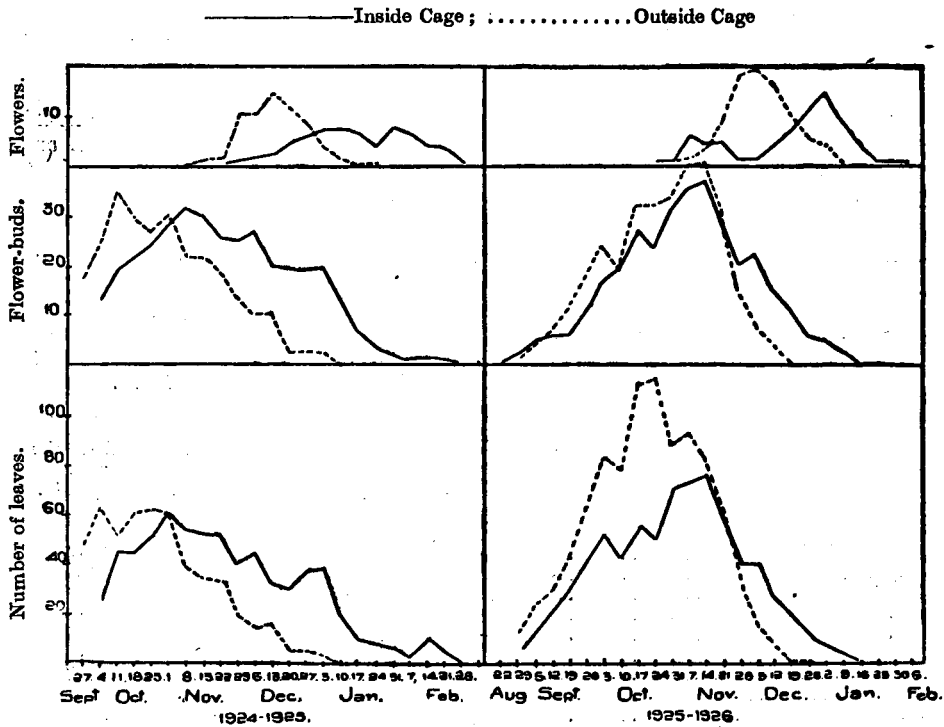
Further, the plants in the cage produced a larger number of flower-buds, a smaller number of flowers but an equal number of bolls. On this account, the percentage

shedding of buds in these plants was greater and that of boll shedding always less, the net result amounting to a reduction in the percentage success of buds developing into mature bolls.

The study of the cage plants from the stand-point of the time required to put up the total growth is of special interest. The leaf production was of a protracted nature and continued longer than that in the control by a period of nearly a month (Graph No. 29 and Table No. 74 in the Appendix). While the production of leaves

GRAPH No. 29.

Periodical average production of leaves, flower-buds and flowers of plants grown inside and outside the cage.



ceased by the middle of December in the case of control plants, that in the cage continued till about the middle of January. Flower-buds appeared rather late and their production was also similarly prolonged by one month or so. Flowering commenced later by one or two weeks and was likewise of a protracted nature. The

intensity of flowering of the control plants at any stage was much higher and was confined to about four weeks. In the cage-plants, on the other hand, this was delayed by one month. It may be further observed that in the year 1925-26 the flowering period of the cage-plants was characterised by two flushes, owing to causes that will be referred to later.

AGE OF BUDS AT FLOWERING UNDER CAGE CONDITIONS.

Flower-buds require a longer time to open into flowers (Table No. 62). This

TABLE NO. 62.

Frequency of flower-buds according to the number of days required for flowering inside and outside the cage.

Class value in days.	1924-25. Total of 8 plants.		Class value in days.	1925-26. Total of 10 plants.	
	Plants in the cage.	Plants outside the cage.		Plants in the cage.	Plants outside the cage.
	Frequency.	Frequency.		Frequency.	Frequency.
23 .. .. .	....	2	20.5	1	4
28 .. .. .	....	4	24.5	4	38
33	1	21	28.5	29	235
38	0	59	32.5	130	356
43	50	237	36.5	232	185
48	121	202	40.5	206	43
53	115	84	44.5	38	13
58	100	30	48.5	7	....
63 and above	96	....	52.5	2	....
Total	492	639		649	874
Mean	53.41	45.65		37.16	32.44
S. E. of Mean	0.30	0.23		0.17	0.14

is in general agreement with the protracted nature of growth of the cage-plants as a whole. In 1924-25, the upper and lower limits of the age differences were, twenty-three and sixty-three days, while in the control they were twenty-three and fifty-three. Though the range of differences between the two sets of plants does not appear to be very wide, it will, however, be noticed that whereas about thirty

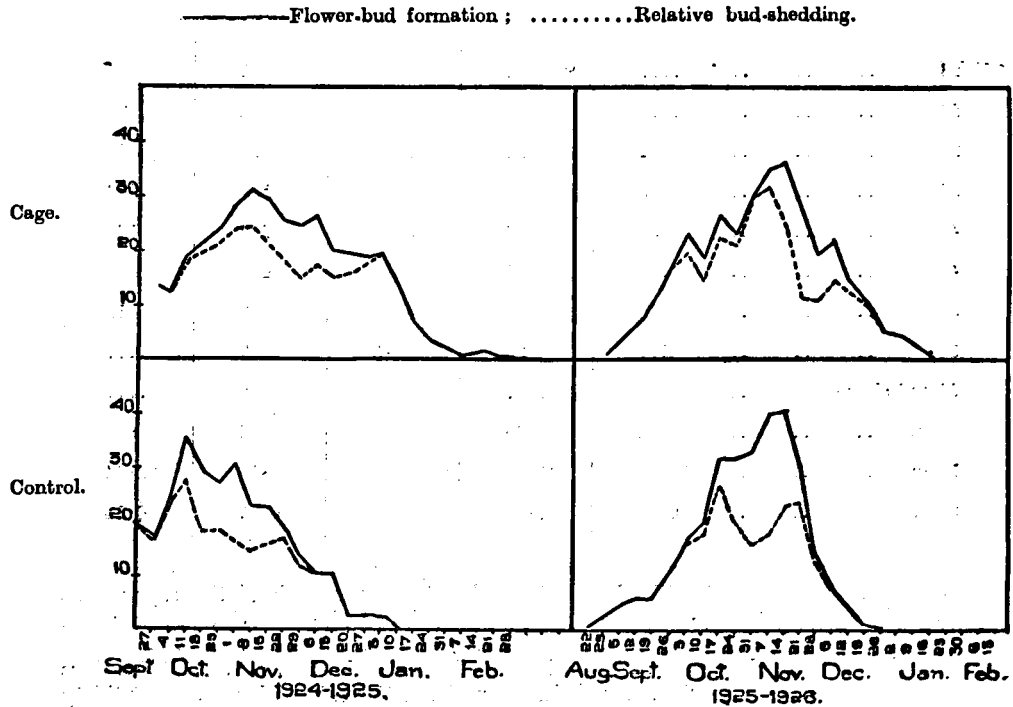
buds (4.6 per cent.) blossomed at the age of fifty-three days and above in the control, the number of flowers older than fifty-three, on the cage-plants, was as much as 196 (39 per cent. of the total). Next year again the same relations were observed, though the range of variation in both the sets of plants shortened by about ten to fifteen days.

EXTENT OF SHEDDING.

Shedding commences soon after bud production and continues throughout the period of bud formation and a little over. This period can well be divided into three sections in relation to the formation of buds. (Graph No. 30 and Table No. 75 in the Appendix.) In the first period which extends over a few weeks, all the buds shed; in the second which covers more than eight weeks some of the buds formed develop into flowers while the rest shed; in the third period, bud shedding is again wholesale. Thus, the total shedding of buds in the cage-plants amounted to eighty-three per cent. as against seventy-eight in the control.

GRAPH No. 30.

Average shedding of buds relative to formation.



THE AGE OF SHED BUDS UNDER CAGE CONDITIONS.

With regard to the age of buds at which they shed, it will be seen that the range of variation in the year 1924-25 in both the sets was longer than that in 1925-26 (Table No. 63). The age of the majority of shed buds in these sets though it varied in the two years, was almost the same. Thus, in the first year it was between thirteen

TABLE No. 63.

Frequency of shed buds of plants in the cage and outside, according to age in days.

Class value in days.	1924-25.		1925-26.	
	Shed buds of 8 plants in the cage.	Shed buds of 10 plants outside the cage.	Shed buds of 10 plants in the cage.	Shed buds of 10 plants outside the cage.
3	12	14	90	203
8	38	42	349	395
13	197	220	968	562
18	307	363	676	420
23	235	280	362	250
28	185	215	141	103
33	88	111	34	34
38	52	70	6	9
43	25	31	1	2
48	15	21	....	....
53 and above	14	20	....	....
Total	1,168	1,387	2,627	1,978
Mean	22.63	23.04	15.79	14.57
S. E. of Mean	0.27	0.25	0.12	0.16

and twenty-eight days, while in the following year it was between eight and twenty-three. This shows that in the second year, younger buds shed in the two sets. It is therefore certain that on the basis of the data for these two years, the character of shedding of buds was not influenced by the altered conditions of environment within the cage.

SIZE OF SHED BUDS UNDER CAGE CONDITIONS.

As a corollary from what has been just discussed in the preceding paragraph, the bulk of shed buds consists of young forms. Their size is generally below 2 mm.

TABLE NO. 64.

Classification of periodically shed buds inside and outside the cage, according to size.
1924-25.

Period ending	Total of 8 plants inside the cage.				Total of 10 plants outside the cage.			
	Size of shed buds.				Size of shed buds.			
	Small.	Medium	Large.	Total.	Small.	Medium	Large.	Total.
22nd Sept. 1925	..	..	..	..	5	..	..	5
29th Sept. 1925	8	..	..	8	82	..	..	82
6th Oct. 1925	44	..	..	44	73	..	..	73
13th Oct. 1925	68	..	..	68	132	..	..	132
20th Oct. 1925	84	..	..	84	159	..	..	159
27th Oct. 1925	93	2	..	95	180	..	..	180
3rd Nov. 1925	110	..	..	110	178	4	..	182
11th Nov. 1925	56	..	..	56	89	3	1	93
17th Nov. 1925	129	..	..	129	146	7	..	153
24th Nov. 1925	113	..	..	113	89	6	3	98
7th Dec. 1925	104	2	..	106	65	5	2	72
8th Dec. 1925	60	..	..	60	94	14	4	112
15th Dec. 1925	102	3	..	105	187	16	6	209
22nd Dec. 1925	87	4	..	91	192	45	14	251
29th Dec. 1925	74	4	1	79	138	23	5	166
5th Jan. 1925	43	2	..	45	38	14	2	54
12th Jan. 1925	30	2	..	32	39	1	3	43
19th Jan. 1925	69	1	..	70	14	2	..	16
26th Jan. 1925	56	2	..	58	23	..	..	23
2nd Feb. 1925	102	7	1	110	28	..	..	28
Total	1,432	29	2	1,463	1,951	140	40	2,131

(Table Nos. 64 and 65). From about the middle of October, medium and large buds begin to shed but their number is small. In the control plants, however, the number of shed buds of the medium and large class is appreciable. This is the result of the spotted boll-worm damage.

TABLE NO. 65.

Classification of periodically shed buds inside and outside the cage according to size.
1925-26.

Period ending	Total of 10 plants in the cage.				Total of 10 plants outside the cage.			
	Size of shed buds.				Size of shed buds.			
	Small.	Medium.	Large.	Total.	Small.	Medium.	Large.	Total.
6th Sept. 1925	..	..	..	..	2	..	..	2
13th Sept. 1925	12	..	..	12	25	..	..	25
20th Sept. 1925	35	..	..	35	39	..	..	39
27th Sept. 1925	81	..	..	81	32	..	..	32
4th Oct. 1925	131	..	..	131	35	7	2	44
11th Oct. 1925	137	..	..	137	78	12	..	90
18th Oct. 1925	81	..	..	81	70	17	5	92
25th Oct. 1925	143	26	3	172	127	91	9	227
1st Nov. 1925	81	18	3	102	103	48	14	165
8th Nov. 1925	69	45	27	141	48	27	11	86
15th Nov. 1925	110	71	17	198	33	15	13	61
22nd Nov. 1925	226	120	34	380	55	68	6	129
29th Nov. 1925	86	3	..	89	56	20	5	81
6th Dec. 1925	42	2	..	44	48	40	11	99
13th Dec. 1925	55	12	2	69	47	53	11	111
20th Dec. 1925	66	16	6	88	25	23	23	71
27th Dec. 1925	54	6	3	63	10	4	1	15
3rd Jan. 1926	80	12	7	99	10	..	6	16
Total	1,489	331	102	1,922	843	425	117	1,385

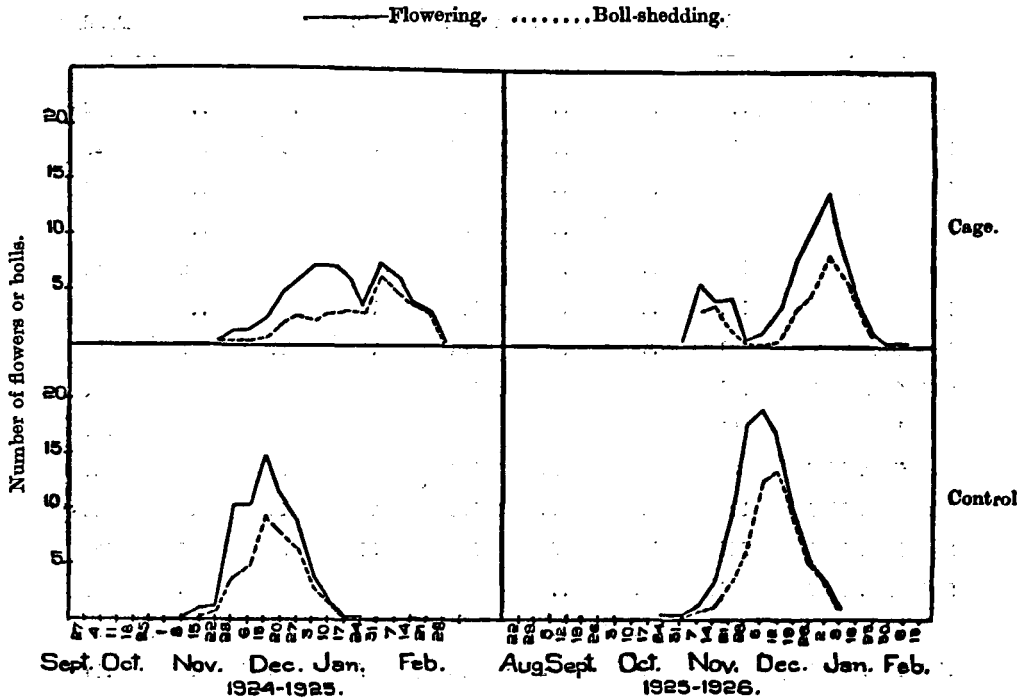
BOLL SHEDDING UNDER CAGE-CONDITIONS.

Like bud shedding, the shedding of bolls commences soon after the start of the flowering period (Graph No. 32 and Table No. 76 in the Appendix), and goes on

in varying degrees throughout. In contrast to bud shedding, all the early forms do not shed and the yield of the plant is built up from these early flowers. All the later bolls, however, shed completely. In the case of the control plants, on the other hand, many of the early bolls shed owing to the spotted boll-worm damage.

GRAPH No. 31.

Weekly average shedding of bolls relative to flower formation in plants in the cage and outside.



AGE OF SHED BOLLS.

Most of the shed bolls in the cage vary in their age from five to eleven days. Bolls older than twenty days rarely shed (Table No. 66). In the case of the control plants, though the bulk of the shed forms are between five to eleven days old, their proportion to that in the cage plants is always greater. Bolls older than twenty days also shed. These differences between the two sets are rather due to boll-worm damage than to the differences in the environment of the two sets.

The age of shed bolls according to the time of their formation on the plant is of considerable interest. The bolls which appear early and late in the season show a tendency to shed young. Those in the midst of the boll-setting period exhibit a tendency to shed when they are older.

TABLE NO. 66.

Frequency of shed bolls inside and outside the cage according to age in days.

Days.	1924-25.		1925-26.	
	Total shed bolls of 8 plants in the cage.	Total shed bolls of 10 plants outside the cage.	Total shed bolls of 8 plants in the cage.	Total shed bolls of 10 plants outside the cage.
2	2	11	25	35
5	44	50	96	152
8	88	96	135	201
11	70	65	65	102
14	25	28	25	41
17	5	25	5	16
20	8	12	3	5
23	4	3	2	5
26 .. .. .	....	2	....	1
29	2	4	....	2
32 .. .. .	....	3	....	2
35 .. .. .	....	1	....	3
38 .. .. .	....	0	....	1
41 .. .. .	....	2	....	1
44	1	0	....	1
47 and above	1	5	....	....
Total	250	307	356	567
Mean	10.14	11.39	8.05	8.73
S. E of Mean	0.33	0.44	0.19	0.21

EFFICIENCY OF RETENTION OF BUDS AND BOLLS ON DIFFERENT KINDS OF BRANCHES UNDER CAGE CONDITIONS.

From the point of view of the total flower-bud production, the number of flowers formed and the bolls retained, the performance of the primary sympodia is the most striking (Table No. 67). Their efficiency is seen from the final number of buds growing into mature bolls out of the total buds produced which stands at twelve as against four and five of the limbs and the auxiliaries respectively. Under the spotted boll-worm conditions the auxiliaries have been found to be the best in this respect.

TABLE No. 67.

Efficiency of limbs, auxiliaries and primary sympodia in regard to flower-bud production and their retention.

1924-25.							
Branch.	Flower-buds formed.	Flowers opened.	Bolls.	Percentage success of			
				Flowerbuds into flowers.	Flowers into bolls.	Flowerbuds into bolls.	
Limbs	122.2	12.1	4.7	9.9	38.8	3.8	
Primary sympodia ..	139.7	38.7	16.7	27.7	43.2	12.0	
Auxiliaries ..	90.1	9.4	3.9	10.4	41.5	4.3	
Total	352.0	60.2	25.3	17.1	42.0	7.2	

From the foregoing it will be abundantly clear that the growth manifested by the cage plants is not merely the result of the unhampered development of the stem, but is largely the expression of the peculiar environment within the cage. The pale yellow appearance of the leaves and bracts indicating a low content of green matter or the chlorophyll, the elongated condition of the different organs, the protracted nature of both the production and subsequent development of the several organs of the plant are among the characteristics which strongly favour of etiolation. The nature of environmental factors which bring about the differences in the mode and manner of growth of plants within the cage and outside will now be taken up.

CLIMATIC CONDITIONS INSIDE AND OUTSIDE THE CAGE.

Complete climatological data could not be maintained during the first two or three months after sowing as the fields were not accessible owing to rains. Temperature records were, however, kept up by installing a thermograph in a Stevenson's screen placed in the laboratory compound about three furlongs west of the experimental area.

Daily records of the climatic factors were maintained both inside and outside the cage after the cessation of rains. Air temperatures were recorded by means of Six's maximum and minimum thermometer fixed to a post in the midst of the crop area at a height of four and a half feet, from the ground. Humidity was measured by the use of Mason's hygrometer. This was kept by the side of the Six's thermometer, both the instruments being exposed to the north side to avoid the direct rays of the sun.

The total desiccating effect of the climate complex was estimated by measuring the quantity of water lost by evaporation from an open pan. For this purpose, an aluminium vessel, twenty-five cms. in diameter with a capacity to hold 5,500 ccs. of water, was employed. This was lined inside with black paint while its rim was covered with white paint. Further, for eliminating the heating effect of the sides, the vessel was encased in a deal-wood box specially made for the purpose. This was

mounted on a wooden platform in the experimental plot. The approach of birds to this vessel was prevented by enclosing it with a fine net about forty-five cms. away from the pot. The vessel was refilled every day at 8 a.m. with a fresh quantity of tap-water after recording the loss during the past twenty-four hours. Thus, two separate sets of instruments were employed for recording the environmental conditions in the cage and outside.

We shall first compare the seasonal fluctuations in the march of meteorological factors in so far as they related to rainfall, temperatures, humidity, wind velocity and the evaporating power of the atmosphere; correlate them with plant performance under field conditions and then turn to the study of the environmental conditions both inside and outside the cage and their influence on plant growth.

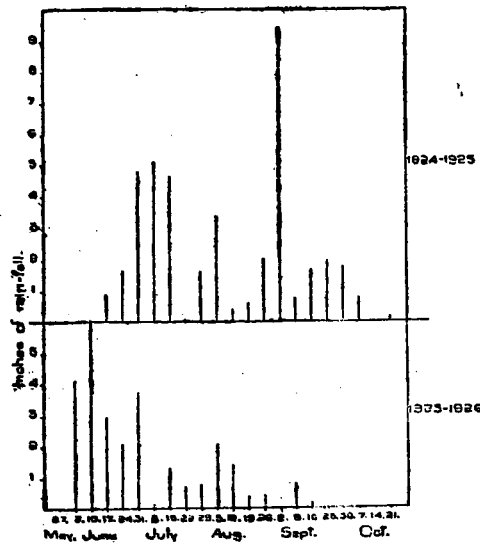
COMPARISON OF THE WEATHER CONDITIONS IN THE YEARS 1924-25 AND 1925-26.

Rainfall.

The two years materially differed with regard to the total amount of rain received and its distribution (Graph No. 32 and Table No. 77 in the Appendix). In the year 1924-25, the rainy season continued up to the end of September, the total rainfall amounting to forty-one inches. The rains, this year, were well distributed. During the next year, however, the total precipitation did not exceed twenty-seven inches and the distribution was also erratic. Nearly nineteen inches of rain fell before sowing (3rd July). The remaining eight inches were obtained during the months of July and August after which the rainy season practically ended. The year 1925-26 was thus drier than the preceding year.

GRAPH NO. 32.

Weekly total rainfall in inches.



Temperature.

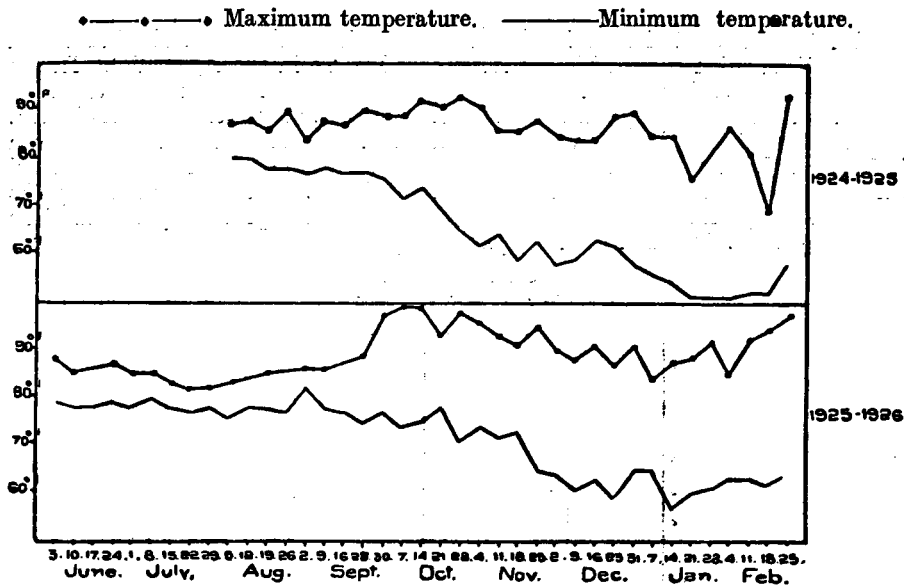
The season of 1925-26 was hotter than the previous one. The maximum temperature this year in the months of October, November and December—the period:

of active growth—was higher by 5° to 10° F., 5° to 7° F., 4° to 7° F., respectively, in the three months. Similarly, the minimum temperature during all these months was higher. It was higher by 2° F. up to the middle of October, by 6° to 14° F. up to the end of November and higher by only one degree during the whole of December (Graph No. 33 and Table No. 78 in the Appendix).

GRAPH No. 33.

Weekly mean maximum and minimum temperatures in 1924-25 and 1925-26.

(Records from a hygrograph housed in a screen in the compound of the laboratory.)



Another important point to which attention may be invited is the time of the commencement of the increasing divergence between the maximum and the minimum temperatures during the two years. In 1924-25, the temperatures diverged from the first of October, while in the next year this occurred a week earlier.

Humidity.

The data on humidity for both the years have been obtained from the records of the Indian Meteorological Station at Surat and these have been studied in addition to those obtained in the field after the end of the rainy season (Table No. 79 in the Appendix). They show that the year 1924-25 was more humid up to the third week of October. Hereafter, however, the humidity was less except in the month of December.

Wind velocity.

Weekly average velocity of the wind in miles per hour was higher during the first year (Table No. 80 in the Appendix).

Evaporating power of the atmosphere.

The evaporating power of the atmosphere represents a single index of the combined effects of all the meteorological factors. It is, therefore, an important measure of the climatic complex. It will be seen from the figures given in Table No. 81 in the Appendix that the rate of evaporation of water was greater in 1925-26, indicating that the tax on water transpired must have been considerable.

Thus, the year 1925-26 was characterised by less rainfall, higher temperatures, less humidity, lighter winds and a higher desiccating power of atmosphere. The effect of all these changes in the environmental conditions on the performance of the field plants had been greater and resulted in an intensive production of vegetative buds, flowers, and bolls and finally a better retention of bolls on the basis of the total flower-buds incepted (Graph No. 29). Further, the span of growth of these plants was shortened by a fortnight or so in spite of the greater virulence of the boll-worm this year.

COMPARISON OF THE CLIMATIC CONDITIONS IN THE CAGE AND OUTSIDE.

The environmental conditions in the cage for the two years are not strictly comparable in view of the modifications introduced in the construction of the cage during the second year which affected, among other things, the light intensity. Hence, a comparison of the atmospheric conditions that prevailed in the cage and outside will only be made for the two years.

Intensity of light.

The most striking difference between the two sets of conditions was in regard to light intensity. While the plants in the open received the full benefit of bright sunshine, those in the cage suffered from weak light intensity. In the second year, the cage was better lighted but the use of the glass panes absorbed some of the light-rays essential for the manifestation of healthy growth.

Temperature.

In the year 1924-25, the maximum temperature in the cage was lower and the minimum higher than that in the open. The difference with regard to the former was of the order of 0.5° to 2° F. while that with regard to the latter varied from 0.5° to 3.5° F. (Graph No. 34).

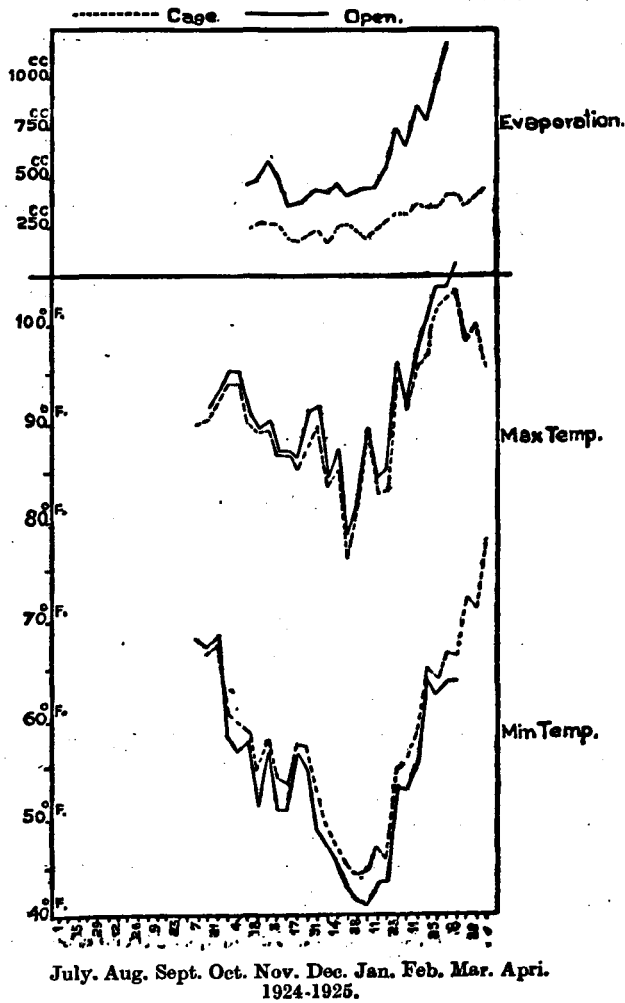
In 1925-26 on the other hand, the maximum temperature in the cage was higher by 0.5° to 1.5° F. (Graph No. 35). The minimum, as in the previous year, was always higher by 1° to 4° F. The higher maximum temperature in the cage during the second year was evidently the effect of the glass panes which being bad conductors gave out heat less readily to the outer atmosphere.

HUMIDITY AND THE WATER EVAPORATING POWER OF THE ATMOSPHERE.

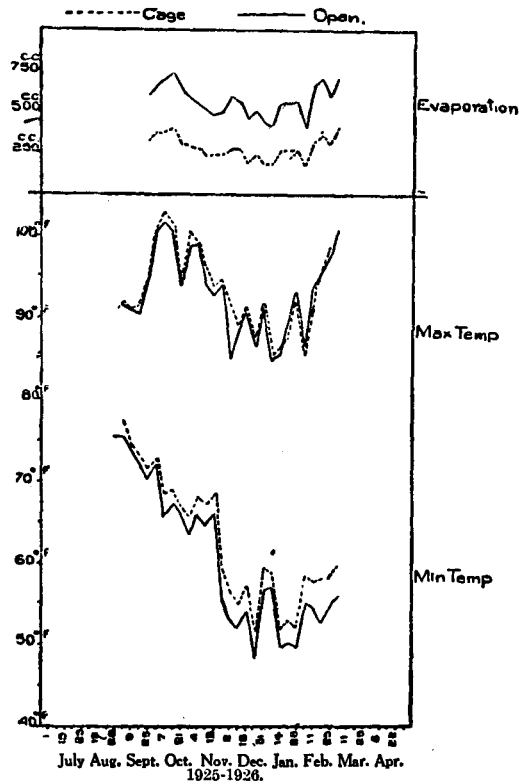
The conditions in the cage during both the years were always distinctly more humid till about 2-30 p.m. Hereafter, the humidity was less than that in the open (Table Nos. 82, 83 and 83A in the Appendix). The water evaporating power of the atmosphere in the cage was much less (Graph Nos. 34 and 35).

GRAPH No. 34.

Weekly mean maximum and minimum temperatures and the rate of water evaporation both in cage and outside.



GRAPH No. 35.
*Mean maximum and minimum temperatures and the rate of water evaporation
 in cage and outside.*



These differences in the environment of the cage and the outside plants were responsible for the characteristic behaviour of growth in the two sets already studied. The etiolated condition of the plants in the cage and the protracted nature of their growth were directly the outcome of low-light intensity and other related factors such as higher humidity, low range of fluctuation in temperature and the resulting low desiccating power of the atmosphere. Further, it has been pointed out in connection with the outside plants that the season of 1925-26 was more conducive to a vegetative type of growth and a better capacity, on the part of the plant, for boll retention. This is seen, though in a less intense form, in regard to the cage plants as well in that year.

Thus although the experiment proved to be successful in keeping out the spotted boll-worm, shedding of buds and bolls continued unchecked, owing probably to the fact that the environment within the cage and outside had not been the same. Thus, the question whether or not shedding of the reproductive organs could be checked if plants were grown in the absence of the boll-worm but under otherwise identical conditions of the environment remained unanswered.

II. PLANTS GROWN IN THE ABSENCE OF BOLL-WORM BY THE METHOD OF "NIGHT-CAGING."

While this was the state of affairs, Kasargode found that the infection of the plant by the spotted boll-worm takes place mainly through two sources, namely, the egg-laying by the moth and the crawling up of the caterpillar from the neighbouring plants. He further discovered as a result of his studies on the life history of this insect that the moth lays eggs on the plant during the night and never by day. On the basis of this knowledge, Kasargode (1927) devised a new and ingenious method for raising plants perfectly free from the spotted boll-worm under normal conditions of environment.

His method is exceedingly simple and requires no technical skill. The equipment necessary is a mosquito-net of suitable dimensions to cover up the whole plant so as to keep out the moth during the night time and a circular, metallic trench about three inches in width to cut off the access of the wandering caterpillar. Before the outbreak of the pest when the plant is between six inches to nine inches in height the trench is introduced and permanently fixed in the ground. It is filled up with water and a small quantity of oil added to form a supernatant layer, water lost by evaporation being replenished everyday. The plant is covered every evening with mosquito-netting fitted up over a light wooden frame ($3' \times 3' \times 4\frac{1}{2}'$) and uncovered every morning. In later years bamboo poles or iron pipes ($\frac{3}{4}$ " in diameter) were substituted in four corners for the wooden frame, to which strings were tied to hold the net. By this means, any number of plants can be protected with a single curtain, each plant requiring independent trenching.

This new method is known by the name of "Night-caging" and the plants grown by this method will be referred to hereafter as "protected plants" so as to distinguish them from those "unprotected" or grown under spotted boll-worm conditions. Kasargode gave a trial to this method on a set of ten plants in 1925-26 and found at the end of the crop season that it surpassed all expectations. With his kind courtesy, we availed ourselves of this method and have grown plants successfully from the year 1926-27, in the absence of the insect.

GROWTH STUDIES OF THE PROTECTED PLANTS.

The development of the protected plants under natural surroundings affords the right type of material for judging the influence of the spotted boll-worm damage on the manner of the plant growth and for elucidating the factors which govern the magnitude of that growth. We may therefore study the development of the plant as it takes place from stage to stage and compare it with that of the unprotected.

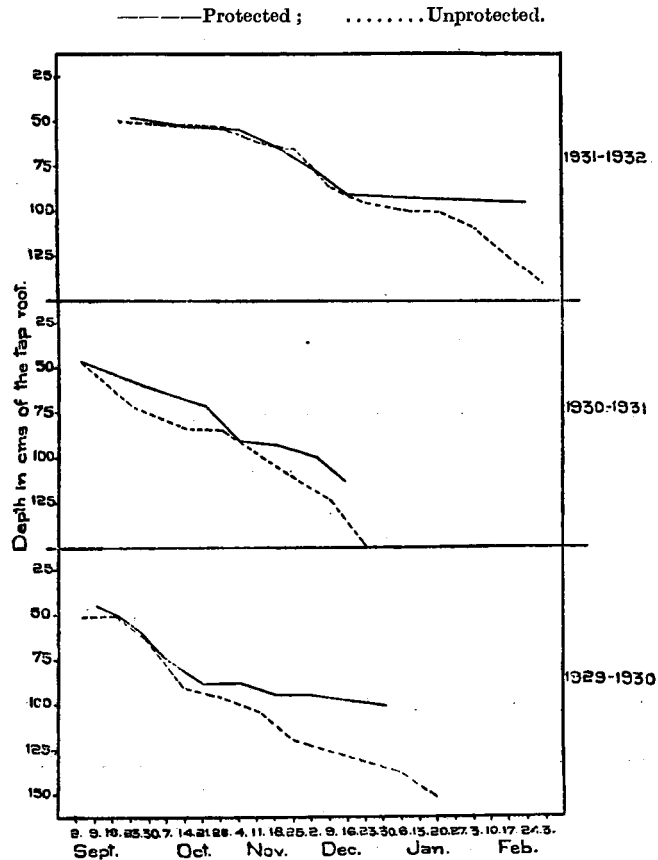
DEVELOPMENT OF THE ROOT SYSTEM.

The study of the root system of the protected plants was started for the first time in the year 1929-30 and was continued till 1931-32. The manner of growth and the general structure of the root system of these plants are essentially the same as those found under the spotted boll-worm conditions (pages 36-48) and need not be repeated. Attention may, however, be drawn here to the differences in the numerical strength of roots of the different orders, their length and the feeding zone of the system as a whole.

The tap root penetrates the soil to an average depth of about 100 cms. within the period of four to five months, the range being from 90 to 120 cms. in the different years (Table No. 84 in the Appendix). It may be further noted that the intensive period of growth of the tap root and its cessation was the earliest in 1929-30; very late in 1931-32 and intermediate in 1930-31 (Graph No. 36).

GRAPH No. 36.

Downward march of the tap root of the protected and the unprotected plants.



The tap root gives rise to a number of primary branches varying from sixty to seventy (Table No. 85 in the Appendix). Out of these twenty to twenty-three grow to their full size to form the frame-work of the system, their length oscillating between 1,350 to 1,500 cms. (Table No. 86 in the Appendix). The majority of these roots are produced before the end of October and are confined to a depth of about thirty to forty cms.

The number of roots of the second order fluctuates every year between 300 to 450 (Table No. 87 in the Appendix). Most of these are very small and represent the absorbing surface. The number of large laterals of this order varies over a wider range and on this account, their lengths exhibit great differences (Table No. 87A in the Appendix). The peculiar environment of the year 1929-30 to be referred to later, was responsible for a material reduction in the number of large laterals of this and the subsequent orders, though by way of compensation as it were the magnitude of small roots happened to be greatly increased so much so that compared with other years the density of roots in relation to total length was nearly doubled. This also occurred in the case of the unprotected plants of this year (Table No. 49 in the Appendix).

The roots of the third order are within the range of 150 to 200, their length varying from 225 to 335 cms. Those of the fourth order are always below twenty-six in number. All these roots are small and go to increase the absorbing surface (Table Nos. 88 and 89 in the Appendix).

The total strength of roots of all the orders in different seasons is within the range of 550 to 650 (Table No. 90 in the Appendix). The number of large roots of the entire system lies somewhere between thirty and fifty-five, the total length fluctuating from 1,700 to 2,800 cms. (Table No. 91 in the Appendix).

Nearly sixty per cent. of tips of the large roots or in other words the feeding zone of the root system lies within the depth of forty cms. (Table Nos. 92, 93 and 94, in the Appendix). The rest are spread in the lower reaches of the soil to a depth of 100 cms. It is needless to say that their number rapidly falls with increasing depth. The following table gives an idea of the downward progress of the large laterals.

TABLE No. 68.

Downward march of large roots of the protected plants.

Fortnight ending	9/9	23/9	7/10	21/10	4/11	18/11	2/12	16/12	30/12	14/1
Years.					Soil	depth in	cms.			
1929-30	30	30	40	50	50	50	50	60	70	70
1930-31 .. ..	..	..	40	50	50	90	90	90	90	100
1931-32 .. ..	..	..	..	40	50	70	80	90	100	100

COMPARISON OF THE ROOT SYSTEMS OF THE PROTECTED AND UNPROTECTED PLANTS.

When the plant gets subjected to the usual damage by the boll-worm, the tap root shows extra growth, reaches lower depths and prolongs its march by an interval varying between three to six weeks. This additional depth is not gained by the tap root during only the extra period of elongation. It will be seen that much earlier in the season the tap root manifests more activity and descends faster into the lower layers of the soil than its contemporary under protected conditions (Graph No. 36). The difference between the rates of descent of the tap roots belonging to the two sets of plants first arises soon after the appearance of the boll-worm and widens steadily with the virulence of attack.

The number of large laterals and their length is less in the protected plants while the density of roots per unit length has been found to be higher (Table No. 69).

TABLE NO. 69.

Comparison of the root systems of the protected and the unprotected plants.

	1929-30.		1930-31.		1931-32.	
	Protected.	Un-protected	Protected.	Un-protected	Protected.	Un-protected
<i>Roots of the 1st order.</i>						
Number of small roots ..	56	56	40	25	41	30
Number of large roots	23	21	22	25	24	23
Length of large roots in cms. ..	1342	1549	1461	1671	1494	1800
<i>Roots of the 2nd order.</i>						
Number of small roots ..	461	468	286	316	316	316
Number of large roots	8	6	31	32	28	34
Length of large roots in cms. ..	364	574	1136	1578	1059	1203
<i>Roots of the 3rd order.</i>						
Number of small roots ..	144	133	171	236	218	165
Number of large roots	0.4	1	4	5	9	5
Length of large roots in cms. ..	6	30	239	318	385	175
<i>Roots of the 4th order.</i>						
Number of small roots ..	..	10	26	34	16	15
Number of large roots .. ..	..	..	1	1	0.2	0
Length of large roots in cms. ..	..	..	12	45	4	..
<i>Roots of all orders.</i>						
Number of small roots ..	638	638	491	613	555	501
Number of large roots	29	32	56	60	57	59
Total No. of roots	667	670	547	673	612	560
Total length of all large roots in cms.	1746	1976	2795	3547	2831	2888
The number of roots per 100 cms.	38.2	35	19.5	19	21.6	19.4

Other important differences between the root systems of the two sets are those related to the period of their growth, their dry matter and the extent of depth reached by them. Under protected conditions, the plant builds up its root system earlier by a period which varies from three to six weeks in different years. Further, with the commencement of damage by the boll-worm, the dry matter of the roots of the unprotected plants increases at a greater rate (Table No. 95 in the Appendix). Consequently, the root system of the protected becomes relatively lighter. Finally, although the zone of the majority of roots in the two sets is the same, differences arise in regard to the extent of depth reached by the rest. These roots in the protected plants go to a depth of about 100 cms., while those in the unprotected penetrate the depth of 150 cms.

To sum up, it may be stated that the root system of the protected plants is less extensive and is built up within a shorter time. It is shallow, lighter and more dense in its spread, the rate of descent during the progress of growth being conspicuously less.

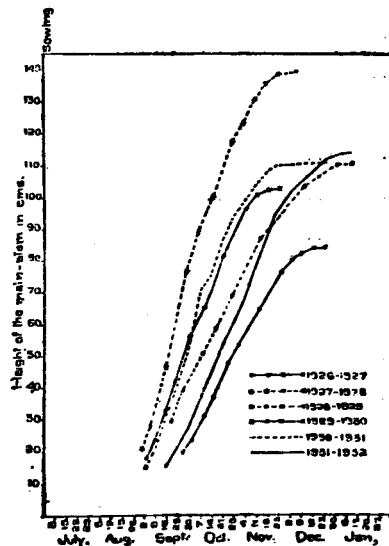
DEVELOPMENT OF THE SHOOT.

Growth of the main stem.

It may be recalled that under crop conditions the main axis of the cotton plant gets pruned by the spotted boll-worm or the shoot-roller specially during the months of September and October. In the case of plants protected from the spotted boll-worm, nearly eighty-five to ninety per cent. of the shoots grow unhampered in their main stem while the rest are damaged by the shoot-roller. The average progressive height reached by the stem from time to time during the season, varies a good deal in different years (Graph No. 37) with regard to the time of accelerated growth, its rate and duration (Table No. 96 in the Appendix).

GRAPH No. 37.

Average progressive height of the main stem of the protected plants.



Normally, the stem grows to a height of 110.7 cms. with a S.D. 11.22 (Table No. 70). The yearly differences which range between eighty-five and 140 cms. are

TABLE No. 70.

Average height of main stem and the period of its elongation.

Years.	Number of plants under measurement.	Date of sowing.	Cessation of stem elongation in week ending.	Days between sowing and cessation of elongation.	Average total height in cms.
1926.. ..	9	4th July ..	17th December ..	167	85
1927.. ..	9	2nd July ..	8th January ..	191	111
1928.. ..	19	7th July ..	30th November	147	140
1929.. ..	18	15th July ..	18th November	126	103
1930.. ..	20	26th June ..	24th November	152	111
1931.. ..	15	2nd July ..	4th January ..	187	114
Average .. ..	.....	.....	.....	161.7	110.7

statistically significant as will be noticed from the following calculations. The period of its growth from the date of sowing works up to 161 days as the average.

PROTECTED PLANTS.

Significance of variation in height of the main stem in centimeters from year to year.

Year.	1926-27.	1927-28.	1928-29.	1929-30.	1930-31.	1931-32.
Number of plants under study.	9	9	19	18	20	15
Mean	84.555	110.722	139.552	102.777	111.050	114.166
Standard Deviation ..	50.548	9.676	16.470	8.498	11.170	8.841
.. Error of Mean	1.849	3.225	3.778	2.042	2.499	2.284

Mean=113.25

S. D. =11.22, i.e., 9.91 % of the mean.

Analysis of Variance.

	Degrees of freedom.	Sum of squares.	Mean square.	1/2 log _e Mean square.
Between years	5	22696.00	4539.20	1.9075
Within years	84	10570.63	125.84	0.1147
	89	33266.63	373.78	1.7928

According to Fisher's table of Z for $N_1=5$ and $N_2=84$, $Z=0.3974$ when $P=0.05$, and 0.5522 when $P=0.01$.

The seasonal differences are significant.

The duration of this period appears to be independent of early or late sowing and is governed entirely by seasonal influences. In 1929-30, in spite of the late sowing the growth of the stem ceased within the shortest period of 126 days. In 1927-28 on the other hand, although sowing was done thirteen days earlier the growth extended over 190 days. The earliest sowing took place in 1930-31; the stem nevertheless continued to grow for a period of 150 days.

Similarly the height of the stem and the time during which it is made up, bear no relation to each other. Thus in the year 1927-28, although the period of growth was the longest the growth failed to exceed 111 cms. In 1928-29, the stem grew to 140 cms. in as short a period as 147 days.

It is during two years out of six under study that the accelerated growth of the main stem took place earlier within the first eight weeks (Table No. 71). The

TABLE No. 71.

Percentage of the total height attained by the stem at different times in the season.

Years.	Weeks from sowing.									
	0-8	8-10.	10-12.	12-14.	14-16.	16-18.	18-20	20-22.	22-24.	24-26.
1926-27 ..	..	..	22.6	35.1	53.8	68.8	83.8	94.7	99.3	100.0
1927-28 ..	..	..	35.1	46.6	59.4	71.9	82.6	90.2	96.0	100.0
1928-29 ..	14.1	31.9	54.5	69.3	83.7	93.0	99.1	100.0	..	..
1929-30 ..	24.2	45.2	61.4	79.2	93.7	99.7	100.0	..	..	..
1930-31 ..	..	12.5	27.8	47.4	67.6	84.1	93.4	99.1	99.7	100.0
1931-32 ..	..	12.6	23.2	38.8	52.0	67.3	82.9	91.2	96.9	100.0
Average ..	6.7	18.0	38.4	53.8	69.3	81.6	90.8	96.0	98.6	100.0

acceleration of growth generally begins in other years after this time. Earlier intensity in growth leads to earlier cessation of the elongation of the stem and consequently of vegetative expansion of the plant as a whole. The different years can be arranged as follows according to the time of accelerated growth of the main stem. (Earliest) 1929, 1928, 1930, 1927, 1926 and 1931 (Latest). The last two years are rather identical in this respect.

Early or late growth of the stem in a season is intimately associated with the number of the node from which the first fruiting branch arises (Table No. 72). Thus in 1929-30, the stem manifested intensive growth very early in the season and in effect the number of node of the first primary sympodium was reduced to fourteen. On the other hand in 1926-27 and 1931-32, the years characterised by late growth, the place of the first fruiting branch on the stem was the eighteenth and nineteenth node respectively.

TABLE No. 72.

Average node-number of the first fruiting branch on the main stem.

Years.	1926-27.	1927-28.	1928-29.	1929-30.	1930-31.	1931-32.	Average.
Plants under observation ..	10	14	20	20	20	19	
Mean node number of the first fruiting branch on the main stem.	18.4	16.9	15.34	14.4	16.15	19.4	16.8

The total production of nodes on the main stem during the season varies in different years within the range of thirty-eight and forty-eight (Table No. 73), average production amounting to 42.49 with a S.D. of 2.182. The year to year

TABLE No. 73.
Average number of nodes on the main stem.

Year.	1926.	1927.	1928.	1929.	1930.	1931.	Average.
Number of plants under growth counts.	9	9	19	18	20	15	
Mean number of nodes on the main stem.	41.1	47.8	44.1	38.2	40.7	45.7	42.93
Average height in cms. of the main stem.	85	111	140	103	111	114	110.7

differences are statistically significant as will be clear from the following calculations,

PROTECTED PLANTS.

Significance of variation in height of the main stem in node numbers from year to year.

	1926-27.	1927-28.	1928-29.	1929-30.	1930-31.	1931-32.
Number of plants under study.	9	9	19	18	20	15
Mean	41.11	47.78	44.05	38.22	40.7	45.67
Standard Deviation ..	2.147	2.387	2.321	1.477	2.755	1.676
Standard Error of the mean.	0.7156	0.796	0.532	0.348	0.616	0.433

Mean=42.49

S.D.= 2.182, i.e., 5.135% of the mean.

Analysis of variance.

	Degrees of Freedom.	Sum of squares.	Mean square.	$\frac{1}{2}$ log. Mean square.
Between years	5	858.46	171.692	2.57283
Within years	84	400.04	4.762	0.78033
Total	89	1258.50	14.100	1.79250

According to Fisher's table of Z for $N_1=5$ and $N_2=84$, $Z=0.3974$ when $P=0.05$, and 0.5522 when $P=0.01$.

The seasonal differences are therefore significant.

Note.—The calculations given in this table and those given on pages 111, 115, 117, 122 and 125, were kindly worked out for us by Dr. R. J. Kalamkar, Ph.D., of the Agricultural Meteorological Research Scheme, Poona, and the authors are indebted to him for the assistance.

and are attributable to seasonal differences. The number of nodes does not necessarily increase with the increase in height of the stem. In 1926-27, while the stem grew to a height of eighty-five cms. and produced forty-one nodes, in 1930-31 its height increased to 111 cms. in spite of the same number of nodes. This is again illustrated in the case of other years as well. The growth of the stem in 1928-29 was characterised by longest internodes while that in 1926-27 by the shortest ones.

SYSTEM OF BRANCHING.

The mode of branching and the manner of development of the different kinds of branches do not materially differ from those studied in the previous chapter on the unprotected plants. The essential difference is that under conditions of protection, the growth of branches takes place quite undisturbed and consequently the plant acquires a conical shape (Plate No. 6).

The average production of limbs is about twelve with a seasonal variation ranging between nine and fourteen (Table No. 74). Out of these, nearly fifty per

TABLE No. 74.

Average production of limbs, primary sympodia and auxiliaries on the cotton plant.

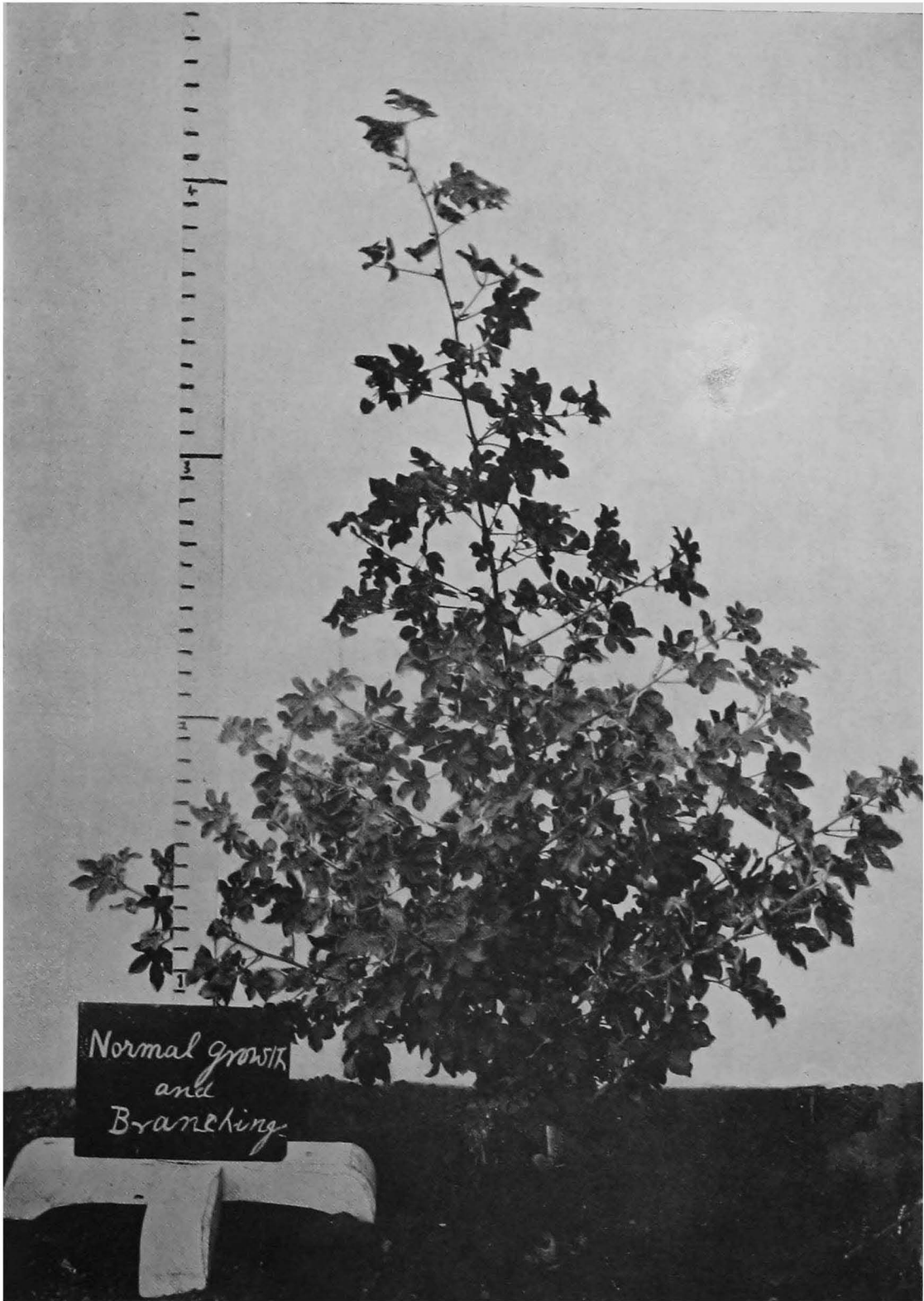
(For individual performance, refer to Table Nos. 97 to 101 in the Appendix.)

Year.	Number of plants under study.	Limbs.			Primary sympodia.	Auxiliaries.			Height of the main stem in cms.
		Large.	Small.	Total.		Large.	Small.	Total.	
1926-27 ..	9	5.5	8.7	14.2	32.1	8.1	7.7	15.8	85
1927-28 ..	9	5.0	4.2	9.2	34.8	15.4	11.2	26.6	111
1928-29 ..	19	7.0	5.3	12.3	34.3	16.3	8.6	24.9	140
1929-30 ..	18	7.3	6.4	13.7	27.8	8.9	5.5	14.4	103
1930-31 ..	20	5.5	5.8	11.3	28.7	10.2	3.8	14.0	111
1931-32 ..	15	8.4	5.6	14.0	33.9	7.0	8.3	15.3	114
Average of six years.	..	6.4	6.0	12.4	31.9	11.0	7.5	18.5	110.7

cent. develop into large branches and give rise to secondary sympodia, the rest remaining small and "ineffective." The total number of primary sympodia varies from year to year from twenty-eight to thirty-five. The average for all years in this regard works up to 31.9. The total production of auxiliaries is much larger than that of the limbs and stands at eighteen, the annual range of variation being between fourteen and twenty-six. The effective branches belonging to this class number as much as eleven.

PLATE No. 6.

Normal growth and branching.



Thus, the cotton plant produces on an average about twelve limbs, eighteen auxiliaries and thirty primary sympodia showing a rising grade in production with the rising level on the stem. Further, the ratio of primary sympodia to effective limbs and auxiliaries put together increases with increasing lateness in growth of the stem. This will be more particularly observed if alternate years of the series referred to before (page 114) are compared. For, in this order of procedure the seasonal variations are well defined and the differences in the ratios more marked.

The number of primary sympodia is always greater than the number of nodes on the main stem above the node at which the first sympodium arises. This is because accessory sympodial branches spring up from certain nodes. This tendency is more pronounced in years of late growth (Table No. 75). Thus in 1926-27 and 1931-32, the number of accessory sympodia was about nine, while in the other years where the growth was comparatively early, it was about four.

TABLE No. 75.
The number of accessory sympodia in different years.

Earliest.	1929-30.	1928-29.	1930-31.	1927-28.	1926-27.	1931-32.
Accessory sympodia ..	4.0	5.5	4.1	3.9	9.3	8.0

EFFECT OF DAMAGE TO MAIN SHOOT ON THE PRODUCTION OF BRANCHES.

Under field conditions, as the stem happens to be damaged by the shoot-roller and the spotted boll-worm at various heights, the number of auxiliaries and primary sympodia is sensibly reduced (Table No. 76). Whereas the protected plants give rise on an average to eighteen auxiliaries and thirty primary sympodia, the unprotected are not allowed to produce more than ten branches belonging to each type. It may be expected that this serious reduction in the number of sympodial and auxiliary branches should lead to increased production of limbs. This happens by increasing the number of effective branches of this order.

TABLE No. 76.
Average production of branches in the unprotected plants.

Year.	Number of plants.	Limbs.			Primary fruiting branches.	Auxiliary branches.			Total.
		Large.	Small.	Total.		Large.	Small.	Total.	
1923-24 ..	99	7.0	2.6	9.6	11.5	7.8	1.0	8.8	29.9
1924-25 ..	50	8.24	2.34	10.58	14.94	8.90	2.64	11.54	37.06
1925-26 ..	10	5.2	5.2	10.4	6.0	2.1	2.7	4.8	21.2
1926-27 ..	10	5.7	5.4	11.1	17.4	9.3	6.7	16.0	44.5
1927-28 ..	20	7.10	6.35	13.45	8.05	5.05	5.45	10.50	32.00
1928-29 ..	20	7.55	4.65	12.20	9.95	9.15	5.20	14.35	36.5
1929-30 ..	18	10.3	6.8	17.1	9.8	8.4	3.9	12.3	39.2
1930-31 ..	20	7.50	4.00	11.50	10.10	8.55	4.40	12.95	34.55
1931-32 ..	20	7.35	4.55	11.90	4.30	2.50	2.95	5.45	21.65
Average.		7.3	4.7	12.0	10.2	6.9	3.9	10.8	33.0

It is important to state further that the percentage increase of effective limbs rises or falls according to the extent to which the plant is permitted to produce the normal number of auxiliaries indicated by the protected plants. If the stem is damaged after production of auxiliaries equal to those in the protected (Table No. 77), the percentage increase of effective limbs is enhanced.

TABLE No. 77.
Percentage increase of limbs in the unprotected plants.

Year.	1926-27.	1927-28.	1928-29.	1929-30.	1930-31.	1931-32.
Percentage increase in the production of effective limbs	12.3	1.5	4.9	6.9	16.6	1.8
Percentage of total production of auxiliaries when the stem is damaged by boll worm*	101.3	39.4	57.6	85.4	92.5	35.7

If on the other hand the production of auxiliaries is less than that in the protected, the percentage increase of effective limbs is greatly reduced. Pruning of the main stem after the appearance of about forty per cent of the expected auxiliaries in a given season, exerts no influence on raising the percentage of effective limbs.

PRODUCTION OF VEGETATIVE BUDS.

Average production of vegetative buds in the protected plants amounts to 335.55 with a S.D. of 78.44 (Table No. 78). The number of buds incepted from year to year varies widely from 227 to 535 and the differences are statistically

TABLE No. 78.
Comparative production of vegetative buds in the protected and unprotected plants.

Year.	1926-27	1927-28	1928-29	1929-30	1930-31	1931-32	Average.
Number of plants under growth counts.	10	Protected plants.					..
		14	20	20	20	20	
Average Number of vegetative buds produced.	257	535	426	288	227	300	339
Number of plants under growth counts.	10	Unprotected plants.					..
		20	20	18	20	20	
Average Number of vegetative buds produced.	328	627	431	371	328	371	410

significant as will be seen from the following calculations. The period of six years covered by these studies falls into two broad divisions: years during which total inception has been very high and those in which it is low.

$$* \text{ These are calculated as } \frac{\text{number of auxiliaries in unprotected.}}{\text{number of auxiliaries in protected.}} \times 100.$$

PROTECTED PLANTS.

Significance of variation in the number of vegetative buds from year to year.

Year.	1926-27.	1927-28.	1928-29.	1929-30.	1930-31.	1931-32.
Number of plants under study.	10	14	20	20	20	20
Mean	257.8	535.5	426.55	287.95	226.75	299.85
S.D.	43.69	137.9	89.95	56.85	46.50	65.90
S.E. of the mean ..	13.83	36.87	20.12	12.72	10.40	10.74

Mean=335.55

S.D.= 78.44, i.e., 23.38% of the mean.

Analysis of variance

	Degrees of freedom.	Sum of squares.	Mean square.	$\frac{1}{2}$ log _e Mean square.
Between years	5	1093398.01	218679.60	2.6936
Within years	98	602989.75	6152.96	0.9084
Total	103	1696387.76	16469.78	1.7852

According to Fisher's table of Z for $N_1=5$ and $N_2=98$, $Z=0.3974$ when $P=0.05$, and 0.552 , when $P=0.01$.

The seasonal differences are therefore significant.

The intensity of periodical inception of vegetative buds has taken place exactly in the same order in which the growth of the main axis has occurred in different years (Table No. 79). Similarly, early acceleration of the rate of inception

TABLE NO. 79.

Progressive production of vegetative buds in terms of percentage of the total production.

Year.	Weeks from sowing.											
	0-8	8-10	10-12	12-14	14-16	16-18	18-20	20-22	22-24	24-26	26-28	28-30
1926-27 .. ..	..	..	7.2	16.5	35.3	53.8	73.6	87.9	95.4	97.8	99.3	100.0
1927-28 .. ..	..	..	9.5	19.0	38.0	54.4	73.2	84.9	92.8	97.1	99.1	99.9
1928-29	4.0	11.3	25.2	41.9	66.9	86.0	96.2	99.7	100.0	..	..	..
1929-30	7.4	23.5	51.6	77.4	89.5	97.7	99.8	100.0	..	..	..	..
1930-31 .. ..	..	5.3	14.0	25.8	46.5	65.8	84.2	96.2	99.0	99.9	100.0	..
1931-32 .. ..	..	4.5	9.5	21.3	32.4	46.5	66.5	78.7	89.7	98.3	100.0	..
Average	1.9	6.9	19.0	32.9	51.2	67.2	82.1	90.9	95.9	98.7	99.7	100.0

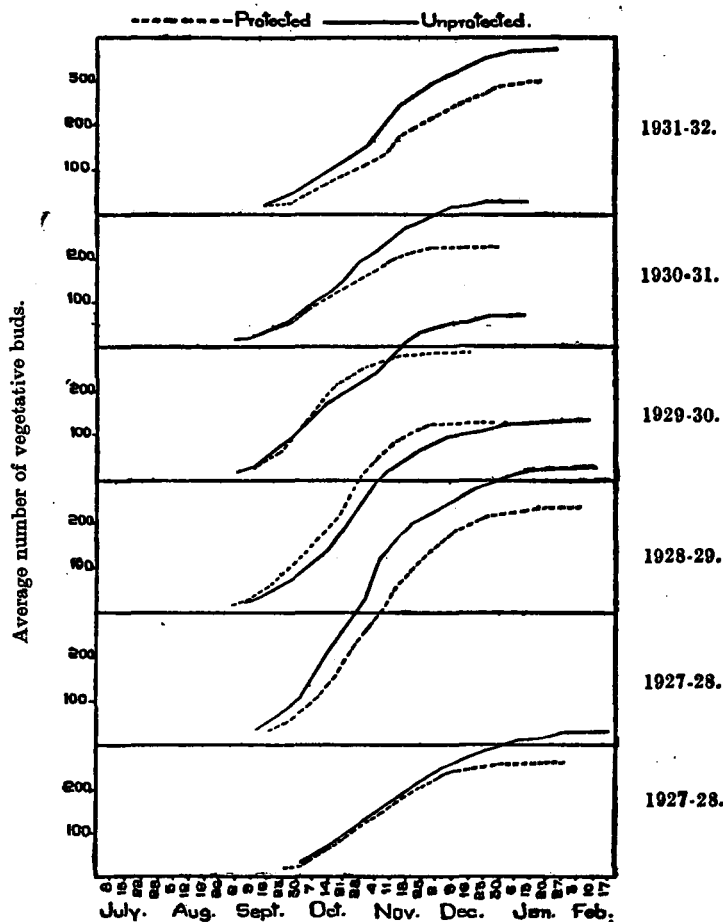
leads to its early cessation. The rate is generally very low in the first two months but gets intensified after this period.

COMPARISON OF VEGETATIVE BUD PRODUCTION IN THE PROTECTED AND UNPROTECTED PLANTS.

The most notable differences which arise between the protected and the unprotected plants are with respect to the magnitude and duration of vegetative bud production. In the former set, the total inception of vegetative buds is, as a rule, less and the span of production is shorter by about a fortnight or so. (Graph No. 38 and Table No. 102 in the Appendix.) As in the case of roots, in the present

GRAPH No. 38.

Comparison of the average progressive production of vegetative buds in the protected and the unprotected plants.



case also, the extra production of vegetative buds in the unprotected plants is not due so much to the additional period as to the higher rate of inception which commences pretty early in the season.

PRODUCTION OF FLOWER-BUDS.

Average production of flower-buds varies from 216 to 528 with a mean of 347.81 with S.D. of 93.05 (Table No. 80).

TABLE NO. 80.

Comparison of average production of flower-buds in the protected and the unprotected plants.

Years.	1926-27.	1927-28.	1928-29.	1929-30.	1930-31.	1931-32.	Average.
		<i>Protected Plants.</i>					
Number of plants under growth-counts.	10	14	20	20	20	20	..
Number of flower-buds ..	215.7	525.93	528.4	278.4	230.95	294.85	345.7
		<i>Unprotected Plants.</i>					
Number of plants under growth-counts.	10	20	20	18	20	20	..
Number of flower-buds ..	312.7	312.6	303.1	297.5	293.1	203.85	287.1
Difference	97.0	-213.33	-225.3	19.1	62.15	-91.00	-58.6

The seasonal differences are statistically significant as will be evident from the following calculations.

PROTECTED PLANTS.

Significance of variation in the number of flower-buds from year to year.

Years.	1926-27.	1927-28.	1928-29.	1929-30.	1930-31.	1931-32.
Number of plants under study.	10	14	20	20	20	20
Mean	215.7	525.93	528.4	278.4	230.95	294.85
Standard deviation ..	50.18	114.9	133.4	63.88	75.63	82.75
Standard Error of the mean.	15.88	30.72	29.84	14.29	16.92	18.51

Mean=347.81

S.D.=93.05, i.e., 26.75% of the mean.

Analysis of Variance.

	Degrees of freedom.	Sum of squares.	Mean square.	$\frac{1}{2} \log_e$ Mean square.
Between years	5	1696528.02	339305.60	2.9134
Within years	98	848406.13	8657.20	1.0792
Total	103	2544934.15	24708.10	1.8342

According to Fisher's table of Z for $n_1=5$ and $n_2=98$, $Z=0.3974$, when $P=0.05$ and 0.5522 when $P=0.01$.

The seasonal differences are therefore significant.

Plants in the years 1927-28 and 1928-29 showed exuberance of growth and in consequence, the number of buds incepted in these years was nearly twice that in any of the remaining years.

Flower-buds begin to appear within ten weeks after sowing and their intense production starts two weeks later (Table No. 81). The span of their inception varies every year within the range of six to eight weeks. The several years under

TABLE No. 81.

Progressive production of flower-buds during the season in terms of percentage of the total flower-buds incepted.

Year.	0-8	8-10	10-12	12-14	14-16	16-18	18-20	20-22	22-24	24-26	26-28
1926-27 .. ..	..	..	0.6	4.8	19.2	41.5	67.8	89.0	98.4	99.9	100.0
1927-28 .. ..	..	..	2.8	8.5	18.4	35.2	64.5	82.7	93.8	98.4	99.8
1928-29	0.1	2.7	10.9	26.1	58.8	80.4	96.1	99.8	100.0	..	..
1929-30	0.4	6.6	22.6	49.9	77.4	97.4	100.0	..	..	..	..
1930-31 .. ..	..	0.4	2.5	9.6	32.5	61.0	82.5	96.6	99.8	100.0	..
1931-32 .. ..	..	..	0.8	4.6	11.1	28.4	55.0	76.1	92.1	98.7	100.0
Average	0.1	1.8	7.1	17.9	37.3	57.9	78.6	90.9	97.1	99.4	100.0

study range themselves in the same order of early or late acceleration of the rate of flower-bud inception as that observed in respect of growth of the stem and production of vegetative buds. The years 1926-27 and 1927-28 have, however, interchanged their places.

COMPARISON OF FLOWER-BUD PRODUCTION IN THE PROTECTED AND UNPROTECTED PLANTS AND THE EFFECT OF SHOOT-PRUNING.

While the magnitude of flower-bud production varies a good deal in the protected plants from 216 to 528, it remains pretty steady in the unprotected plants at about 300 except in 1931-32 (Table No. 80). It will be seen that the effect of pruning the main shoot by the spotted boll-worm does not always lead to larger production of flower-buds. In years 1927-28, 1928-29 and 1931-32 the number of buds incepted was sensibly less than that in the protected plants. On the other hand, it increased in the remaining three years. These differences cannot be explained on the ground of seasonal changes in the environment as they have occurred during the same season. The differences have to be mainly ascribed to the stage of plant growth at which the shoot happens to be damaged. It has already been noted that if the shoot is injured after production of all the auxiliaries of which the season is capable, the percentage increase of effective limbs is enhanced. If, however, it is pruned earlier, the number of lower monopodia which give rise to flower-buds is reduced. As the main stem is damaged generally within the zone of auxiliaries and as no correct measure for judging the percentage increase in their effectiveness is available, it may reasonably be assumed that what happens to the plant in regard to the limbs must be taking place with regard to the upper primary laterals as well.

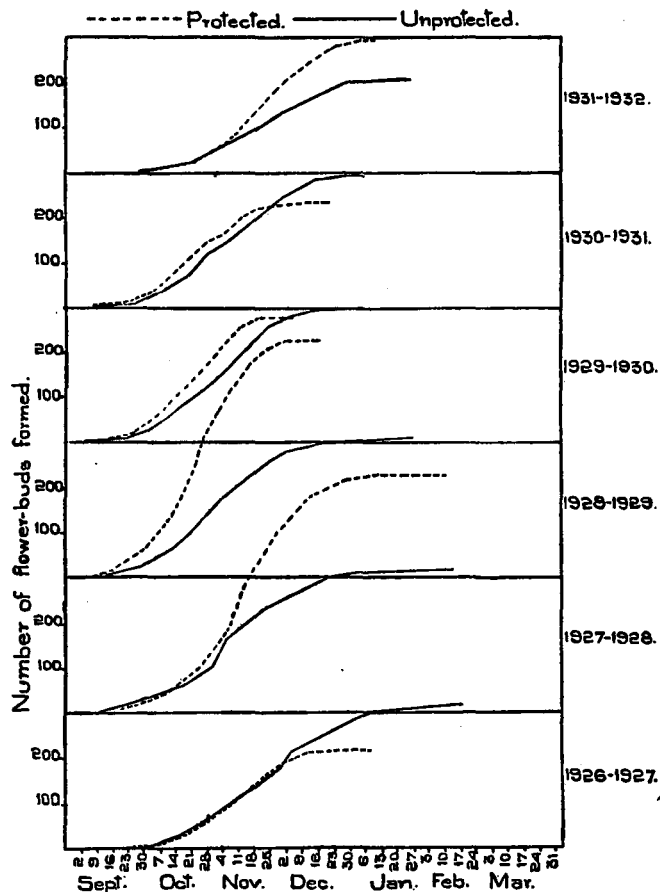
On the strength of this knowledge, it will be seen that the years during which production of flower-buds in the unprotected is higher than that in the protected, are characterised by an increase in the number of effective limbs and *vice versa*,

production of about forty per cent. of the normal number of auxiliaries being the lowest limit of this variation.

Another point which needs special mention is with regard to the period of bud inception. This is prolonged in the unprotected by an interval which varies in different years from one to four weeks (Graph No. 39 and Table No. 103 in the Appendix).

GRAPH NO. 39.

Progressive production of flower-buds during the season, in the protected and unprotected plants.



PRODUCTION OF FLOWER-BUDS ON DIFFERENT TYPES OF BRANCHES.

Production of flower-buds by different kinds of branches varies a good deal in different years (Table No. 82). Limbs, primary sympodia and auxiliaries show no definite relation to one another in this respect. As the average of six years, it

may be said that the sympodia contribute the largest share towards total bud-production; the limbs stand second while the auxiliaries occupy a third position.

TABLE No. 82.

Flower-bud production on different kinds of branches.

Years.	Number of plants averaged.	Number of flowers on.				Percentage bearing of the total on.		
		Limbs.	Primary sympodia.	Auxiliaries.	Total.	Limbs.	Primary sympodia.	Auxiliaries.
1926-27	9	78·9	95·8	43·0	217·7	36·2	44·0	19·8
1927-28	9	125·3	167·4	167·4	460·1	27·2	36·4	36·4
1928-29	19	156·0	177·2	196·5	529·7	29·5	33·4	37·1
1929-30	18	101·0	104·6	71·8	277·4	36·4	37·7	25·9
1930-31	20	73·25	114·35	43·85	230·95	31·7	49·6	18·8
1931-32	15	122·5	123·0	55·3	301·1	40·8	40·8	18·4
Average .. .. .	..	109·5	130·4	96·2	336·1	32·6	38·8	23·6

This order, however, is not followed every year though it appears to be frequent.

COMPARISON OF THE RATIO OF VEGETATIVE BUDS TO FLOWER-BUDS IN THE PROTECTED AND UNPROTECTED PLANTS AND THE EFFECT OF SHOOT-PRUNING.

The ratio of vegetative buds to flower-buds in the protected plants is nearly one in all years (Table No. 83). In the unprotected plants, however, it has considerably varied. On this account, the difference between the ratios of the two sets has failed to remain constant. Years (1926-27, 1929-30 and 1930-31) in which the percentage increase of effective limbs is high, the ratio difference fluctuates between minus 0·15 to plus 0·18; those (1927-28, 1928-29 and 1931-32) in which it is low, the value of the difference stands somewhere between 0·62 and 0·99. This behaviour of the plant is very important as it leads to the observation that if pruning of the main stem occurs before production of about forty per cent. of the expected number of auxiliaries in a given season, the result of the damage is reflected on greater production of vegetative buds.

TABLE No. 83.

Comparison of the ratio of vegetative buds to flower-buds in the protected and unprotected plants.

Years.	1926-27.	1927-28.	1928-29.	1929-30.	1930-31.	1931-32.	Average.
Number of plants under counts.	10	<i>Protected Plants.</i>			20	20	..
Number of vegetative buds	257	14	20	20	227	300	339
Number of flower-buds ..	216	535	426	288	231	295	346
Ratio	1·2	1·02	0·8	1·04	0·98	1·02	0·98
Number of plants under counts	10	<i>Unprotected Plants.</i>			20	20	..
Number of vegetative buds	328	20	20	18	328	371	410
Number of flower-buds ..	313	627	431	371	293	204	287
Ratio	1·05	2·01	1·42	1·24	1·1	1·8	1·43
Difference in Ratio ..	0·15	0·99	0·62	0·18	0·12	0·78	0·45

AGE OF BUDS AT FLOWERING.

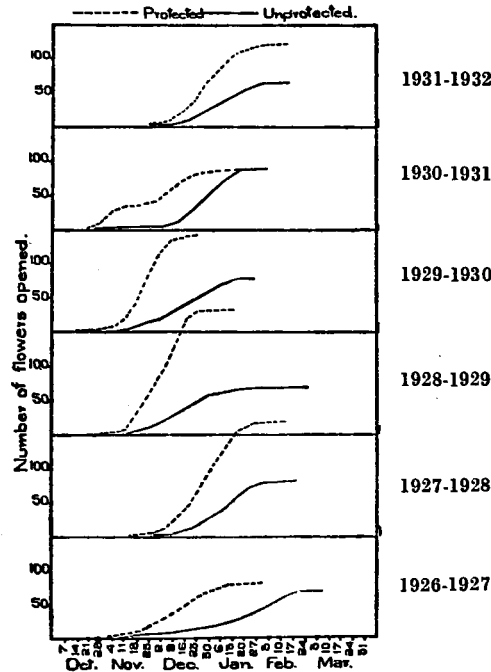
Age of buds at flowering varies a good deal not only in the same season but also in different seasons (Table No. 84). The ages are related to the early or late growth of the plant. Plants in the year 1929-30 were conspicuous for their earliness in growth and consequently not only the whole period of flowering was shifted earlier but the buds also showed a tendency to blossom within a shorter interval. Plants in 1931-32, on the other hand, were characterised by a very late growth. This year, buds took the longest time to flower. The same thing was again exhibited in other years.

TABLE NO. 84.
Frequency of buds according to age at flowering.
Protected plants.

Years.	Number of plants under counts.	Class value in days taken by buds to bloom.										
		8-14	15-21	22-28	29-35	36-42	43-49	50-56	Rest.	Total.	Mean	S. E. of mean.
		Number of buds.										
1926-27 ..	10	..	1	35	300	377	76	6	..	804	36.49	0.18
1927-28 ..	14	..	..	Data not collected.			..	..	..	..	..	..
1928-29 ..	20	6	13	480	2,236	864	42	1	..	3,652	32.80	0.08
1929-30 ..	20	3	109	1,128	1,380	151	3	..	..	2,784	25.99	0.09
1930-31 ..	20	..	18	631	880	174	5	..	..	1,708	30.05	0.11
1931-32 ..	20	..	1	25	533	1,287	529	42	1	2,418	39.08	0.10

GRAPH NO. 40.

Progressive production of flowers in the protected and unprotected plants.



FLOWERING.

Flowering in the protected plants commences generally in the second fortnight of October and ceases some time in the month of January. In 1926-27 and 1930-31, the rate of flowering was less intense and the period of production was prolonged. High rate of flower formation is associated with a short span of flowering. (Graph No. 40 and Table No. 104 in the Appendix.)

The average number of flowers per plant in the different years and the statistical significance of the differences is shown in the following calculations.

Significance of variation in the number of flowers from year to year.

Protected plants.

Years.	1926-27.	1927-28.	1928-29.	1929-30.	1930-31.	1931-32.
Number of plants under study.	10	14	20	20	20	20
Mean	80.4	169.21	182.6	139.25	85.4	120.9
Standard Deviation ..	15.99	36.73	41.08	33.22	29.77	31.83
Standard Error of the mean.	5.06	9.82	9.19	7.43	6.66	7.12

Mean=132.08

S.D.=33.34, i.e., 25.24 % of the mean.

Analysis of Variance.

	Degrees of freedom.	Sum of squares.	Mean square.	$\frac{1}{2} \log_e$ Mean square.
Between years	5	144167.47	28833.494	1.6807
Within years	98	108955.91	1111.795	0.0526
Total	103	253123.38	2457.508	1.6281

According to Fisher's table for Z of $n_1=5$ and $N_2=98$, $Z = 0.3974$, when $P=0.05$ and 0.5522 when $P=0.01$.

The seasonal differences are therefore significant.

FLOWERING IN THE PROTECTED AND UNPROTECTED PLANTS.

Owing to incessant damage to flower-buds by the spotted boll-worm, flowering is delayed and its span protracted by a fortnight in the unprotected plants. (Table No. 85.) Further, the number of flowers is always less than that in the protected. This is due to increased shedding of flower-buds caused by the spotted boll-worm as will be seen later.

TABLE No. 85.

Time of the commencement and cessation of flowering in the protected and unprotected plants.

(Average results.)

Years.	1926-27	1927-28	1928-29	1929-30	1930-31	1931-32	Average.
Number of plants under counts.	10	14	20	20	20	20	..
	<i>Protected Plants.</i>						
Commencement of flowering in week ending.	24/10	13/11	28/10	20/10	19/10	22/11	..
Cessation of flowering in week ending.	16/1	29/1	30/12	15/12	4/1	31/1	..
Period of flowering in weeks.	12	11	9	8	11	10	10.1
Number of flowers produced per plant.	80.4	169.2	182.6	139.2	85.4	120.9	129.6
	<i>Unprotected Plants.</i>						
Number of plants under study.	10	20	20	18	20	20	..
Commencement of flowering in week ending.	30/10	27/11	11/11	3/11	26/10	29/11	..
Cessation of flowering in week ending.	27/2	5/2	27/1	19/1	18/1	7/2	..
Period of flowering in weeks.	17	10	11	11	12	10	11.8
Number of flowers produced per plant.	69.6	81.8	68.65	77.7	87.0	64.8	74.9

AVERAGE PRODUCTION OF FLOWERS ON DIFFERENT TYPES OF BRANCHES ON PROTECTED PLANTS.

The number and proportion of flowers on the different kinds of branches vary considerably from year to year (Table No. 86), although average figures show that by far the greater crop of flowers is borne by the primary sympodia.

TABLE No. 86.

Average flower production on different kinds of branches.

Year.	Plants under counts.	Number of flowers on,				Percentage of the total flower-production on.		
		Limbs.	Primary Sympodia.	Auxillaries.	Total.	Limbs.	Primary Sympodia.	Auxillaries.
1926-27	9	27.0	42.3	11.3	80.6	33.5	52.5	14.0
1927-28	9	37.1	55.4	57.2	149.8	24.8	37.0	38.2
1928-29	19	46.9	66.3	69.9	183.1	25.6	36.2	38.2
1929-30	18	54.0	50.4	35.3	139.7	38.6	36.1	25.3
1930-31	20	20.6	51.3	13.5	85.4	24.1	60.1	15.8
1931-32	15	47.6	58.4	17.5	123.5	38.5	47.3	14.2
Average of six years ..	..	38.9	54.0	34.1	127.0	30.6	42.5	26.9

Percentage success of buds into flowers on different kinds of branches is shown in Table No. 87. Average figures indicate that sympodia exhibit the highest efficiency in this respect.

TABLE No. 87.

Percentage success of buds into flowers on different kinds of branches.

Year.	Number of plants under observation.	Percentage success of buds into flowers calculated on buds produced on the respective branches.		
		Limbs.	Primary sympodia.	Auxiliaries.
1926-27	9	34.2	44.2	26.3
1927-28	9	29.6	33.1	34.2
1928-29	19	30.1	37.4	35.6
1929-30	18	53.5	48.2	49.2
1930-31	20	28.1	44.9	31.1
1931-32	15	38.8	47.5	31.6
Average .. .. .	..	35.5	41.4	35.4

PRODUCTION OF BOLLS.

The number of bolls per plant is not constant every year. It varies from forty-two to fifty-five, the average of all years amounting to 46.6 (Table No. 88). There does not appear to be any relation between the number of flowers and the number of bolls which develop from them. Thus in 1926-27, the number of flowers was only eighty and the number of bolls was forty-five. Next year though the production

TABLE No. 88.

Production of mature bolls in the protected plants.

Years.	1926-27.	1927-28.	1928-29.	1929-30.	1930-31.	1931-32.	Average.
Plants under counts ..	10	14	20	20	20	20	..
Number of flowers ..	80.4	169.2	182.6	139.2	85.4	120.9	129.6
Number of bolls ..	43.9	48.4	55.5	44.4	42.25	45.85	46.7

of flowers was more than doubled, the number of bolls did not exceed forty-eight. Similarly, in other years no definite relation could be established in this respect.

Thus, the cotton plant under conditions of protection produces about 343 flower-buds out of which 130 reach the flower stage and out of this again only forty-six develop into mature bolls.

The significance of variation in the number of bolls from year to year will be seen from the following calculations.

PROTECTED PLANTS.

Significance of variation in the number of bolls from year to year.

Years.	1926-27.	1927-28.	1928-29.	1929-30.	1930-31.	1931-32.
Number of plants under study.	10	14	20	20	20	20
Mean	43.9	48.43	55.55	44.45	42.45	45.85
S.D.	10.04	15.14	12.93	9.86	14.92	13.15
S.E. of Mean	3.18	4.05	2.89	2.21	3.34	2.94

Mean=46.91

S.D.=12.95, *i.e.*, 27.61% of the mean.*Analysis of Variance.*

	Degrees of freedom.	Sum of squares.	Mean square.	$\frac{1}{2}$ log. Mean square.
Between years	5	2193.6926	438.7385	0.73933
Within years	98	16429.9050	167.6521	0.25823
Total	103	18623.5976	180.8116	0.48110

According to Fisher's Table of Z, for $n_1 = 5$ and $n_2 = 98$, $Z = 0.3974$ when $P = 0.05$ and 0.5522 when $P = 0.01$.

The seasonal differences are therefore significant in 5 and insignificant in 1%.

AVERAGE PRODUCTION OF BOLLS ON DIFFERENT BRANCHES.

Primary sympodia bear the largest number of bolls every year (Table No. 89). Barring the year 1927-28, the production of bolls on the limbs was always found to be greater in comparison with that on the auxiliaries.

TABLE No. 89.

Production of bolls on different types of branches on protected plants.

Year.	Number of plants under study.	Number of bolls on.				Percentage on		
		Limbs.	Primary sympodia.	Auxiliaries.	Total.	Limbs.	Primary sympodia.	Auxiliaries.
1926-27	9	14.4	23.3	5.9	43.6	33.1	53.4	13.5
1927-28	9	10.1	17.3	13.0	40.4	25.0	42.9	32.1
1928-29	19	15.9	23.9	15.6	55.4	28.7	43.1	28.2
1929-30	18	17.2	19.0	8.1	44.3	28.8	42.9	18.3
1930-31	20	11.05	24.65	6.55	42.25	26.2	58.3	15.5
1931-32	15	17.8	24.6	5.4	47.8	37.2	51.5	11.3
Average of six years .. .. .	..	14.4	22.1	9.1	45.6	31.6	48.5	19.9

Note.—The above figures are the averages of lesser number of plants than were actually under observation, as the plants that got pruned on the main stem in early stages are rejected for the purpose of this study.

Percentage success of flowers into mature bolls was the highest in the case of primary sympodia (Table No. 90). The year 1930-31 was, however, an exception. The efficiency of limbs in all years was greater than that of auxiliaries.

TABLE NO. 90.

Percentage success of flowers into mature bolls on different types of branches on the protected plants.

Years.	Plants under counts.	Percentage success of flowers into bolls on.		
		Limbs.	Primary fruiting branches.	Auxiliaries.
1926	9	53.3	55.1	52.2
1927	9	27.2	31.2	22.7
1928	19	33.9	36.0	22.3
1929	18	31.9	37.9	22.0
1930	20	53.7	48.1	48.5
1931	15	37.4	42.1	30.9
Average		37.0	40.9	26.7

With regard to the success of flower-buds into mature bolls on the basis of the total flower-buds incepted, the same relationship is again observed amongst the three kinds of branches (Table No. 91).

TABLE NO. 91.

Percentage success of flower-buds into bolls on protected plants.

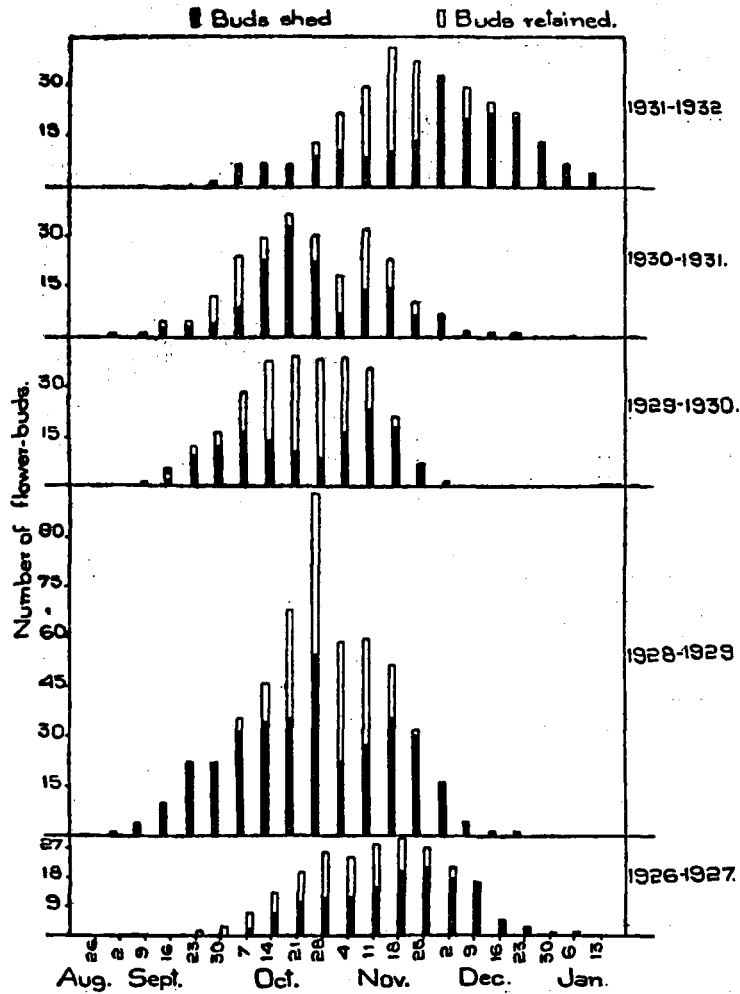
Year.	Plants under counts.	Percentage success of buds into bolls on buds produced on respective branches.		
		Limbs.	Primary fruiting branches.	Auxiliaries.
1926	9	18.3	24.3	13.7
1927	9	8.1	10.3	7.8
1928	19	10.2	13.5	7.9
1929	18	17.1	18.2	11.3
1930	20	15.1	21.6	15.1
1931	15	14.5	20.0	9.8
Average		13.1	16.9	9.5

EXTENT OF BUD SHEDDING IN PROTECTED PLANTS.

Even though the spotted boll-worm is absent, bud-shedding continues at varying rates throughout the period of bud formation. The rates of flower-bud production and of shedding relative to bud-formation are given in the following graph. Relative shedding shows three distinct periods. During the first and the third periods, shedding of flower-buds is wholesale. It is during the second period that many flower-buds escape shedding and develop into flowers. (Table No. 105 in the Appendix.)

GRAPH NO. 41.

Periodical average formation of flower-buds and their absolute and relative shedding.



COMPARISON OF BUD SHEDDING IN THE PROTECTED AND UNPROTECTED PLANTS.

Under spotted boll-worm conditions the first period in which wholesale shedding of flower-buds occurs is longer (Table No. 92) and therefore flowering is delayed. The rate of shedding hereafter is generally higher than that in the protected plants. As flower-bud formation continues longer in the unprotected plants, bud-shedding is also correspondingly prolonged.

TABLE No. 92.

Percentage relative shedding of flower-buds in the protected and unprotected plants.

Weeks from the commencement of flower-bud formation.	1928-29.		1929-30.		1930-31.		1931-32.	
	Prot.	Unprot.	Prot.	Unprot.	Prot.	Unprot.	Prot.	Unprot.
1	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
2	100.0	100.0	97.2	100.0	100.0	100.0	..	..
3	100.0	..	79.2	97.9	..	89.1	..	100.0
4	..	99.8	34.4	95.8	59.4	91.5	95.0	..
5	98.6	96.5	57.8	92.5	28.5	95.2	70.5	..
6	87.5	85.2	34.0	87.3	36.2	98.8	48.5	96.4
7	76.0	81.9	25.9	86.5	78.7	98.5	29.2	89.2
8	52.8	76.0	21.9	86.0	91.4	94.7	25.7	79.1
9	53.6	71.8	40.7	80.4	75.3	78.0	35.5	62.1
10	37.5	68.8	64.9	70.0	39.5	54.0	50.7	47.4
11	46.3	63.9	88.1	63.8	44.4	39.3	69.3	44.4
12	68.6	65.9	99.2	55.1	62.7	34.5	86.6	41.6
13	90.9	72.4	100.0	54.4	66.3	34.8	96.1	52.9
14	97.7	79.2	..	67.4	88.4	61.4	99.2	64.0
15	98.8	78.3	..	80.3	92.6	85.5	99.2	84.3
16	100.0	86.6	..	95.9	98.8	94.1	100.0	93.5
17	100.0	83.7	..	90.6	100.0	97.8	..	97.1
18	..	88.9	..	100.0	..	100.0	..	98.6
19	..	86.7	..	100.0	..	..	..	100.0
20	..	80.0	..	..	..	..	..	100.0
21	..	100.0	..	..	..	..	..	..

Total percentage of bud shedding in the protected is always less than that in the unprotected plants, the average percentages being 62.5 and 73.9 respectively. It has already been pointed out that (Table No. 47, Chapter III) of the total buds shed, not less than thirty-one per cent. of buds on an average are injured by the boll-worm. The total shedding in the protected plants, however, does not decrease to an equal extent, the difference being only 11 per cent. (Table No. 93). This means that even though the pest is absent the plant does not retain an equally higher proportion of buds as are lost by the insect damage. Evidently, the protected plants shed the extra buds later.

TABLE No. 93.

Total percentage shedding in the protected and unprotected plants.

Year.	Percentage bud-shedding in years.						
	1926-27.	1927-28.	1928-29.	1929-30.	1930-31.	1931-32.	Average.
			<i>Protected Plants.</i>				
Plants under counts	10	14	20	20	20	20	..
Flower-buds formed	215.7	525.9	528.4	278.4	230.9	294.8	345.7
Flower-buds shed	135.3	356.7	345.8	139.2	145.5	173.9	216.1
Percentage shedding	62.7	67.8	65.4	50.0	63.0	59.0	62.5
			<i>Unprotected Plants.</i>				
Number of plants under counts	10	20	20	18	20	20	..
Flower-buds formed	312.7	312.6	303.1	297.5	293.1	203.8	287.1
Flower-buds shed	243.1	230.8	234.5	219.8	206.1	139.0	212.2
Percentage shedding	77.7	73.8	77.4	73.9	70.3	68.2	73.9

SIZE OF SHED BUDS.

Figures in the following table indicate that as much as seventy per cent. of the shed buds are very small; eighteen per cent. are of medium size and twelve per cent. are large.

TABLE No. 94.

Classification of shed buds in the protected plants.

Years.	Number of plants under counts.	Total number of buds shed.	Total number of shed-buds collected.	Shed buds lost.	Shed buds classified.		
					Small.	Medium.	Large.
1926-27 ..	10	1,353	646	707	287	155	204
1927-28 ..	Data	not available.					
1928-29 ..	10	2,999	2,325	674	1,299	646	380
1929-30 ..	10	1,541	1,364	177	838	183	343
1930-31 ..	10	1,332	1,096	236	590	392	114
1931-32 ..	10	1,663	971	692	671	208	92
Total ..	..	8,888	6,402	2,486	3,685	1,584	1,133
Average ..	..	177.76	128.04	49.72	73.70	31.68	22.66
Per cent. ..	..	..	..	28.4	41.5	17.8	12.7

AGE OF SHED BUDS.

Age of buds at shedding varies a good deal. But the majority of the shed buds are of ages varying between one and three weeks (Table No. 95). As a large

TABLE No. 95.

Frequency of shed buds according to age in weeks.

Protected plants.

Year.	Number of plants under study.	Age of shed buds in weeks.									Total.	Mean.	S.E. of Mean.				
		0.	1.	2.	3.	4.	5.	6.	7.	8.				9.			
1926-27 ..	10	6	164	394	411	255	97	20				4	1	..	1,352	2.86	0.03
1927-28 ..	14																
1928-29 ..	20	135	1,614	2,032	1,235	522	186	37	1	..	..	..	..	..	5,762	2.19	0.01
1929-30 ..	20	78	980	1,021	469	193	35	7	..	..	..	..	..	..	2,783	1.95	0.02
1930-31 ..	20	80	698	1,287	690	127	23	3	3	..	..	..	..	..	2,911	2.06	0.02
1931-32 ..	20	58	600	1,012	687	464	172	76	24	5	..	..	..	..	3,098	2.60	0.2

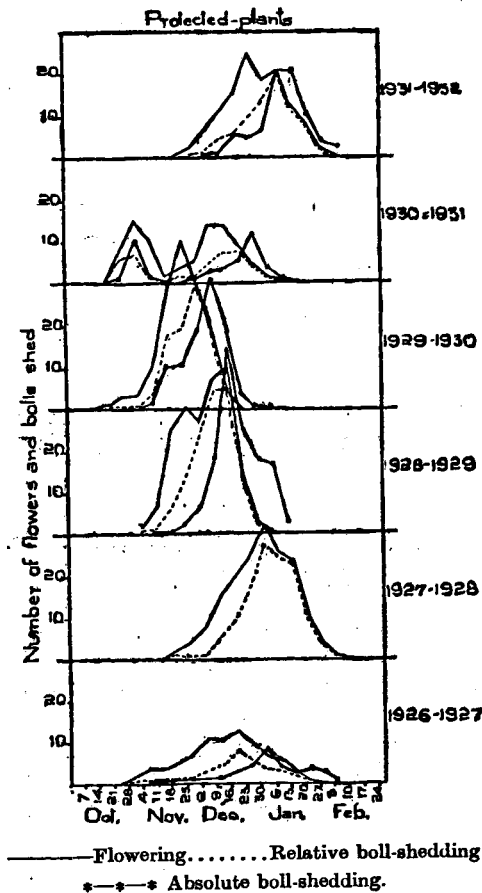
majority of shed buds are of small size, the flower-buds seem to linger on the plant in an arrested condition of growth.

EXTENT OF BOLL-SHEDDING.

Boll-shedding begins soon after the commencement of flowering and goes on with varying intensity throughout the period of boll formation (Graph No. 42 and Table No. 106 in the Appendix). The rate of shedding is very slow in the beginning

GRAPH NO. 42.

Rate of flowering and of relative and absolute boll-shedding in the protected plants.



but later on it increases to such an extent that bolls formed during the closing weeks of the flowering season completely shed.

The rate of boll-shedding in the protected plants, during the early part of the season, is always less than that in the unprotected. This is principally due to the prevalence of boll-worm at this time.

Total boll-shedding in the protected plants is higher than in the unprotected plants in some years while it is less in certain others. (Table No. 96.) The average of six years, however, amounts to about sixty-four per cent. in both the sets.

TABLE No. 96.

Magnitude of boll-shedding in the protected and unprotected plants.

Years.	1926-27.	1927-28.	1928-29.	1929-30.	1930-31.	1931-32.	Average.
	<i>Protected Plants.</i>						
Plants under counts ..	10	14	20	20	20	20	..
Flowers opened	80.4	169.2	182.6	139.2	85.4	120.9	129.6
Bolls shed	36.5	120.8	127.05	94.8	43.15	75.05	82.9
Percentage boll-shedding..	45.5	71.4	69.6	68.1	50.5	62.0	63.9
	<i>Unprotected Plants.</i>						
Plants under counts ..	10	20	20	18	20	20	..
Flowers opened	69.6	81.8	68.6	77.7	87.0	64.8	74.9
Bolls shed	43.8	49.8	44.5	50.7	58.75	34.45	47.0
Percentage boll-shedding..	62.9	60.9	64.8	65.3	67.5	53.2	62.8

AGE OF BOLLS AT SHEDDING.

Age of bolls at shedding is given in Table No. 97. The majority of bolls shed between the age of five to fifteen days. This concurs with the age of shed bolls in the unprotected plants. (Chapter III, Table No. 50.)

TABLE No. 97.

Age of bolls at shedding in the protected plants.

Age in days.	Number of bolls shed in				
	1926-27.	1928-29.	1929-30.	1930-31.	1931-32.
0 .. ..	..	..	1	..	3
2	1	50	74	28	22
5	23	473	823	274	540
8	96	428	608	286	532
11	117	206	230	155	205
14	68	80	105	64	122
17	35	40	32	27	38
20	12	20	14	12	17
23	6	10	3	7	7
26	2	12	2	3	8
29	1	14	2	3	1
Above 29 .. ..	..	42	2	4	6
Total	361	1,375	1,896	863	1,501
Mean	11.57	9.2	7.5	8.65	8.35
S.E. of mean	0.22	0.16	0.08	0.15	0.11

EFFICIENCY OF THE PLANT IN RESPECT OF FLOWER AND BOLL RETENTION UNDER PROTECTED AND UNPROTECTED CONDITIONS.

Percentage success of buds into flowers is always higher in the protected plants by an average difference of twelve. (Table No. 98.) That of flowers into bolls is, however, either higher or lower though the average of six years, in the two sets happens to be the same. With regard to the success of buds into bolls, it may be noted that this varies considerably every year from nine to twenty per cent, and is not constant at about ten as in the case of the unprotected. The great reduction in the success of buds into flowers in the unprotected ultimately tells upon the number of mature bolls. The average production of mature bolls in the protected is forty-six against twenty-eight in the unprotected.

TABLE NO. 98.

Percentage success of buds into flowers, of flowers into bolls and of buds into bolls in the protected and unprotected plants.

Years.	1926-27.	1927-28.	1928-29.	1929-30.	1930-31.	1931-32.	Average.
		<i>Protected Plants.</i>					
Percentage success of buds into flowers.	37.3	32.2	34.6	50.0	37.0	41.0	37.5
Percentage success of flowers into bolls.	54.5	28.6	30.4	31.9	49.5	38.0	36.0
Percentage success of buds into bolls.	20.4	9.2	10.5	16.0	18.3	15.5	13.5
		<i>Unprotected Plants.</i>					
Percentage success of buds into flowers.	22.3	26.2	22.6	26.1	29.7	31.8	26.1
Percentage success of flowers into bolls.	37.1	39.1	35.2	34.7	32.5	46.8	35.9
Percentage success of buds into bolls.	8.2	10.2	8.0	9.1	9.6	14.9	9.7

TOTAL SHEDDING IN THE PROTECTED PLANTS.

It will be evident from the studies of the protected plants that even in the absence of the boll-worm and under otherwise natural conditions of environment shedding of young buds and fruits occurs to an extent which varies from eighty to ninety-one per cent. of flower-buds formed. These results place above doubt the fact that the phenomenon of shedding of reproductive forms in cotton is natural to the plant. We shall examine in a later chapter the nature of internal chain of events leading to the incessant and heavy shedding.

Yield.

When plants are grown free from the spotted boll-worm they produce a much larger number of bolls, the average of six years being forty-six. Plants grown under spotted boll-worm conditions give on an average only twenty-eight bolls per plant. It means that the spotted boll-worm is responsible for lowering the yield of bolls from forty-six to twenty-eight which amounts to a loss of nearly forty per cent.

The same relations are again noticed in the yield of seed cotton per plant in the two sets. These are shown in the following Table No. 99.

TABLE NO. 99.

Average yield of seed cotton per plant in grammes in protected and unprotected plants.

Years.	1926-27.	1927-28.	1928-29.	1929-30.	1930-31.	1931-32.	Average.
Protected plants	69.13	117.98	103.47	91.4	77.85	83.72	90.59
Unprotected plants	47.97	58.46	43.60	54.10	59.20	52.70	52.67
Difference	21.16	59.52	59.87	37.30	18.65	31.02	37.92
Percentage loss	30.6	50.5	57.9	40.8	24.0	37.0	41.9

SUMMARY.

This chapter deals with the developmental studies of plants grown free from the spotted boll-worm with a view to ascertaining whether the retention of buds and bolls could be improved in proportion to the reduction in their damage by the pest. Immunity from the pest was attained in two ways: the one in which plants were grown from the beginning in a cage or a plant-house and the other in which they were covered with mosquito-netting at night. This latter method was invented by Kasargode and found to be the most successful, as in this case plants receive full benefit of the natural conditions of environment. Plants grown by this method known as "Night-Caging" are called protected plants to distinguish them from those unprotected or exposed to boll-worm damage.

CAGE-PLANTS.

Owing to weak light intensity and other associated changes of environment within the cage, plants raised in the cage exhibit etiolated condition of growth and take a longer time than those outside, to finish their career on the land. The total bud and boll shedding in these plants is as high as that in the case of the unprotected plants, the number of mature bolls being equal in both the sets.

PROTECTED PLANTS.

The mode of growth of the protected plants is just the same as that observed in the unprotected. The root system is similar to that of the unprotected plants. It is, however, less extensive and is built up in a comparatively short time. Further, it is lighter in weight and more dense in its spread, the rate of descent being conspicuously less.

Normally, the stem attains a height of about 110 cms. within the period of five months and produces about forty-three nodes on an average. The number of node from which the first fruiting branch arises is not constant but increases with the lateness of growth of the plant. The stem gives rise on an average to six effective limbs, eleven effective auxiliaries and thirty-two primary sympodia. Late growth is associated with greater production of accessory primary sympodia. The ratio of primary sympodia to "Effective" limbs increases with lateness in growth of the plant.

The number of vegetative buds in the protected plants is equal to that of the flower-buds, though the magnitude of production may vary considerably every year, the average figure for both being 343. Damage to the main shoot earlier in the season leads to the inception of a larger number of vegetative buds; if this occurs later, the number of flower-buds is only increased. The age of buds at flowering not only varies in different seasons but also in the same season. The age increases with increased lateness in growth of the plant. High rate of flowering is associated with a short span of the flowering period. The plant produces about 130 flowers out of which only forty-six develop into mature bolls. There is no relation between the number of buds incepted and the bolls that arise from them.

Among the different types of branches primary sympodia give rise to the largest number of bolls. Generally, the number of bolls on limbs is higher than that on auxiliaries. In regard to percentage success of flowers into bolls and buds into bolls, the same relationship among the three types of branches is again observed.

Bud and boll shedding takes place in the same fashion as that observed in the unprotected plants. The rate of early shedding is, however, less in the protected. On this account, total bud-shedding is less by about ten per cent. The average of all years indicates that the extent of boll-shedding is the same in the two cases. The age of buds and bolls at shedding increases in years of late growth of the plant. The results indicate that a large number of buds and bolls which shed owing to insect injury would have shed of their own accord at a later stage. Total shedding of buds and bolls in the protected plants varies from eighty to ninety-one per cent.

Owing to boll-worm damage, the number of primary sympodia, flowers and bolls is appreciably reduced and the career of the plant is prolonged by a fortnight to six weeks. In the case of the cage plants, this period is prolonged by one and a half months.

Evidence shows that even in the absence of boll-worm, shedding of reproductive forms is almost as heavy as that in the unprotected plants and is intimately associated with the physiology of the plant.

CHAPTER V.

CHEMISTRY OF THE COTTON PLANT.

After studying the behaviour of the cotton plant under unprotected and protected conditions and definitely assigning the role of shedding to physiological causes, it was necessary to inquire into the nature of chemical changes which take place within the plant and to ascertain whether they are associated with the shedding of buds and bolls on the one hand and their retention and development on the other. With this end in view, a chemical study of the cotton plant was started as early as 1926 and continued for a period of six years. Analysis was mainly confined throughout this period to unprotected plants. In 1928, however, unprotected plants receiving an application of seventy pounds of nitrogen per acre were taken up in addition. From 1929 to 1931, a comparative study of the protected and the unprotected plants was made to find out internal differences which promote to a greater extent, the success of flower-buds into mature bolls in the former set.

The technique followed in the conduct of this work is given in Appendix II. Before presenting the data, a brief survey of environmental factors during the last four years of the investigation, is made with a view to correlating seasonal influences with plant growth. In the pages that follow, a complete study of the unprotected plants is first given; that of the manured unprotected and the protected plants is shown as far as possible by comparison. This procedure is considered to be the best as it avoids repetition of certain details which otherwise would be necessary.

ENVIRONMENTAL FACTORS.

Rainfall.

Total rainfall during the years, 1928, 1929, 1930 and 1931 was 26.21, 48.29, 41.28 and 53.38 inches respectively (Table No. 1-B in the Appendix). These figures as they stand are of little value for understanding the nature of the plant growth. What is most important is the mode and manner of its delivery during the season. From this point of view, the year 1929 may be said to be the driest, though the total quantity of rain received was almost twice that in the previous year. This is because nearly eighty-nine per cent. of the total rainfall was received during comparatively a short period prior to sowing (15th July). This was not so in the previous year. A large quantity of rainfall was obtained after sowing and was evenly distributed. In 1930, the rains were well distributed over a longer period and continued up to the middle of September. In the following year, the total quantity of rain obtained was the highest and again this was distributed over a still longer period till the middle of October. Thus broadly speaking, the various

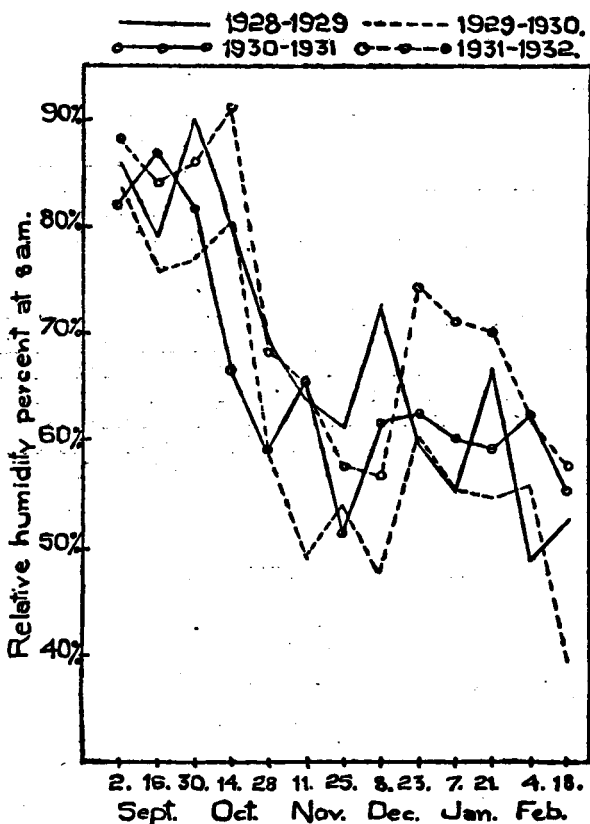
years range themselves in order of the degree of their dryness as follows. (Driest) 1929, 1928, 1930 and 1931 (Wettest). This arrangement of the years also indicates the order of early or late setting of drier conditions.

Relative humidity.

The degree of dryness in the different years is further shown by the relative humidity figures given in Table No. 3 in the Appendix. The mean fortnightly humidity is worked out from those figures and is graphically reproduced below.

GRAPH No. 43.

Relative humidity of the air.



Air temperature.

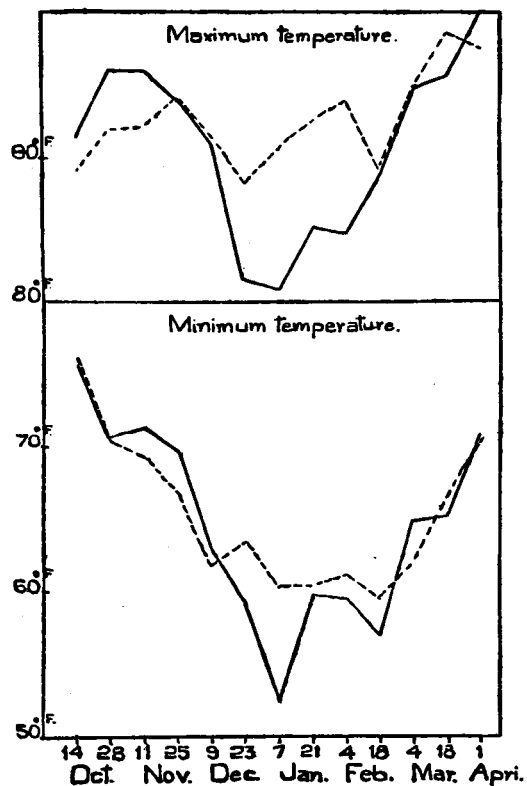
Of the environmental factors humidity of the air is the most susceptible to wide variations and on this account the differences appearing every year, in this regard, are well marked. With respect to air temperature, however, the range of difference is so small and the temperature curves intersect one another at so many places that it is at times difficult to understand the general sense of the curve in one year

in relation to that in any other unless the years characterised by extreme dryness are compared with those extremely wet. If such years are compared, it will be seen that in 1929 the maximum temperature was throughout higher till the end of November than that in 1931 (Graph No. 44). The minimum temperature remained more or less the same in the two years.

GRAPH No. 44.

Comparison of maximum and minimum temperatures in 1929 and 1931.

———1929-30;1931-32.



Desiccating power of the air.

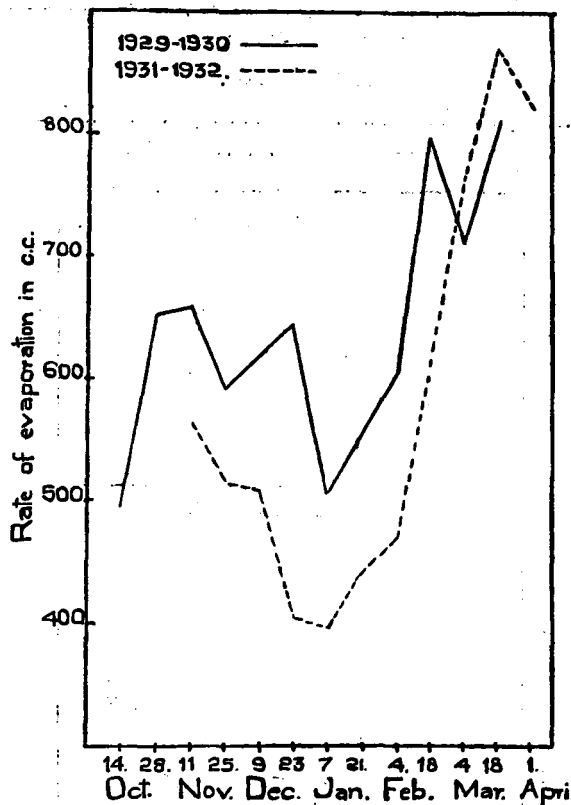
The rate of water evaporation was higher in 1929 as will be seen from Graph No. 45 given below.

Soil temperature.

The dry years are associated with higher soil temperature. The period during which high temperature continues to rise in October is also prolonged by a fortnight or so (Graph No. 46 and Table Nos. 40A and 41 in the Appendix).

GRAPH NO. 45.

Comparison of the rate of water evaporation in 1929 and 1931.



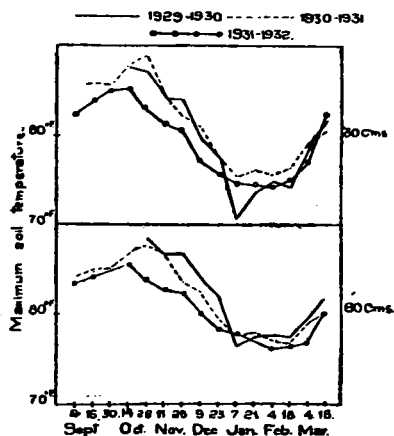
I. THE UNPROTECTED PLANTS.

(a) *Moisture content of various organs.*

Determinations of moisture in different organs of the unprotected plants grown under the usual crop condition were made in years commencing from 1926 and ending with 1931. The results obtained are reproduced in Table Nos. 108 to 113 in the Appendix. In the first two years, moisture was estimated after the plant had been brought to the laboratory. This used to take up more than an hour as an interval between the removal of samples and their first weighing. On this account, a certain amount of moisture was always lost. It may be noted that these determinations were not specially made but were incidental to chemical analysis where they were required for expressing results on the basis of dry matter. These estimations are, however, useful in connection with the rate of transpiration by young and fully developed leaves and we shall refer to them on a later occasion. During the next four years, more attention was paid to this constituent. Plant.

GRAPH NO. 46.

Comparison of soil temperatures in 1929 and 1931.



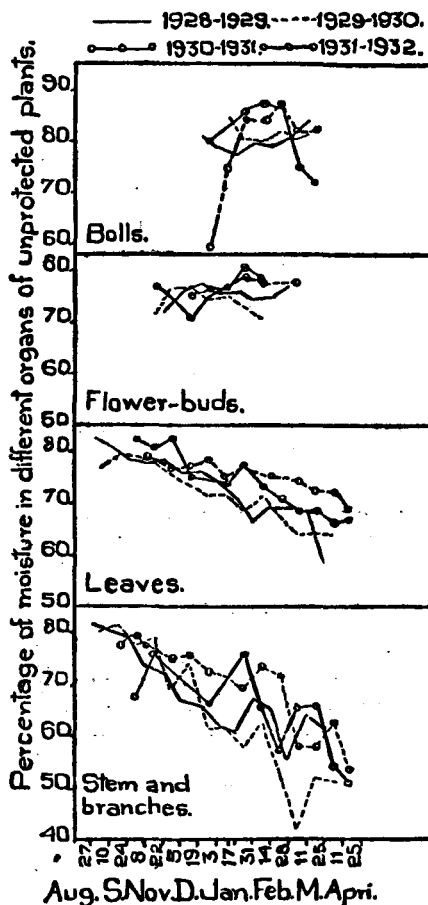
organs were weighed in the field immediately after removal and reweighed in the laboratory. In this way, the extent of loss in moisture which took place in bringing the samples to the laboratory was ascertained and the figures for oven-driven moisture corrected. We shall therefore restrict ourselves to the interpretation of the data of the last four years only. Moisture was not determined in roots as they were profusely watered prior to excavation, the shoot being removed earlier.

The figures indicate that the boll contains the highest percentage of moisture which is generally above eighty. Flowers and flower-buds are the next in order. With the exception of certain abnormal figures, it will be seen that moisture in flowers is pretty constant. This is, however, not surprising as the flowers represent a definite physiological stage of bud growth. The leaves contain less moisture than either the flower-buds or flowers. The stem and branches are the poorest in this regard. There is thus a gradation in percentage moisture. It rises from the stem to the bolls. In the vegetative organs, percentage moisture decreases with advance in age. The flower-bud, on the other hand, increases in percentage moisture as it passes towards the boll stage.

Percentage moisture in the several organs of the plant varies from year to year and appears to be associated with the duration of rainfall. Thus in 1931, the year of the longest duration, the moisture content of all organs was the highest (Graph No. 47 and Table Nos. 108 to 113 in the Appendix). In 1929 where the duration of rainfall was the shortest, it was the lowest. The commencement and the rate of fall in moisture is also related to the duration of rainfall.

It has already been pointed out that in the years 1926 and 1927 a certain amount of moisture from the samples was lost during the course of an hour before recording the green weight. The percentage moisture in young and fully grown leaves, indicated under these circumstances, that the former contained less moisture than

GRAPH No. 47.
Percentage of moisture in different organs.



the latter. Moisture determinations carried out under controlled conditions however, showed that the percentage moisture in leaves does not increase with age, suggesting that the higher content of moisture in old leaves was the result of the difference in the rates of transpiration of the young and old leaves. This means that young leaves transpire water at a greater rate than those fully grown.

(b) *Dry matter.*

Dry matter of different organs of the plant was estimated during years 1927, 1928, 1929, 1930 and 1931. In the first year, shed organs such as leaves, flower-buds and bolls were not collected and therefore the dry matter only of organs on the plant was recorded from time to time. In the second year, endeavour was

made to collect all the shed organs but as will be seen from the figures the collection was not satisfactory from the third week of January. It was only during the last three years that this collection had been thorough. For purposes of discussion and interpretation, the data of these years will be taken though use will be made of those of the preceding two when possible and necessary.

The results obtained are incorporated in Table Nos. 114 to 118 in the Appendix. They indicate that during the first three months (July, August and September) from sowing, the growth of the plant is extremely slow. It is only in October and November that the vegetative organs rapidly increase in dry matter. Thereafter their growth slows down till the third week of December. When this takes place, bolls begin to increase in weight and continue to do so till about the middle of February. Further, owing to the commencement of leaf-fall the weight of leaves on the plant begins to decrease from the first week of January. Most of the dry matter of the bolls is built up after this period when there is an increasing reduction of the photosynthetic area of the plant. The importance of the phenomenon of leaf-fall as affecting the supply of assimilates will be discussed at a later stage.

The data further tell us that the dry matter of leaves is the highest. Next in order of their descending weights are the stem and branches and finally the roots. This gradation amongst the vegetative organs which is so striking during the early part of the season cannot, however, be observed in the latter part. Due to certain factors which will be referred to in the comparative study of the protected plants, the growth of these organs is so modified that the difference in dry matter between roots and stem and branches or that between the latter two and the leaves tends to disappear.

Total dry matter built up by the plant every year is constant at 200 grms. (Table No. 100). The dry matter production of bolls has, however, varied from fifty to seventy-two grammes in spite of the fact that the weight of leaves in all the years is the same, amounting to fifty grammes. Nearly fifteen grammes of leaves remain on the plant when the crop is ready for the harvest. The weight of stem and branches is thirty-eight and of roots thirty-one grammes. Although shed organs were not collected in 1927 and some escaped collection in 1928, it will be

TABLE No. 100.
Dry matter of different organs of the plant at harvest.
(On oven-dry basis).

Year.	Roots gms.	Stem and branches gms.	Leaves.			Shed buds and bolls inclusive of corollas. gms.	Ripe bolls gms.	Total. gms.
			Green gms.	Shed gms.	Total gms.			
1929-30 ..	37.00	38.33	13.83	36.17	50.00	13.89	49.00	188.22
(17-2-1930) ..								
1930-31 ..	28.75	36.67	13.67	35.33	49.00	13.67	72.83	200.92
(4-3-1931)								
1931-32 ..	27.67	40.00	15.00	35.00	50.00	12.00	72.50	202.17
(16-3-1932)								
Average of three years.	31.14	38.33	14.16	35.50	49.66	13.19	64.78	197.10

evident from the figures for roots, stem and branches that the growth of the plant in these years was rather high. Compared with this growth, the dry matter of bolls was low.

The initiation of early or late growth in terms of dry matter depends upon the early or late release of dry conditions of environment. In 1929, where these conditions were the earliest to appear, the dry matter increase of the plant started very early in spite of the fact that cotton was sown this year late by one fortnight (Table No. 101). In 1930, the rainy season continued for a longer time and delayed the early appearance of better environment for growth. As a result of this change, the dry matter production of the plant as a whole was delayed and its life period prolonged. The same fact was illustrated in 1931 also.

TABLE No. 101.

Periodical production of dry matter in terms of percentage of the total at harvest.
(Unprotected plants.)

Dates.	1929-30.	1930-31.	1931-32.
2nd September	2.19	0.90	..
10th September .. .. .	..	1.50	..
16th September	3.68	Rain.	1.68
25th September .. .. .	..	3.72	2.55
30th September	12.14	7.13	3.03
8th October .. .. .	..	..	..
14th October	20.16	12.87	..
28th October	25.93	19.90	14.62
11th November	38.32	27.50	21.07
25th November	56.43	38.59	38.74
9th December	61.61	50.60	50.94
23rd December	80.87	50.95	53.90
6th January	97.97	63.63	67.94
20th January	98.09	79.10	70.91
3rd February	111.75	102.13	88.32
17th February	100.0	95.63	82.22
4th March .. .. .	..	100.100	98.95
16th March .. .. .	..	..	100.100

The complement of percentage moisture in plant organs is their dry matter. As the percentage moisture varies with the degree of dryness of environment (page 142), it will be evident that drier conditions of the latter are associated with higher percentage of dry matter.

Dry matter of the root and the shoot.

The ratio of dry matter of the shoot and root ($\frac{\text{shoot}}{\text{root}}$) gradually falls from the end of October and reaches a minimum value towards the end of December when the vegetative growth of the plant ceases. (Table No. 102.) At this time, the weight of the shoot is nearly three to four times that of the root. The progressive fall in the ratio during October and November is due to the fact that the growth of the root proceeds at a higher rate than that of the shoot. From the end of December the ratio steadily rises till the crop matures. This rise in the ratio is solely due to the growth of bolls. The weight of the shoot at this time is four to six times that of the root.

From these results it will be apparent that the activity of roots does not depend upon the total output of their dry matter. With the same amount of root growth, different quantities of dry matter of the shoot can be built up.

TABLE No. 102.
Ratio of dry matter of the shoot to that of the root.
(Unprotected plants.)

Dates.	1929-30.	1930-31.	1931-32.
18th September	7.7	..	4.1
25th September	5.8	..	4.2
1st October .. .. .	..	5.9	4.8
8th October .. .. .	..	..	4.8
15th October	6.0	4.9	..
29th October	5.5	5.0	5.2
12th November	5.2	5.9	4.7
26th November	4.1	3.2	4.4
10th December	3.6	2.9	4.4
24th December	3.0	3.2	4.1
7th January	3.4	4.3	4.1
21st January	3.5	4.3	4.7
4th February	3.7	7.5	5.9
18th February	4.1	5.77	4.9
3rd March	4.1	5.99	5.7
17th March .. .. .	..	6.1	6.3

Dry matter of shed buds and bolls.

The loss of shed buds has varied from one to four grammes in the three years. (Table No. 103.) Making allowance for the weight of shed corollas of developing bolls, it will be seen that from ten to eleven grammes of dry matter is lost in the form of the shed bolls. The loss is equivalent to about four mature bolls per plant.

TABLE No. 103.
Dry matter of shed buds and bolls in grammes.
(Unprotected plants.)

Organs.	1929-30.	1930-31.	1931-32.	Average.
Shed buds	4.0	1.5	1.1	2.2
Shed bolls	10.0	14.0	15.0	13.0

(c) *Ash.*

Percentage ash in stem and branches, roots and bolls decreases with increase in dry matter. (Table Nos. 119 to 121 in the Appendix.) In leaves, however, it continuously increases till the crop matures. In flower-buds and bolls, it is almost constant. In shed reproductive forms also the ash content does not much vary. The ash percentage of shed leaves, however, steadily rises with advance in season. Those incepted earlier fall with a lower content of inorganic matter than those appearing later. Percentage ash in shed leaves is always higher than that in leaves

on the plant. As the latter grow older, the difference between the two kinds of leaves gradually becomes less. It may be pointed out that in 1929, there was practically no difference between the percentage of leaves on the plant and those shed. It does not, however, follow that the former were as old as the latter. Leaves on the plant which show the same percentage as those shed, at any particular time of the season, fall off later with a higher content of inorganic matter. (Table No. 160 in the Appendix.) The equality in ash percentage of shed and non-shed leaves may be the result of the disturbance in the normal production of leaves caused by the boll-worm.

Leaves show the highest percentage of inorganic matter. Next in the descending order of percentage are the flower-buds, flowers, stem and branches and roots. When bolls approach maturity their percentage falls to the level of the stem and branches. Percentage ash in different organs of the plant at harvest is given below.

TABLE No. 104.
Percentage ash in different organs of the plant at harvest.

Plant organs.	1929-30.	1930-31.	1931-32.	Remarks.
Roots	5.35	5.95	5.80	
Stem and branches	6.80	6.35	7.15	
Leaves on the plant	20.30	22.75	22.70	
Bolls	5.28	7.15	6.75	
Shed leaves	20.15	21.70	22.20	
Shed buds	12.65	12.73	..	
Shed bolls	10.35	13.00	11.20*	* Buds plus bolls

On an average, the plant contains inorganic matter equivalent to about twenty grammes of ash. (Table No. 105.) Out of this 51.03 per cent. is present in leaves both shed and those on the plant, 8.75 per cent. in roots, 11.22 per cent. in

TABLE No. 105.
Total quantity of ash in grammes in different plant organs.
(For progressive figures refer to Table Nos. 122 to 124 in the Appendix.)

Plant organs.	1929-30.	1930-31.	1931-32.	Average.
Roots	1.98	1.71	1.73	1.80
Stem and branches	2.61	2.33	2.00	2.31
Leaves on the plant.	2.81	3.11	4.62	3.51
Bolls	2.59	5.21	5.74	4.51
Shed leaves	7.29	7.69	5.99	6.99
Shed flower-buds and bolls	1.53	1.77	1.01	1.44
Total	18.81	21.80	21.09	20.56

stem and branches, 21.92 per cent. in mature bolls, and 7 per cent. in the shed reproductive forms. On the basis of these figures, it will be evident that under normal conditions of cultivation nearly 218 pounds of inorganic matter per acre is removed every year from the soil.

The amount of organic matter in the plant at any time during the season is more than six times the weight of ash. The ratio of organic matter to ash gradually increases as the season advances. (Table No. 106.) In 1929, it rose from 7 to 9; in 1930, from 6.6 to 8.75 and in 1931 from 6 to 8.2. These results indicate

TABLE No. 106.

Ratio of organic to inorganic matter in the plant.

Dates.	1929-30.	1930-31.	1931-32.
8th October .. .. .	..	..	6.70
14th October	11.28	6.62	..
29th October	7.74	6.66	6.24
12th November	7.17	7.18	6.15
26th November	7.66	7.47	6.92
10th December	7.98	7.31	6.91
24th December	9.50	7.05	6.93
7th January	8.57	7.06	6.74
21st January	9.41	7.50	6.53
4th February	8.97	8.07	8.22
18th February .. .. .	..	7.71	7.54
3rd March .. .. .	..	8.26	8.49
11th March .. .. .	..	8.75	..
16th March .. .. .	..	..	7.86

that drier conditions of environment are associated with a higher ratio. This means that the rate of photosynthesis proceeds at a higher rate than that at which mineral matter is absorbed by the plant.

(d) *Phosphoric acid, lime and potash.*

The absorption of phosphates during the early stage of growth is low (Table Nos. 125 and 126 in the Appendix). It, however, increases with the commencement of flowering. From this time onwards, the percentage of phosphoric acid in the vegetative organs steadily falls with the progress of season. In flower-buds, flowers and young bolls the percentage is rather high. When bolls increase in dry matter, they show a progressive fall in the percentage of this constituent. In the shed organs, the percentage is more or less constant.

Lime does not appear to be necessary till the plant is distinctly in the reproductive mood. Lime content of roots, stem and branches and leaves increases during flowering period and remains high throughout the remaining part of the season. It rises in flower-buds and continues to do so till the boll is formed and once this happens, it gradually declines with dry matter growth of the boll. Further, the percentage of lime in the shed reproductive forms remains pretty steady. Leaves which shed early in the season are less rich in lime than those which fall off later.

Potash is taken up in the early stage of plant growth. In roots, stem and branches, its percentage is high at first. Then it steadily declines till the end of the season. In leaves on the other hand, it accumulates till the crop matures. This is observed in shed leaves also. Shed leaves are, however, richer in lime than in potash.

The distribution of phosphoric acid, lime and potash in different organs of the plant at harvest is shown below (Table No. 107). Potash seems to be the major constituent. Nearly fifty per cent. of the total potash absorbed by the plant is present in bolls. The quantity of lime taken up is almost as great as that of potash. Lime accumulates mostly in leaves. About six per cent. of the total lime is found in the bolls. The amount of phosphoric acid in the plant is comparatively small

TABLE No. 107.

Total quantities of phosphoric acid, lime and potash in different organs of the plant at harvest—in grammes.

1931-32.

Constituents.	Roots.	Stem and branches	Leaves.	Bolls.	Shed leaves.	Shed buds and bolls.	
Phosphoric acid	0.1481	0.1125	0.1269	0.7754	0.3202	0.0936	1.5767
Lime	0.6426	0.5376	1.7377	1.2580	2.4570	0.3132	6.9461
Potash	0.5671	0.6508	1.0381	3.4774	1.2971	0.2929	7.3234

1930-31.

Lime	0.3522	0.7334	1.0252	0.6989	2.2804	0.3718	5.4619
Potash	0.1417	0.4730	0.1778	1.1430	1.7791	0.1651	3.8797

and of this, fifty per cent. is in the bolls. On the basis of these figures it is found that the plant removes from the soil about eighteen pounds of phosphoric acid, seventy-four pounds of lime and seventy-eight pounds of potash per acre. It may be noted that in 1930-31 the amount of lime absorbed by the plant was greater than that of potash.

Vishwanath and his collaborators (1926) worked on the distribution of mineral matter in various organs of Cambodia cotton No. 295 at Coimbatore and obtained similar results. They, however, found that of the mineral matter absorbed the quantity of lime was the highest.

(e) *Nitrogen.*

Leaves indicate the highest percentage of nitrogen (Table Nos. 127 to 130 in the Appendix). Then in the descending order of their percentage are the stem and branches and the roots. Amongst the reproductive forms, the flower-bud exhibits a high nitrogen content which is almost equal to that of leaves in September. As it passes from the flower to the mature boll stage, its percentage gradually declines. With the exception of flowers in which it is constant, the percentage progressively falls in all the organs as the season advances. This is also found in the case of shed organs which are generally poorer in nitrogen than those on the plant.

The fall in nitrogen percentage is due to the rise of dry matter. At first the rate of decline is rapid, but later it is gradual and slow. In all the years, the percentage in leaves remains constant for some time and then begins to decline. The

period of this constancy varies in different years and appears to depend upon the duration and the amount of rainfall. Longer the duration of rainfall, longer also is the period during which the percentage of nitrogen remains constant. In 1928, the duration of rainfall was longer than in 1929; but the total quantity of rain obtained was only twenty-six inches. In other years rainfall was more than forty inches. Thus the total effect in terms of duration appears to be less than that in 1929. The constancy in nitrogen percentage in spite of the rise in dry matter in the earlier stages of leaf growth is only apparent and will be explained later under protected plants. The percentage in leaves does fall with increase in dry matter.

Percentage nitrogen expressed on the total dry matter of leaves (Leaves on the plant plus those shed) falls continuously throughout the season (Table No. 108). It is worthy of note, however, that in all years, especially in 1930 and 1931, the decline in nitrogen continued even when the dry matter remained almost constant from the third week of December. It was therefore inferred that a part of leaf nitrogen was translocated to other parts.

TABLE No. 108.

Percentage nitrogen expressed on total dry matter of leaves.
(Shed plus non-shed).

Dates.	1929-30.		1930-31.		1931-32.	
	Weight of leaves in grammes.	Nitrogen.	Weight of leaves in grammes.	Nitrogen.	Weight of leaves in grammes.	Nitrogen.
18th September.	6.19	3.84	..	..	..	..
24th September.	..	..	4.80	3.56	3.45	2.95
1st October ..	14.38	3.30	8.92	3.35	4.05	2.89
8th October ..	..	..	..	..	9.00	3.20
15th October ..	23.47	3.34	14.40	3.15	..	..
29th October ..	27.47	2.88	20.40	3.13	17.50	2.79
12th November	42.08	2.76	29.60	3.00	24.17	2.70
26th November	48.83	2.38	36.00	2.80	39.10	2.77
10th December ..	48.60	2.44	43.75	2.68	52.40	2.60
24th December ..	55.70	2.01	44.50	2.41	49.00	2.69
7th January ..	59.50	1.89	48.40	2.11	60.00	2.28
21st January ..	57.33	1.67	50.40	1.79	54.75	2.10
4th February ..	64.00	1.72	55.75	1.38	51.58	1.94
18th February ..	50.00	1.49	48.75	1.55	48.50	1.65
4th March ..	45.99	1.44	48.99	1.32	47.33	1.44

Nitrogen percentage in leaves on the plant and in fact in all the vegetative organs is related to the early or late cessation of rainfall. Earlier the cessation, the greater the production of dry matter and less the percentage nitrogen in plant parts. In 1931-32, where the rains continued as late as the middle of October, the nitrogen percentage in leaves was the greatest. In 1929, on the other hand, the rain stopped as early as 15th August and the nitrogen content of leaves was found to be the poorest. The year 1930-31 was intermediate in this respect.

In the case of shed leaves, it is important to note that the percentage nitrogen expressed either on total dry matter or on ash-free basis gradually falls throughout

the season. (Table No. 109.) Shed leaves in the earlier part of the season are richer in nitrogen than those in the latter part. It may be further observed that the order in which the percentage nitrogen can be arranged in respect of magnitude in the three years is just the reverse of that found in the leaves on the plant. It has been

TABLE No. 109.

Percentage nitrogen in shed leaves on dry matter free of ash.

Dates.	1929-30.	1930-31.	1931-32.
15th October	2.82	2.36	..
29th October	2.98	2.44	2.25
12th November	3.05	2.94	1.93
26th November	2.55	2.31	2.18
10th December	2.63	2.43	2.04
24th December	2.46	2.40	1.94
7th January	2.40	2.05	1.98
21st January	1.95	1.93	1.85
4th February	1.99	1.73	1.59
18th February	1.83	1.64	1.43
4th March .. .. .	..	1.55	1.39
18th March .. .. .	..	1.53	1.37

pointed out that in 1929, the percentage nitrogen in the leaves on the plant was the lowest. When these shed they contained the highest amount compared with the shed leaves of the other two years. In 1928, the earlier figures of percentage nitrogen in shed leaves ought to have been the highest to be in keeping with the reverse order. This was, however, not so. Ash determinations were not made this year and therefore it is difficult to estimate whether the percentage nitrogen in shed leaves was really higher if expressed on dry matter free of ash.

Percentage nitrogen in shed leaves is lower than that found in leaves on the plant. The difference between the two varies, however, from year to year. (Table Nos. 128 to 130 in the Appendix.) It was nominal in 1929, appreciable in 1930 and highest in 1931. This gradation of difference between the percentage nitrogen in shed and non-shed leaves appears to be related to differences between the percentage nitrogen in the shed leaves of the three years.

Periodical determinations of nitrogen in growing bolls from the flower stage to maturity indicate that the young boll takes about two months to mature and contains nearly forty milligrammes of nitrogen at this stage. (Table No. 131 in the Appendix.) Although the percentage nitrogen falls as in all organs, with increase in dry matter it may be noted that the boll requires comparatively more nitrogen than other substances during the early phases of its growth, as within the first fortnight from the day of anthesis, the fall in percentage amounts to 2.7 while during the remaining period of one month and a half it is only 0.4.

The quantity of nitrogen absorbed by the plant at various stages of its growth is given in the Table Nos. 132 to 135 in the Appendix. It is to be noted that prior to the commencement of boll growth and at harvest the plant contains 1.8595 (88%) and 2.1047 grammes respectively of this element. Thus, during the period of boll growth which extends at least over a month and a half, only 0.2452 (12%)

grammes of nitrogen is taken up from the soil. The amount of this element in bolls is however far greater, indicating that the additional nitrogen has been contributed by the other organs of the plant, particularly the leaves.

TABLE No. 110.

Total nitrogen in grammes as the mean of three years in different organs of the plant at two stages of growth.

Plant organs.	Before the commencement of boll growth 24/12.		At harvest (Completion of boll growth).	
	<i>Dry matter.</i>	<i>Nitrogen.</i>	<i>Dry matter.</i>	<i>Nitrogen.</i>
Roots	27·92	0·1273	31·77	0·1143
Stem and branches	29·18	0·1623	34·33	0·1483
Leaves on the plant	40·32	0·9978	15·94	0·2763
Shed leaves	10·00	0·1758	32·83	0·4172
Leaves on the plant <i>plus</i> shed leaves..	50·32	1·1736	48·77	0·6935
Mature bolls	4·70	0·1299	68·94	0·9004
Other reproductive organs	8·92	0·2663	12·52	0·2480
All reproductive forms shed and non-shed.	13·12	0·3962	81·46	1·1484
Total in the whole plant	121·03	<u>1·8595</u>	196·40	<u>2·1047</u>

The figures underlined in the above table make it at once evident that more than two-thirds of the nitrogen utilised in the reproductive forms, both shed and non-shed, during the period from the commencement of boll growth to their maturity, is derived from the degradation products of protoplasmic nitrogen in leaves (Maximov 1930, page 244). The leaves thus serve as it were as storage organs for nitrogen. Kudrin (1928) worked on cotton in Turkestan under conditions of irrigation and obtained analogous results. He found that in addition to nitrogen, translocation of ash constituents from the vegetative to the reproductive parts also occurs. The results here presented do not, however, corroborate his observation in regard to the translocation of inorganic constituents.

The draft made by the cotton plant on nitrogen of the soil during its career on the land, amounts to 22·44 pounds per acre. Out of this quantity 10·04 pounds per acre are returned to the soil, in the form of shed organs such as the leaves, flower-buds and bolls.

Distribution of nitrogen in different plant parts is given below (Table No. 111) as the percentage of the total quantity absorbed during the season. From this distribution it will be clear that the demand for nitrogen on the part of the bolls is the greatest. More than fifty per cent. of the total nitrogen taken up by the plant is present in the bolls inclusive of shed forms. The mature bolls contain as much as forty-three per cent. As a result of their study on the transport of nitrogenous substances in cotton, Maskell and Mason (1929) reach the conclusion that nitrogen absorbed by the plant goes largely to the bolls. These results are in accord with our findings also.

The ratio of mineral matter expressed as ash, to nitrogen absorbed by the plant at different stages of growth is of special interest. (Graph No. 48 and Table

TABLE NO. 111.

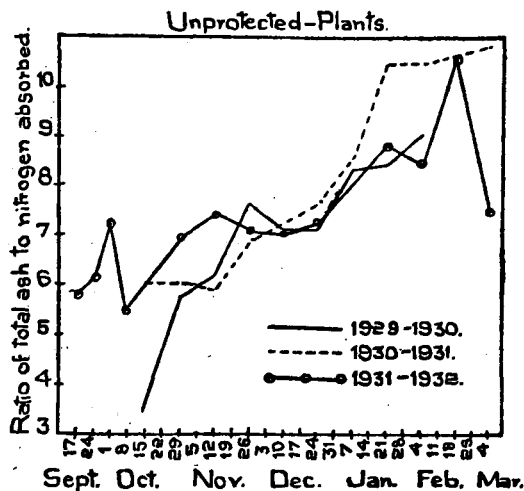
percentage distribution of nitrogen as the mean of three years in different organs of the plant.

Roots.	Stem and branches.	Leaves on the plant.	Mature bolls.	Shed leaves.	Shed buds.	Shed bolls.	Total.
5.4	7.05	13.13	42.78	19.82	2.26	9.52	99.97

No. 199 in the Appendix.) It rises till the middle of November and then remains steady or falls slightly for over a month and a half. From the end of December it again ascends, almost at the same rate as that in the beginning, till the bolls are ready for picking. This throws light on selective absorption of the plant and indicates that the requirement of inorganic matter other than nitrogen in the early and late stages of growth is comparatively high. The period during which more nitrogen is taken than other mineral matter, that is the second half of November and the whole of December, synchronises with the latter half of flowering and the early half of bolling period. It may be further observed that on the whole the ratio steadily increases till the end of the season, showing that the quantity of nitrogen

GRAPH NO. 48.

Ratio of total ash to total nitrogen at different stages of plant growth.



increasingly falls with the advance in season in relation to other inorganic constituents of the plant. This progressive fall in the absorption of nitrogen has to be attributed, in the main, to its shortage in the soil as the plant has been found to respond to this element at any stage of its growth (pages 198 to 216). These results are important as they show the relative importance of nitrogen and other ingredients of the soil to plant growth. More striking results are obtained in the protected plant in regard to this ratio (page 177.)

Different forms of nitrogen.

The total nitrogen so far discussed either as percentage or in quantity, comprises soluble and insoluble albuminoid nitrogen, amid, ammoniacal and the nitrate nitrogen. All these forms of nitrogen were estimated in 1926 and 1927 in the succulent parts of the plant such as leaves, flower-buds, flowers and bolls. In addition to these organs, shed reproductive forms were also analysed and studied.

Leaves on the plant were divided into two portions: the young leaves and those that were fully grown or adult. The samples of flower-buds consisted of young forms, all of which were of the same size. Freshly opened flowers were taken every time for analysis. As in the case of flower-buds so in the case of bolls, the samples comprised young forms—all of the same size. In regard to shed reproductive forms, the procedure adopted in their collection was to shake the plant on the day of sampling and collect all the flower-buds and bolls that dropped down at that time. Out of these only such forms were finally selected for analysis as were equal in size to those plucked from the plant on that day. It is necessary to point out that although the size of the plucked and shed buds and bolls were the same on any given day of sampling, they differed on different days of sampling.

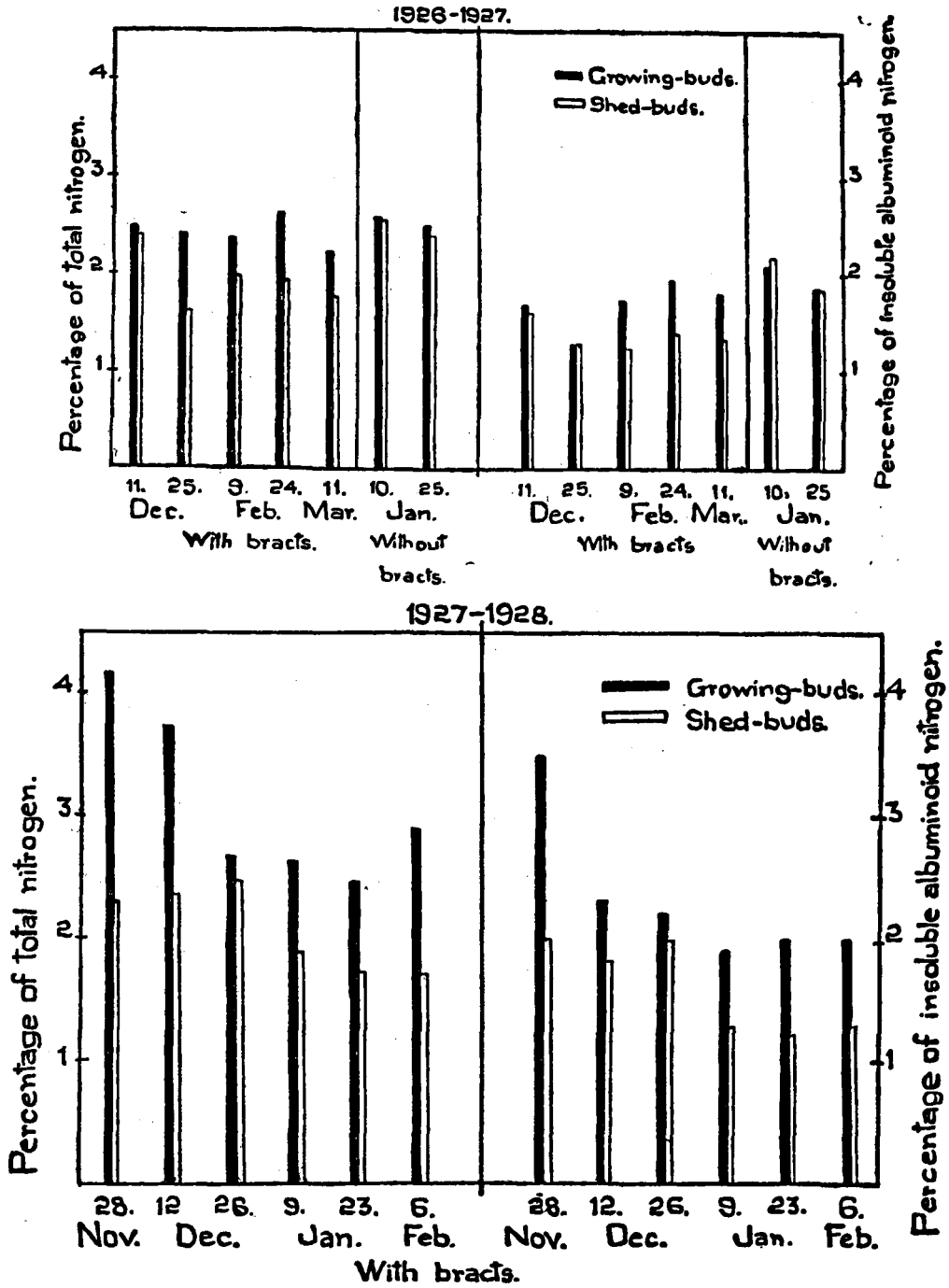
The results obtained in regard to different forms of nitrogen are presented in Table Nos. 136 and 137 in the Appendix. As the nitrates were present only in traces, they have not been estimated. From these tables, it will be evident that the percentage of insoluble albuminoid nitrogen is by far the greatest and it behaves just like the percentage of total nitrogen in the plant. The percentage of soluble nitrogen which consists of amido, soluble albuminoid and the ammoniacal nitrogen is indeed very small. Their percentages range themselves in the order named, that is amid nitrogen being the highest in the lot. This gradation of the different forms of nitrogen was noticed in all the organs studied with the exception of shed bolls in 1926 in which case only the percentage of ammoniacal nitrogen was slightly higher than that of soluble albuminoid nitrogen. This was apparently due to the conversion of the latter into the ammoniacal form as an after effect of shedding.

One striking fact which the tables illustrate is the constancy of the soluble nitrogen in the plant. As an instance, the case of leaves may be cited. Although the percentage of insoluble albuminoid nitrogen in the leaves steadily declines with advance of the season, that of soluble nitrogen remains pretty steady throughout.

Of greater importance, however, is the fact that on the basis of size, the percentage of total and insoluble albuminoid nitrogen in the shed buds and bolls is conspicuously less than that in the corresponding forms on the plant. (Graph No. 49.) The other forms of nitrogen are almost of the same order in the two cases. Thus relative to insoluble albuminoid nitrogen, the percentage of soluble nitrogen in the shed organs is greater than that existing in organs growing on the plant. On two occasions in 1926, both the shed and non-shed bolls were analysed after removal of their bracts. This analysis showed that the differences between the shed and non-shed forms were not as striking as they were when the bracts had been included. It is, therefore, to be inferred that the bracts are affected to a greater extent than the ovary and on this account they play a prominent part in the early stages of boll growth. The fact that the buds and bolls drop down along with the bracts and that they form a greater portion of dry weight of these organs during the bud and the early stages of boll growth suggests that they serve as storage organs on which the reproductive forms should fall in times of need.

GRAPH No. 49.

Percentage of total and insoluble albuminoid nitrogen in non-shed and shed buds and bolls, on the basis of size.



Leaving aside the shed organs in which the process of decomposition may start, the results show that on the whole the amid-nitrogen predominates amongst the soluble forms of nitrogen in all the succulent organs analysed. Hass and Hill (1922) quote a lot of literature and come to the conclusion that growth is associated with the presence of asparagine or the amides. According to Prianichnikov, as quoted by these authors, ammonia is the end product of protein dissociation and asparagine is the form in which it is stored. Sure and Tottingham (1916) as a result of their study on the germination of pea, conclude that amino acids serve for the production of amides in the plant. Newton (1927) worked on the metabolism of nitrogenous compounds in dormant and non-dormant potato tubers and found that amid-nitrogen content of the juice was greater in non-dormant than in dormant juice. He feels that asparagine is a factor on which growth depends. Palladin (2nd Am. Ed. 1922) cites numerous references on this subject. Our results indicate that the soluble nitrogen is the active and the mobile form of nitrogen and in which the amide form dominates. Further, as the percentage of amino-nitrogen is higher than that of ammoniacal nitrogen and that of amid-nitrogen higher than that of amino-nitrogen, it may be assumed that probably ammoniacal nitrogen is converted into the amido form and the amino-nitrogen in the ammoniacal form as suggested by Prianichnikov.

(f) ETHER EXTRACT.

Among the vegetative organs of the plant, leaves record the highest percentage of ether extract at any time in the season (Table Nos. 138 to 141 in the Appendix). The percentage remains constant at about four till the middle of December and then steadily ascends to about seven by the middle of February. It may be noted that although the dry matter of leaves rapidly increases, the percentage of ether extract is almost the same till the middle of December. Hereafter the leaves on the plant are all advanced in age and the rise in ether extract indicates the accumulation of resins and yellow pigments which gradually increase as the leaves grow older. In shed leaves, the percentage ether extract is always lower in the early stages of plant growth. It is only in January that the percentage in the two cases becomes equal.

Next in the descending order of percentage are the roots. In 1930, they showed a constant percentage in spite of the fact that their dry matter growth was rising all along for considerable time in the season. In 1931 on the other hand, the percentage was constant till the middle of December after which time it gradually increased. The percentage of ether extract in the stem and branches in both the years was the lowest and fairly constant at all times during the season.

In flower-buds, flowers and young bolls the percentage is intermediate between that of the leaves and the roots. In the bolls as they increase in dry matter, the percentage ether extract rapidly rises and takes more than a fortnight to reach a maximum value. The ether extract in plant organs generally contains materials of the type of fats, lipoids, ethereal oils, pigments, etc.; in the case of bolls, however, as the seeds develop when the dry matter of bolls rapidly increases, it is reasonable to ascribe the rise in ether extract to the formation and accumulation of oil. This is corroborated by direct observation also.

(g) FIBRE.

Fibre content of all the organs is not the same (Table Nos. 142 to 145 in the Appendix). In roots, stem and branches it is nearly fifty per cent. In the rest

of the organs its percentage is within the limits of ten and twenty. The fibre content of growing bolls begins to rise generally in the second week of January and continues to do so till it is about forty per cent. at maturity. Shed leaves show the lowest content of fibre owing mainly to the deposition of large quantities of inorganic matter in them.

Percentage fibre in roots rises in the beginning to about sixty and then declines steadily to forty, some time in January or in the early part of February, and again rises towards the end of the crop season. It behaves in a like manner in stem and branches but the extent of decline is not as great and there is no second rise also. In leaves on the plant, the percentage varies within the range of ten and fifteen. The fluctuations in fibre percentage in roots and its rapid rise in bolls are important and will be presently discussed.

(h) HYDROLYSABLE CARBOHYDRATES.

The percentage of hydrolysable carbohydrates in leaves on the plant is on the whole at fifty; in roots, stem and branches it is about thirty-five and in young reproductive forms generally higher than that in the leaves (Table Nos. 146 to 149 in the Appendix). Shed bolls contain more than fifty-five per cent. of these.

Fibre does not dissociate into less complex forms of carbohydrates and hence the rise or fall in its percentage may be relative in character depending upon the decrease or increase in the percentage of other constituents. It will therefore be evident that the fall in the percentage fibre in roots is the result of the deposition of hydrolysable carbohydrates which dominate the other constituents. In 1930-31, the fibre content of roots declined from sixty to forty per cent. owing to the accumulation of hydrolysable carbohydrates (Table No. 112) and rose again to fifty. This increase in fibre percentage which took place in the month of January was not caused by the translocation of hydrolysable carbohydrates to other organs of the plant thus relatively raising the fibre percentage but was due entirely to their conversion into fibre. This conversion of less complex forms of carbohydrates into fibre in roots also occurred in 1931-32.

TABLE No. 112.

Percentage and total fibre, hydrolysable carbohydrates and other constituents of roots. 1930-31.

Dates.	Dry matter in gms.	Per cent. fibre.	Total fibre in gms.	Per cent. total hydrolysable carbohydrates.	Total hydrolysable carbohydrates in gms.	Percentage of other constituents.
15th October ..	4.90	61.25	3.00	25.87	1.27	12.87
29th October ..	6.60	61.00	4.03	27.47	1.81	11.53
12th November ..	8.00	53.60	4.25	34.62	2.77	11.79
26th November ..	16.00	49.87	7.98	36.55	5.85	13.58
10th December ..	25.60	52.10	13.34	37.30	9.55	10.60
24th December ..	24.00	50.85	12.20	39.13	9.39	10.02
7th January ..	24.25	41.50	10.06	47.27	11.46	11.23
21st January ..	30.00	47.00	14.10	43.19	12.96	9.81
4th February ..	24.00	46.45	11.14	44.15	10.59	9.40
18th February ..	28.25	54.95	15.52	35.34	9.98	9.71
4th March ..	28.75	51.75	14.88	36.94	10.62	11.31
11th March ..	26.25	48.45	12.72	39.75	10.44	11.79

Transformation of hydrolysable carbohydrates into fibre also occurs in growing bolls when they rapidly increase in dry matter (Table No. 113). In this case, it may be noted that a part of hydrolysable carbohydrates is changed into oil as well. The last analysis given in the following table shows the percentage composition of mature bolls.

The high content of hydrolysable carbohydrates in leaves and their accumulation in roots during the season places above doubt the fact that they do not fall short of the requirement of the plant at any stage.

TABLE NO. 113.
Periodical percentage composition of growing bolls.
1930-31.

Dates.	Dry matter	Proteids.	Ether extract	Fibre.	Hydrolysable carbohydrates.	Ash.
24th December ..	4.00	17.91	2.08	20.35	45.21	14.45
7th January ..	13.44	16.43	1.80	17.40	52.98	11.39
21st January ..	25.40	9.20	2.20	31.05	50.11	7.44
4th February ..	75.50	7.22	5.70	39.70	40.15	7.23
18th February ..	72.50	7.21	5.10	40.20	39.04	8.45
4th March ..	72.83	7.97	7.45	41.60	36.10	6.88

1931-32.

23rd December ..	2.50	16.56	1.85	14.70	53.85	13.04
6th January ..	12.13	13.13	2.00	18.95	56.37	9.55
20th January ..	25.00	12.17	2.60	20.05	54.99	10.19
3rd February ..	50.00	9.33	2.55	27.85	54.67	5.60
17th February ..	47.25	7.84	5.60	32.50	45.54	8.52
2nd March ..	85.00	7.84	6.35	37.50	37.08	11.23(?)

(i) RATIO OF TOTAL HYDROLYSABLE CARBOHYDRATES TO TOTAL NITROGEN.

A good deal of work has been done during the last decade on the relative proportions of carbohydrates and nitrogen in the plant in relation to different phases of growth. Following upon the classical researches of Klebs, Kraus and Kraybill (1918) studied the chemistry of tomato and were the first to point out that the vegetative or reproductive growth made by a plant depended upon the "balanced condition" of carbohydrates and nitrogen within. They state, among other things, that plants grown with an abundant supply of nitrogen and an opportunity for carbohydrate synthesis are vigorously vegetative and fruitful; those grown with a moderate supply of nitrogen are less vegetative but fruitful and again those grown with a low supply of nitrogen are weakly vegetative and unfruitful. Subsequently, numerous investigators prominently amongst whom may be mentioned Hooker, Harvey, Murneek, Crocker, Gurjar, Nightingale, etc., worked on plants such as tomato, apple and peach trees, salvia, soybeans, etc., and have substantiated, in the main, the conclusions reached by Kraus and Kraybill.

Crocker (1919) interpreted the balanced condition in terms of the ratio of carbohydrates to nitrogen. Nightingale (1922) came to the conclusion that the relation of carbohydrates to insoluble nitrogen in the plant was more significant than that of the former to total nitrogen. Gurjar (1920) gave definite ratios for the vegetative and reproductive phases of growth.

The ratio of total hydrolysable carbohydrates to total nitrogen present in different organs of the cotton plant (Table No. 114) as determined by us rises continuously with advance in the season. It is very low during the vegetative state and rises to high proportions during the reproductive state of the plant. It is not possible, as Gurjar has done, to assign a definite ratio to the two phases of growth in cotton as the ratios in the two years have differed considerably when the reproductive phase is initiated. This subject will be discussed in full detail under the protected plants.

TABLE No. 114.

Ratio of total hydrolysable carbohydrates to total nitrogen in different organs.

(Shed organs excluded.)

1930-31.

Dates.	Roots.	Stem and branches.	Leaves.	Flower-buds.	Flowers.	Bolls.
15th October	32.50	33.61	12.76	14.96	..	..
29th October	48.21	40.62	12.17	14.93	..	..
12th November	54.84	54.76	16.54	14.91	..	..
28th November	57.89	54.86	16.61	14.66	..	..
10th December	75.96	57.82	16.81	16.54	16.41	..
24th December	90.31	65.32	18.51	13.48	16.93	15.76
7th January	92.73	82.58	20.76	17.05	16.32	19.79
21st January	107.52	81.46	24.69	..	..	35.03
4th February	136.01	93.68	35.97	..	..	34.76
18th February	89.60	87.45	27.31	..	..	33.85
4th March	99.71	91.04	30.99	..	..	29.51
11th March	88.81	87.86	33.87	..	..	28.66

1931-32.

25th September	36.58	29.88	15.91	..	..	..
1st October	57.71	31.27	16.19	..	..	..
8th October	51.31	32.08	15.31	..	..	..
28th October	45.31	36.07	16.77	..	..	..
12th November	40.83	27.57	16.69	15.16	..	..
26th November	48.52	46.67	15.90	17.99	20.78	18.89
10th December	62.13	58.58	18.08	14.90	19.89	20.31
24th December	61.16	59.35	16.35	14.90	19.85	20.33
7th January	77.64	67.53	19.34	15.25	19.27	26.82
21st January	80.25	71.42	20.23	20.97	20.58	28.25
4th February	105.16	69.47	20.91	24.64	22.23	36.64
18th February	107.27	75.02	23.62	..	..	35.10
4th March	80.35	70.13	24.75	..	..	29.27(?)
18th March	103.88	73.65	26.09	..	..	35.38

II. MANURED UNPROTECTED PLANTS.

In the year 1928-29, in one of the plots, unprotected plants were manured on the 23rd August with twenty pounds of nitrogen per acre as sulphate of ammonia. The plants were grown eighteen inches apart on high ridges (a foot high) spaced six feet apart. The fertilizer was applied at the base of the slopes of the ridge on both the sides. The manure was thus a foot away from the young plants. It may be noted that no appreciable rain was received till the third week of September. The plants were given on the 19th October, a second dose of nitrogen as nitrate of soda at the rate of fifty pounds of nitrogen per acre. This time, the fertilizer was given in the centre of the furrow, *i.e.*, three feet away from the plants. No rain was received after the application of this dose, the last rains having fallen on the 23rd September. Unprotected plants in an adjacent plot, spaced three feet both ways, served as control. Although the square space allotted per plant in both the sets was the same, the planting was required to be modified in the manured plot to suit the convenience of manuring on field scale.

The analytical data on the unprotected manured plants in regard to dry matter, moisture and nitrogen are assembled in Table Nos. 150 to 153 in the Appendix. They show that the differences noticed in the moisture content of different organs of these plants were similar to those observed in the control. The applied nitrogen failed to affect the moisture content of the vegetative parts of the plants. The reproductive organs, however, showed all along a higher moisture content than that in the corresponding forms of the control. The production of dry matter of the treated plants was nearly twice that of the control. As the dry matter built by the plant must be to some extent proportional to water transpired, it is within the limits of reason to assume that the drain of water from the soil in the manured plot was considerably greater than that in the untreated plot. Such unequal drain of soil moisture in the same year can also be seen if comparisons are instituted between the dry matter of the protected and the unprotected plants. It appears therefore to be fairly certain that the supply of available moisture in the Surat soils is always above the current needs of the plant.

The effect of applied nitrogen as expressed in dry matter was felt from the first week of November. The dry matter of the treated plants began to increase more rapidly from this time onwards. The general nature of growth of all organs was on the whole the same in the two sets. Owing to manuring, the time of commencement of leaf-fall and boll growth did not differ from that in the control. The most notable difference between the two sets was in regard to the magnitude of growth. The dry matter of the manured plants was twice as great as that of the control (400 against 200 grammes). Again, the treated plants gave more than double the yield of bolls as the untreated (130 against 50 grammes).

It may be further observed that although the root system of the manured plants was heavier by about ten to fifteen grammes, the relation of the shoot to root indicate that for the same weight of the roots in the untreated a greater amount of dry matter of shoot was built up in the manured set.

It has been noted above that although the plants had been manured as early as the 23rd August, their dry matter production did not differ from that of the control till as late as the middle of November. Whilst this was the case, figures for percentage nitrogen indicate that the vegetative organs of the plant recorded a higher percentage within a month from the date of the first application of the manure (Table No. 115). Its effect on stem and branches could be seen even earlier.

As the dry matter production of these plants did not show any extra increase over the control, it is concluded that the higher nitrogen content of the vegetative parts of the treated plants was not due to a higher rate of production of new buds, but was entirely the result of accumulation of this element during the period. Percentage nitrogen in vegetative parts was throughout higher. The nitrogen content of other organs was almost the same in the manured and the control sets.

TABLE No. 115.

Percentage nitrogen in vegetative organs of the manured and control plants.
1928-29.

Dates.	Roots.		Stem and branches.		Leaves.	
	Manured.	Control.	Manured.	Control.	Manured.	Control.
15th August	1.71	..	1.39	..	3.76	..
23rd August .. ..	..	..	..	..	..	..
27th August .. ..	..	1.20	..	1.75	..	3.39
3rd September	1.07	..	1.67	..	3.59	..
10th September .. ..	..	1.07	..	1.76	..	3.40
17th September	Rain	..	Rain	..	Rain	..
24th September .. ..	..	0.87	..	1.39	..	3.02
1st October	0.89	..	1.31	..	3.25	..
8th October .. ..	..	0.58	..	0.78	..	2.86
15th October	0.71	..	1.08	..	2.84	..
22nd October .. ..	..	0.55	..	0.70	..	2.54
29th October	0.75	..	0.77	..	2.64	..
5th November .. ..	..	0.47	..	0.63	..	2.47
12th November	0.48	..	0.64	..	2.83	..
19th November .. ..	..	0.38	..	0.51	..	2.16
26th November	0.55	..	0.78	..	2.30	..
3rd December .. ..	..	0.39	..	0.46	..	2.03
10th December	0.46	..	0.56	..	2.19	..
17th December .. ..	..	0.33	..	0.40	..	19.6
24th December	0.34	..	0.50	..	2.01	..
31st December .. ..	..	0.33	..	0.40	..	1.70
7th January	0.36	..	0.54	..	1.76	..
14th January .. ..	..	0.34	..	0.39	..	1.65
21st January	0.32	..	0.42	..	1.87	..
28th January .. ..	..	0.28	..	0.37	..	1.54
4th February	0.34	..	0.44	..	1.64	..
11th February .. ..	..	0.32	..	0.38	..	1.51
18th February	0.39	..	0.42	..	1.59	..
25th February .. ..	..	0.29	..	0.33	..	1.62

The question now arises as to whether the nitrogen in the form of ammonium sulphate or sodium nitrate or both was utilized by the plant. As there was no rain since the 23rd September and as sodium nitrate was administered nearly one month later in the hottest part of the season, it is inferred from our experience over a number of years that it remained unused in the surface layer of the soil for want of water to carry it down and nitrogen of ammonium sulphate given in August alone was used by the plant. Had it not been to the precipitation of about five inches rain in the third week of September, even ammonium sulphate would not have been available to the plant.

This will be seen from the results of experiments conducted in 1929-30 where fifty pounds of nitrogen to an acre as ammonium sulphate was applied on the 6th September in two plots, nine inches away from the plants, on both sides of the ridges on which the plants were situated. There was no effective rain since the 15th July that year. One of these plots was irrigated on the 4th November with about six acre-inches of water. Control was maintained in a plot near by. Chemical analysis was confined throughout the season to leaves on the plant in the three sets. Determinations of moisture, dry matter and nitrogen (Table No. 116).

TABLE No. 116.

Percentage moisture, dry matter and nitrogen in leaves (on the plant) of plants under different treatments.

1929-30.

(a) Percentage moisture in leaves.

Dates.	Manured.	Control.	Manured & irrigated.
2nd September	83.8	79.8	81.9
16th September	78.2	77.7	77.0
30th September	75.5	77.4	75.3
14th October	78.1	76.5	77.2
28th October*	75.3	76.7	75.3
11th November	76.7	77.3	77.3
25th November	73.3	74.7	74.4
9th December	73.1	71.8	73.9
23rd December	71.4	72.3	73.1
6th January	70.2	72.4	73.7
20th January	69.99	69.2	72.3
3rd February	69.5	69.7	69.2
17th February	67.7	68.4	71.4
3rd March	66.8	65.5	66.1
17th March	63.9	64.4	62.8

(b) Dry matter of leaves on the plant in the above sets.

2nd September	1.46	2.86	0.98
16th September	4.20	6.20	4.44
30th September	9.28	16.12	11.82
14th October	26.32	20.46	21.22
28th October*	37.08	24.48	34.42
11th November	33.22	26.16	46.44
25th November	42.78	35.14	67.18
9th December	48.02	52.10	95.80
23rd December	38.16	48.54	89.10
6th January	49.10	36.58	65.28
20th January	44.54	48.06	94.72
3rd February	60.86	32.08	88.12
17th February	25.42	19.70	40.66
3rd March	19.32	21.67	31.56
17th March	16.26	28.70	24.22

* Irrigated.

TABLE No. 116—(concl'd.)

Percentage moisture, dry matter and nitrogen in leaves (on the plant) of plants under different treatments.

1929-30.

(c) Percentage nitrogen in leaves.

Dates.	Manured.	Control.	Manured & irrigated.
16th September	3.55	3.69	3.60
30th September	3.26	3.14	3.37
14th October	3.22	3.16	3.35
28th October *	3.08	3.08	3.39
11th November	2.81	2.94	3.87
25th November	2.72	2.78	3.38
9th December	2.63	2.40	2.86
23rd December	2.34	2.27	2.77
6th January	2.13	2.10	2.60
20th January	1.93	2.06	2.24
3rd February	1.80	1.86	2.13
17th February	1.78	1.95	1.99
3rd March	1.56	1.50	1.64
17th March	1.53	1.38	1.45

* Irrigated.

indicate that the plant did not respond to the applied nitrogen unless supplied with water to make it mobile. The dry matter of leaves and their moisture and nitrogen content in the manured and control plots did not much differ. In the plot which received both the manure and irrigation, the dry matter, the percentage of moisture and nitrogen increased within a few days from the date of irrigation, and remained all along higher till the end of the season. It is difficult to say with the data, based as they are on aggregate samples of leaves, whether the increase in the percentage of nitrogen and to some extent of moisture is to be ascribed to the greater content of individual leaves or to differences in the relative increase in the proportions of younger to older leaves. However, the change of colour from yellowish green to deep green within a few days after the irrigation and the greater production of leaves from this time onwards suggest that the increase in percentage of moisture and nitrogen, must have been due to both.

Returning now to the manured and the control plants of the year 1928-29, it will be seen from Table Nos. 132 and 153 in the Appendix that the quantity of nitrogen absorbed by the former was about four grammes as against two in the latter. It has already been stated that the collection of shed forms this year was not quite satisfactory from the 21st January 1929 and therefore the quantities of nitrogen absorbed by the plants during the season must have been somewhat greater than what the above figures indicate. Nitrogen in bolls of the treated and the untreated plants amounted to 1.6 and 0.6 grammes respectively. Further, the figures for total nitrogen reveal the fact that the economic transfer of nitrogen from leaves to the parent plant takes place and that the nitrogen so transferred is utilized by the developing bolls.

III. PROTECTED PLANTS.

The study of the protected plants was started in the year 1929-30 and continued for a period of three years. The analytical data on these plants will now be considered from two points of view. Firstly, the behaviour of the protected plants as such under the influence of the three seasons will be studied and secondly, their performances will be compared with those of the unprotected in the corresponding years. In this comparison the season remains the same and on this account, the differences in the growth of plants belonging to the two sets are well seen.

(a) DRY MATTER.

The different organs of the protected plants range themselves in the same descending order of their weights as that observed in the unprotected (Table Nos. 154 to 156 in the Appendix). The growth of bolls, however, does not bear any such relation to that of the other organs. Their dry matter may remain below the weight of leaves in one year or may be as much as twice the weight of leaves in another, the magnitude of the difference depending upon the conditions of environment. Further, it may be noted that in spite of the varying influence of the seasons the commencement of leaf-fall in all the three years occurred at the same time from the middle of December. The rate of fall however varied, late years being associated with a less rate.

The time of the commencement of leaf-fall and boll growth has an important bearing upon the yield of the latter. In 1930 and 1931, both the processes began simultaneously from the middle of December as happens in the protected plants. In 1929 on the other hand, the dry matter of bolls began to increase one month earlier. On this account, the yield of bolls this year was twice that in any of the other two. As the leaves are the photosynthetic organs, the arrival of bolls before the start of leaf-fall is of special advantage to the plant.

With regard to the influence of the three seasons on the vegetative and reproductive growth, it may be stated that drier conditions of environment are more congenial for reproductive growth. This will be seen from the following ratios of the dry matter of the vegetative organs to that of the reproductive, in the three years, 0·87, (1929) 1·09, (1930) 1·79, (1931).

The total production of dry matter differed considerably in the three years (Table No. 117). In 1929, it was 256 grammes, while in other years it was much

TABLE No. 117.

Dry matter in grammes of different organs in the protected plants at harvest.
(On oven-dry basis.)

Years.	Roots.	Stem and branches.	Leaves.	Bolls.	Shed leaves	Shed buds and bolls.	Total.
1929-30	20·00	44·40	17·60	116·00	37·00	21·96	256·96
1930-31	19·40	22·00	11·25	57·25	26·50	15·00	151·40
1931-32	21·50	46·00	27·00	46·50	27·78	21·50	190·28
Average	20·30	37·47	18·62	73·25	30·43	19·49	199·55

less. The season of 1929 appears therefore to be more conducive to a "balanced" growth of the vegetative and the reproductive organs. ..

(b) CORRELATIVE INFLUENCES OF GROWTH.

The growth of bolls on the plant exerts a retarding influence on the development of vegetative organs (Table No. 118). This will be particularly observed in 1930 and 1931. In 1929, however, the growth of bolls proceeded simultaneously with that of the vegetative parts for over a month till the middle of December. Thereafter, the vegetative organs did not increase in dry matter but the growth of bolls still continued till the end of the season.

TABLE No. 118.

Dry matter in grammes of the vegetative organs and that of growing bolls.

Dates.	1929-30.		1930-31.		1931-32.	
	Vegetative organs.	Bolls.	Vegetative organs.	Bolls.	Vegetative organs.	Bolls.
7th October	29.05	..	16.84	..	..	..
21st October	56.38	0.27	34.20	..	19.37	..
4th November	74.02	1.12	42.88	0.51	35.92	..
18th November	85.39	10.00	68.90	1.80	75.17	..
2nd December	103.43	41.25	80.17	6.00	98.40	0.69
16th December	119.04	75.30	79.20	14.20	109.25	5.75
30th December	116.87	99.83	91.00	37.80	105.25	27.50
14th January	120.04	94.20	94.20	43.40	103.00	50.00
28th January	119.00	116.00	98.75	53.75	107.75	45.75
11th February	118.57	137.67	78.47	50.33	122.28	46.50
25th February .. ..	..	..	79.15	57.25	127.50	95.75

While this was the case with regard to the whole vegetative growth of the plant, the depressing effect of the growing fruit was felt by the roots even much earlier (Graph No. 50). In all the years under study, the root growth stopped with the commencement of rapid increase in dry matter of the bolls. These results indicate that all the energy of the plant is directed and utilized in the development of the fruit, and consequently the vegetative growth ceases. Debudding experiments (page 237) throw further light on this problem. They show that if the reproductive organs are removed as they arise the vegetative growth of the plant is prolonged.

These observations are in accord with those made by Mason, Ewing, Balls and Holton on cotton though their evidence is based on different data. Mason (1922) correlated the rate of elongation of the central axis with the number of flowers and fruits set. He found that the rate of elongation of the axis decreased proportionately to the number of flowers formed and the fruit set. The retarding influence of the developing fruit on vegetative growth has been observed on other plants also (Murneek, 1926).

(c) COMPARISON OF DRY MATTER GROWTH OF THE PROTECTED AND UNPROTECTED PLANTS.

The protected plants differ from the unprotected in the weights of their root systems. The dry matter of roots of the former is always less from the first week of November (Table No. 119) which synchronizes with the start of flowering in those plants. This difference in the dry matter of root systems of the two sets, arises mainly as a result of damage to flower-buds by the spotted boll-worm

TABLE No. 119.

Comparison of dry matter of the root systems of the protected and unprotected plants.

Dates.	1929-30.		1930-31.		1931-32.	
	Protected gms.	Unprotected gms.	Protected gms.	Unprotected gms.	Protected gms.	Unprotected gms.
9th September..	0.81	..	..	..	..	..
..	..	1.00	..	..	..	..
23rd September	2.53	..	..	..	..	..
..	..	3.38	..	2.08	..	1.06
7th October ..	3.74	..	3.44	..	..	..
..	..	5.45	..	4.90	..	..
21st October ..	7.79	..	4.60	..	2.67	..
..	..	7.48	..	6.60	..	4.75
4th November ..	13.55	..	7.04	..	4.67	..
..	..	11.50	..	8.00	..	7.50
18th November	12.92	..	9.60	..	12.67	..
..	..	21.00	..	16.00	..	14.60
2nd December ..	13.60	..	13.00	..	18.00	..
..	..	25.20	..	25.60	..	19.00
16th December ..	15.80	..	16.20	..	18.75	..
..	..	38.50	..	24.00	..	21.25
30th December ..	19.50	..	18.00	..	17.50	..
..	..	41.63	..	24.25	..	26.75
14th January ..	19.00	..	17.60	..	19.50	..
..	..	41.50	..	30.00	..	25.13
28th January ..	20.00	..	20.00	..	20.00	..
..	..	45.00	..	24.00	..	26.00
11th February ..	21.40	..	19.80	..	21.50	..
..	..	..	..	28.25	..	28.00
25th February ..	..	..	..	..	20.00	..

(page 108), and starts from the time of attack till bolls are set on the plant. The magnitude of the difference varies from year to year according to virulence of the pest.

The cause of this higher weight of roots in the unprotected plants is not far to seek. With the growing area of leaf-surface, the production of carbohydrates rapidly increases and gets divided between the vegetative and the reproductive organs as occurs in the protected plants. In the unprotected, however, when the extra flower-buds and young bolls shed owing to damage by the spotted boll-worm, their share of carbohydrates is translocated to the roots and hence the increase in dry matter. This also explains the cessation of root growth and later of other organs when the growing bolls monopolize all nutrition of the plant.

The translocation of carbohydrates from leaves to roots when the damage to flower-buds by the spotted boll-worm is in progress does not, however, lead to their accumulation as reserve food but is converted into fibre and utilized by the plant for mechanical purposes during descent of roots into lower depths of the soil. This will be evident from the figures for percentage and total hydrolysable carbohydrates and fibre in Table Nos. 184 to 186 and 190 to 192 in the Appendix.

The differences noticed in the dry matter of the root systems of the two sets are not, however, to be found in the weights of the stem and branches. This is but natural as the products of photosynthesis in the unprotected plants are not deposited in these organs during the period of boll-worm pruning but are removed to roots as stated before. The stem and branches in the unprotected plants, nevertheless, continue their growth longer than those of the protected.

With regard to leaves, it may be stated that in the protected plants leaf-fall starts nearly three weeks earlier when the maximum weight of the leaves on the plant is reached. This is not, however, noticed in the unprotected. Owing to shoot damage by the spotted boll-worm, new leaves arise which continue the growth and in consequence their dry matter on the plant remains at a maximum level for a longer time.

No consistent behaviour is exhibited by the two classes of plants in respect of dry-matter production of bolls. (Table No. 120.) Leaving out of consideration

TABLE NO. 120.

Dry matter in grammes of the vegetative and reproductive organs of the protected and unprotected plants at harvest.

Years.	Protected plants.			Unprotected plants.		
	Vegetative organs.	Bolls.	Shed buds and bolls.	Vegetative organs.	Bolls.	Shed buds and bolls.
1929-30	119.00	116.00	21.96	125.33	49.00	13.89
1930-31	79.15	57.25	15.00	114.42	72.83	13.67
1931-32	122.28	46.50	21.50	117.67	72.50	12.00

the protected and unprotected plants of 1930-31 where the total vegetative growth appreciably differed, it will be found that in the other two years there was a great disparity between the dry matter yields of bolls in the two sets. This indicates that the protected plants did not live up to their reputation as high yielder during these years. The characteristics of the protected plants were less pronounced in the

years 1930 and 1931 while those in 1929 were the most typical. The loss of shed flower-buds and bolls together in these plants was always greater even if allowance is made for the shed corollas of mature bolls.

Finally, it is important to mention that owing to absence of the spotted boll-worm, the protected plants finish their life-cycle earlier by a period of three weeks or so.

(d) MOISTURE CONTENT IN THE PROTECTED AND UNPROTECTED PLANTS.

The behaviour of percentage moisture in different organs of the protected plants is the same as that studied in the unprotected. (Table Nos. 157 to 159 in the Appendix.) The data in the two sets may now be compared. Broadly speaking, it is found that on the basis of age the moisture content of the protected and unprotected plants does not much differ. According to the stage of boll growth, however, conspicuous differences are noticed in the two sets. The protected plants always indicate a higher content of moisture during boll growth. The differences in moisture between the two sets are most striking in 1929 and less so in the remaining two years.

From these observations it appears to be certain that during the development of bolls, the protected plants are not in the same condition of growth as those unprotected. The former are less advanced in age and are more vigorous and energetic.

(e) ASH IN THE PROTECTED AND UNPROTECTED PLANTS.

The gradation of ash percentage in different organs of the protected plants (Table Nos. 160 to 162 in the Appendix), and its variation during the season are almost identical with those in the unprotected. Similarly, the effects of seasonal variation observed on the ash content of the unprotected plants are also found in the protected. Thus drier seasons are associated with a lower ash percentage, indicating a greater rate of photosynthesis than that of absorption of inorganic matter.

Periodical intake of mineral matter by the protected plants is shown in Table Nos. 163 to 165 in the Appendix. This naturally varies in the two sets according to the production of dry matter, ash percentage remaining the same in the two cases. The mean of three years (Table No. 121) indicates that the total quantity of inorganic material taken up, during the season, amounts to about 20·50 grammes per plant in the two sets.

TABLE No. 121.

Ash content in grammes of the protected and unprotected plants at harvest.

Year.	Protected plants.	Unprotected plants.
1929-30	24·04	18·79
1930-31	15·38	21·80
1931-32	21·96	21·08
Mean	20·46	20·56

(f) PHOSPHORIC ACID, LIME AND POTASH.

The determinations of lime, potash and phosphoric acid carried out at different stages of growth of the protected plants (Table Nos. 166 and 167 in the Appendix) lead in fact to the same observations made when dealing with the unprotected plants. Hence, their consideration here may be omitted. Mention may, however, be made of the distribution of these ingredients in different parts of the boll. (Table Nos. 122 to 124.) The data in the following tables represent the average of eighty bolls.

TABLE NO. 122.

Percentage mineral composition of mature bolls on dry matter.

Ash.	Phosphoric acid.	Potash.	Lime.	Other inorganic matter.
5.9367	0.8739	2.8262	1.3867	0.8426

TABLE NO. 123.

Percentage mineral composition of the different parts of mature bolls.

	Ash.	Phosphoric acid.	Potash.	Lime.
Burs	9.88	0.4338	5.1756	1.8000
Lint	3.38	0.3190	0.6200	1.9000
Seed	4.90	1.4990	2.6340	0.8000

TABLE NO. 124.

Dry matter in grammes of different parts of the mature boll.

Burs.	Lint.	Seed.	Total weight of boll.	Number of seeds per mature boll.
0.8275	0.7700	1.2509	2.8484	21.8250

From the tables given above, it will be evident that potash is the major constituent of the boll and most of this is present in the burs. Lime comes next. Nearly twenty per cent. of the total quantity is found in the seeds while the remaining eighty per cent. is almost equally divided between the burs and the lint. The seeds are particularly rich in phosphoric acid.

(g) NITROGEN.

The study of the behaviour of percentage nitrogen in different organs of the protected plants (Table Nos. 168 to 170 in the Appendix), elicits almost the same information as has been obtained under the unprotected and therefore a repetition of the same is here avoided. Percentage nitrogen in leaves and flower-buds and bolls will, however, be considered as their study throws light on certain points which have remained hitherto untouched.

It has been stated under unprotected plants that the percentage nitrogen falls with increase in dry matter in all organs. This observation, however, meets with an apparent contradiction in the figures of percentage nitrogen in leaves of protected plants (Table No. 125). In 1929, the percentage nitrogen in leaves of the protected plants gradually declined with increase in dry matter till the middle of December. In 1930 on the other hand, it was constant till the first week of November and then decreased throughout the season. The same fact was again observed in 1931. In this case, however, the period of constancy extended to the middle of December and then the decline proceeded at a rate exceeding that either

TABLE No. 125.

Percentage nitrogen in leaves on the protected plants.

Dates.	1929-30.		1930-31.		1931-32.	
	Dry matter.	Percentage nitrogen.	Dry matter.	Percentage nitrogen.	Dry matter.	Percentage nitrogen.
	Gms.		Gms.		Gms.	
8th October	15.67	3.47	8.10	3.39	..	..
22nd October	26.40	3.47	15.80	3.51	11.20	3.02
5th November	31.90	2.82	13.60	3.43	18.75	2.87
19th November	37.50	2.75	28.70	3.23	32.00	3.25
3rd December	44.33	2.28	29.67	2.99	46.00	3.01
16th December	45.70	2.13	32.20	2.46	51.50	3.19
31st December	35.87	2.05	27.20	2.46	48.50	2.73
14th January	26.94	1.89	22.40	2.26	40.75	2.49
28th January	17.60	1.90	21.75	2.02	41.50	2.25
11th February	12.67	1.92	14.50	1.95	27.00	1.82

in 1929 or in 1930 till the time of crop maturity. This steadiness in percentage nitrogen when the dry matter rapidly increased, is indeed embarrassing and needs explanation.

The percentage did fall with increase in dry matter but the fall was masked during these years owing to greater production of dry matter of young leaves as a result of the prolonged rainfall in 1930 and 1931. This interpretation of the steadiness in percentage nitrogen in leaves is borne out by the study of individual leaves incepted towards the beginning of September, October and November in 1931. (Table Nos. 171 to 174 in the Appendix.) The data for these leaves show that the percentage nitrogen declined with rise in dry matter growth and further the leaves incepted on the first of October and November remained on the plant till the middle of December. As the leaves appearing on the plant in November had a short career of about a month compared with those incepted in October, leaf-fall commenced by the middle of December as usual. On this account, the fall in percentage of older leaves in September was counter-balanced by the higher percentage

of those in October and the fall, if at all it existed, in the percentage of the aggregate leaves of September and October was counter-balanced by a greater production of dry matter of younger leaves incepted after this period and indicating a higher percentage. Hence, the constancy in percentage nitrogen up to the middle of December in 1931 and up to the first week of November in 1930.

Percentage nitrogen calculated on the basis of the total dry matter (shed *plus* non-shed) of leaves began to fall in 1931 from the middle of December, the dry matter remaining the same (Table No. 126). This suggests that the nitrogen in leaves

TABLE NO. 126.

Percentage nitrogen expressed on the total leaf production (shed plus non-shed) in the protected plants.

Dates.	1929-30.		1930-31.		1931-32.	
	Dry matter.	Percentage nitrogen.	Dry matter.	Percentage nitrogen.	Dry matter.	Percentage nitrogen.
	Gms.		Gms.		Gms.	
22nd October	30.81	3.02	18.40	3.30	11.70	2.97
5th November	37.29	2.71	22.25	3.26	21.08	2.72
19th November	44.67	2.64	34.50	3.03	36.33	3.06
3rd December	53.83	2.19	38.00	2.78	52.80	2.82
17th December	58.70	2.04	39.20	2.36	60.50	2.94
31st December	53.20	1.91	43.20	2.26	57.50	2.55
14th January	57.44	1.65	47.40	1.98	53.75	2.23
28th January	54.66	1.49	49.25	1.79	57.25	1.96
11th February	56.67	1.49	38.00	1.70	54.78	1.50
25th February .. .. .	..	..	37.75	1.59	60.00	1.55

was removed somewhere else. The same fact was again manifested in 1929. Here, the percentage declined from the end of December even though the dry matter stood at a uniform level from the middle of December. In the year 1930, as the total dry matter continued to increase practically till the end of the season in consequence perhaps of the disturbed growth occasioned by a long spell of clouds terminating in rain on the 28th October and as the percentage continued to descend till the crop was ready for harvest, the transfer of leaf nitrogen appears rather difficult to be established, although it did occur in this case also.

These indirect observations with regard to economic transfer of nitrogen from leaves to the parent plant are substantiated by the results of studies carried out on the nitrogen content of individual leaves from their inception to shedding. (Table No. 127 and Table Nos. 171 to 174 in the Appendix.) These determinations conclusively prove that translocation of nitrogenous substances occurs when the leaf yellows and during this process, more than fifty per cent. of the total quantity of leaf nitrogen is transferred. As the average production of dry matter of leaves amounts

to about fifty grammes both in the protected and unprotected plants, it is estimated that over 0.65 grammes of nitrogen is returned to the plant, the percentage nitrogen in shed leaves at the end of the season being 1.3 as the mean of three years.

With regard to shed leaves, it is necessary to mention that they were not separately collected according to time interval as such. All of them as they came down were picked up and placed in one bag tied to each plant for the purpose. No data are, therefore, available to show whether or not the shed leaves collected during one period differed from another in percentage nitrogen. Nevertheless, the trend of figures obtained on the aggregate samples indicates that even on ash-free basis

TABLE NO. 127.

Periodical nitrogen content in grammes of individual leaves.

1930-31.			1931-32.		
Leaves incepted on 3rd October.			Leaves incepted on 1st September.		
Age in days.	Dry matter per leaf.	Total nitrogen per leaf.	Age in days.	Dry matter per leaf.	Total nitrogen per leaf.
	Gms.	Gms.		Gms.	Gms.
8 ..	0.1400	0.0054	6 ..	0.1392	0.0057
12 ..	0.2468	0.0087	12 ..	0.2383	0.0077
16 ..	0.2481	0.0102	17 ..	0.2802	0.0091
20 ..	0.3087	0.0107	22 ..	0.2758	0.0096
24 ..	0.3111	0.0103	28 ..	0.4192	0.0126
28 ..	0.3183	0.0103	33 ..	0.4333	0.0121
32 ..	0.3205	0.0098	38 ..	0.4958	0.0133
36 ..	0.3495	0.0104	45 ..	0.4417	0.0112
43 ..	0.3523	0.0099	52 ..	0.4438	0.0104*
50 ..	0.3650	0.0101	54 ..	0.4483	0.0077
57 ..	0.3846	0.0100	56 ..	0.4082	0.0067†
78 ..	0.4745	0.0108	60 ..	0.4421	0.0068
85 ..	0.3792	0.0068*	64 ..	0.4421	0.0057
..	0.3976	0.0066			
100 ..	0.3776	0.0041†			
107 ..	0.3876	0.0050			

1931-32.			1931-32.		
Leaves incepted on 2nd October.			Leaves incepted on 3rd November.		
	Gms.	Gms.		Gms.	Gms.
6 ..	0.1367	0.0053	8 ..	0.1556	0.0058
13 ..	0.3614	0.0123	13 ..	0.1839	0.0061
18 ..	0.3525	0.0094	20 ..	0.2377	0.0076
22 ..	0.4373	0.0113	25 ..	0.2071	0.0069
27 ..	0.4244	0.0106	32 ..	0.2116	0.0066
32 ..	0.4167	0.0109	39 ..	0.2133	0.0067
40 ..	0.4778	0.0120	46 ..	0.2160	0.0039*
47 ..	0.4450	0.0109	53 ..	0.2143	0.0041
50 ..	0.3911	0.0093	60 ..	0.2200	0.0039
57 ..	0.4726	0.0109	75 ..	0.2199	0.0036†
64 ..	0.5009	0.0113			
78 ..	0.4708	0.0088*			
84 ..	0.4801	0.0053†			
89 ..	0.4778	0.0059			

* Commencement of yellowing of leaf.

† Completely detached from the plant.

(Table No. 128) reduction in percentage nitrogen occurs to an increasing extent with advance in the season. This point has been already referred to under the un-protected plants but is here repeated by way of emphasis.

TABLE NO. 128.

Percentage nitrogen in shed leaves of the protected plants on dry matter free of ash.

Dates.	1929-30.	1930-31.	1931-32.
	Percentage nitrogen.	Percentage nitrogen.	Percentage nitrogen.
7th October	2.98	2.08	..
22nd October	2.88	2.60	2.31
5th November	2.34	2.64	2.08
19th November	2.58	2.84	2.03
3rd December	2.28	2.58	1.96
17th December	2.19	2.38	2.05
31st December	2.04	2.47	1.98
14th January	1.83	2.29	1.82
28th January	1.62	2.45	1.53
11th February	1.74	1.99	1.53
25th February .. .. .	..	1.87	1.41

The decline in percentage nitrogen in leaves on the plant is caused, for a considerable part of the season, by a higher rate of increase of non-nitrogenous matter. Later in the season when dry matter growth of leaves ceases, the decline is due to actual transfer of nitrogen to places of active growth. The continued fall in percentage nitrogen of shed leaves as expressed on dry matter free of ash is rather unexpected. Shed leaves represent the last and definite stage and should therefore indicate constancy in percentage, at least on ash-free basis. It is probable that the progressive decadence in nitrogen of shed leaves is associated with nutritional conditions in the plant.

Percentage nitrogen in flower-buds may now be studied. It has been pointed out in the previous chapters that shedding of flower-buds occurs when they are young. Once they begin to grow they continue to do so until the flower stage is reached. The last samples drawn for analysis, therefore, consisted of flower-buds which were distinctly older than those shed. This was also supported by direct observations. As young flower-buds are richer in nitrogen than the old ones, it is within reason to expect that shed flower-buds should indicate a higher nitrogen content than the old growing forms drawn in the last samples in the season (of flower-buds). Contrary to these expectations, however, it is found that the percentage nitrogen in shed young flower-buds is lower than that in the older growing forms. Even more surprising is the important fact that it is less than the percentage nitrogen in flowers. (Table No. 129.)

TABLE No. 129.

Percentage nitrogen in shed flower-buds and flowers in the protected plants.

Dates.	1929-30.		1930-31.		1931-32.	
	Flowers.	Shed flower-buds.	Flowers.	Shed flower-buds.	Flowers.	Shed flower-buds.
21st October	2.93	2.69	2.91	2.50	..	..
4th November	3.09	2.59	3.02	2.76	..	..
18th November	2.71	2.46	Nil.	2.93	..	..
2nd December	2.66	2.45	2.81	2.25	..	..
16th December .. ..	..	2.33	2.71	2.20	2.24	2.82
30th December .. ..	..	2.33	2.92	2.26	2.87	2.50
13th January .. ..	..	..	..	2.47	..	..

This reduction in percentage nitrogen of shed flower-buds may be explained by supposing that either these forms received during their life, less nitrogen than those that continued to develop under otherwise identical conditions of growth or they received it at the same rate and to the same extent and had perfectly normal growth; but, during the interval between the reception of the shedding stimulus and the formation of abscission layer, all the available nitrogen was sucked back by the plant. The former alternative does not appear to be possible. It is probable that withdrawal of nitrogen from flower-buds occurs during the formation of abscission layer.

More definite results were obtained in connection with the comparative study of percentage nitrogen in shed and growing bolls on the basis of age. Such study has already been recorded under the unprotected plants but the basis chosen for comparison was the size of the shed and growing forms. The data on this study are presented in Table No. 130. These data are important and interesting as they

TABLE No. 130.

Percentage nitrogen in shed and growing bolls of the same age in the protected plants.
(Corollas are excluded.)

1931-32.

Age in days.	Average of bolls.	Weight in grammes per boll on oven-dry matter.		Percentage nitrogen.	
		Shed bolls.	Growing bolls.	Shed bolls.	Growing bolls.
5	6	0.0758	0.1167	1.9137	2.5318
6	32	0.0795	0.1534	1.9428	2.7359
7	44	0.1056	0.1586	1.6553	2.5422
8	26	0.0861	0.1881	1.7337	2.5468
9	17	0.1310	0.2176	1.6077	2.4039
10	15	0.1415	0.2640	1.5939	2.4177
11	6	0.1733	0.3017	1.5339	2.4223
12	5	0.2660	0.4390	1.6492	2.4607
Average ..	..	..	..	1.7038	2.5077

throw light on the time required for the formation of abscission layer and on the nature of events which immediately precede the shedding of reproductive forms. With regard to the first, the dry matter figures suggest that the shed bolls, in all cases, were younger than what their ages indicated and that they lingered on the plant after the arrest of their growth till the abscission layer was formed. The interval between the cessation of boll growth and shedding extended over two to four days, taking dry matter as the basis of determining the age. To make this point more clear, an instance as to how this period is arrived at, may be cited. The dry matter of shed bolls supposed to have grown for twelve days from the time of anthesis was 0.2660 grammes. This weight was made up by the growing bolls in ten days. It is, therefore, inferred that the bolls which shed on the twelfth day must have grown normally for a period of ten days when they received the stimulus to shedding or got arrested in their growth, the event of actual dropping taking place two days later. This interval between the reception of shedding stimulus and shedding is the time required for the formation of abscission layer.

The second and the most important point which the table reveals is the fact that percentage nitrogen in shed bolls is always less, whether considered on the basis of age or dry matter, than that in the growing fruits (1.9% to 1.6% *vs.* 2.7% to 2.4%). As this percentage is less than that in flowers and growing bolls of the same age (Table Nos. 168 to 170 in the Appendix), it is safe to assume that transfer of a part of nitrogen from bolls occurs to the parent plant. Thus the plant withdraws, prior to shedding, nitrogenous substances not only from the leaves but also from flower-buds and young fruits.

Howlett (1923) worked on the nitrogen and carbohydrate composition of the developing flowers and young fruits of the apple and found, among other things, that the nitrogen content of the fruit about to drop, declined from more than four to three per cent. He, however, makes no mention as to whether or not there was any translocation of nitrogenous matter from the fruit.

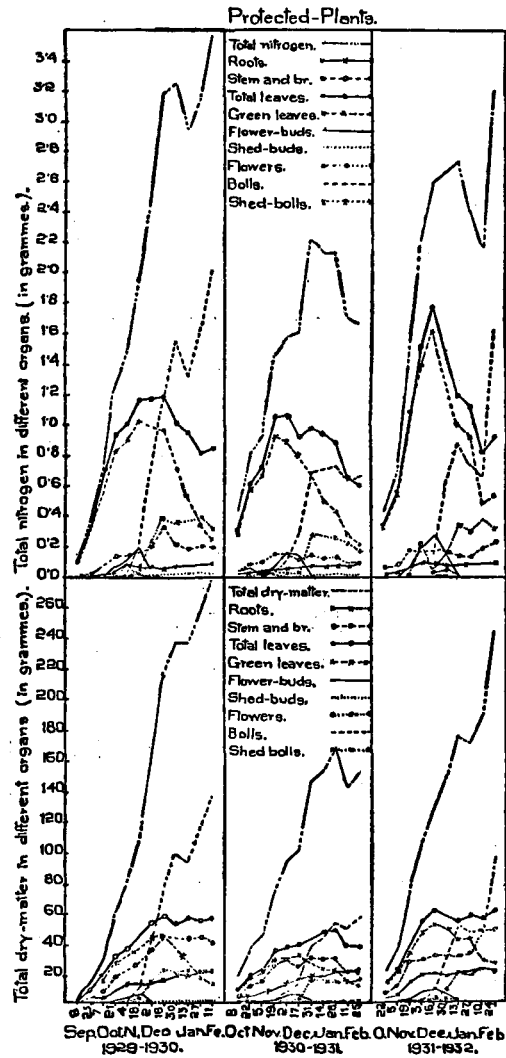
Pfeffer (2nd Edi.) has well said that in Phanerogams, nitrogen once assimilated is husbanded with the greatest care so that almost the whole of it is preserved, however active the metabolism. This is rendered possible by the fact that the nitrogenous metabolic products, like those containing sulphur and phosphorus, are such as can be drawn again into metabolism and are not aplastic ones intended to remain as permanent constituents of the plant. It may be noted that when Pfeffer made these observations, he was not aware of the translocation of nitrogenous material from the reproductive forms to the parent plant. In spite of these economic adaptations to changing conditions of environment, a certain quantity of nitrogen is always lost in shed forms. According to Pfeffer this quantity of nitrogen is structural and therefore cannot be mobilised and consumed.

The destiny of nitrogen withdrawn from flower-buds, bolls and leaves may now be considered. The determinations of total nitrogen absorbed by the plant from time to time and its distribution in different parts are given in the Table Nos. 175 to 177 in the Appendix and reproduced in Graph No. 50. Omitting from consideration the plants of 1930 as they were vitiated owing to a heavy damage to reproductive forms referred to before, it will be evident from the graphs for the remaining years that the absorption of nitrogen from the soil almost ceases by about the middle of December. At this time, the vegetative growth of the plant comes to an end and further increase in dry matter does not occur. The only

organ which continues its growth after this time is the boll which increases in nitrogen at a higher rate than that at which the absorption of nitrogen from the soil proceeds. As in no other organ of the plant except the bolls and the leaves any

GRAPH NO. 50.

Distribution of total nitrogen in grammes in different parts of the protected plants.



change in the nitrogen is observed and as the nitrogen in the former increases while that in the latter steadily decreases, it is obvious that the bolls feed upon the leaf nitrogen in addition to that absorbed from the soil.

Thus, the bolls get nitrogen for their development from two sources, namely, the soil and other organs which shed during the bolling season. The quantity of nitrogen available from these sources is, however, not the same but varies considerably depending upon the time of boll arrival in relation to the commencement of leaf-fall. If they appear earlier as in 1929 before the start of leaf-fall, they get a large part of the nitrogen required from the soil; if they appear later as in 1931, relatively a large quantity of this element is obtained from the leaves. The advent of bolls before the start of leaf-fall is, therefore, of great advantage—a fact which has already been mentioned under the study of dry matter. What happens in the present case is that the bolls obtain nitrogen directly from the soil in addition to that from the shedding leaves with the result that on the whole a large quantity of nitrogen becomes available and the plant is able to put up a larger yield. If the early arrival is not possible owing to unfavourable conditions of environment, boll growth depends entirely upon the fixed quantity of nitrogen released by the leaves. The extent of the availability of leaf nitrogen is roughly estimated at 0.65 grammes (page 171) and is equivalent to not less than sixteen bolls.

The foregoing graph does not, however, indicate the translocation of nitrogen from young flower-buds and fruits. This is because the quantity available from these sources, is very small. It amounts to about 0.160 grammes assuming that 0.8 as the difference between the average percentage nitrogen of shed and growing bolls (page 173) and twenty grammes as the total mean loss in dry matter of shed flower-buds and fruits. In terms of yield, the total recovery of nitrogen works up to four bolls per plant.

The total quantity of nitrogen present in different organs of the plant at harvest is given in Table No. 131. The plant absorbs as much as 2.3314 grammes

TABLE No. 131.

Total nitrogen in grammes in different organs of the protected plants at harvest.

Years.	Roots.	Stem and branches.	Leaves.	Bolls.	Shed leaves.	Shed flower buds & bolls.	Total.
1929	0.0863	0.2061	0.3337	1.6240	0.4839	0.4249	3.1589
1930	0.1026	0.1038	0.2116	0.6680	0.3910	0.1956	1.6726
1931	0.0937	0.1972	0.4909	0.6672	0.3309	0.3827	2.1626
Mean	0.0942	0.1690	0.3454	0.9864	0.4019	0.3344	2.3314
Percentage distribution	4.04	7.24	14.81	42.31	17.23	14.34	99.97

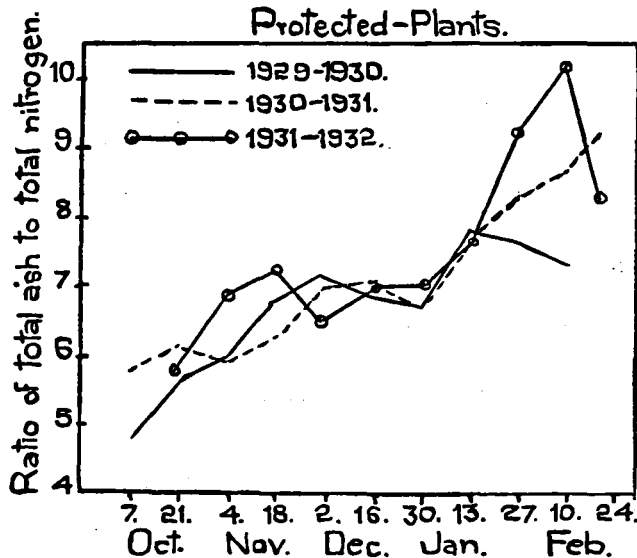
of nitrogen as the mean of three years. Out of this quantity fifty-six per cent. is found in the reproductive forms, the mature bolls containing about forty-two per cent. Further, as the mean figures show, nearly thirty-two per cent. of the total quantity taken up by the plant is lost in the shed forms including the leaves while about eleven per cent. is retained by roots, stem and branches.

The proportion of nitrogen to other inorganic substances absorbed by the plant at different times in the season is shown below (Graph No. 51 and Table No. 200 in

GRAPH No. 51.

Ratio of total ash to total nitrogen at different stages of plant growth.

(Protected plants).



the Appendix) as the ratio of total ash to total nitrogen. The interpretations of these ratios are similar to those offered under the unprotected plants and hence are omitted here.

(h) NITROGEN IN THE PROTECTED AND UNPROTECTED PLANTS.

The most characteristic feature which distinguishes the protected plants from those unprotected is with regard to the general condition of the plant as such at the commencement of boll growth. The protected plants are younger and more efficient to take up the new responsibilities of reproductive growth as will be evident

from the figures of percentage nitrogen in leaves of the two sets (Table No. 132), which is always higher in the protected. The difference in the nitrogen content

TABLE No. 132.

Percentage nitrogen in leaves at the commencement of boll growth in the protected and unprotected.

Years.	1929-30.		1930-31.		1931-32.	
	Protected.	Unprotected.	Protected.	Unprotected.	Protected.	Unprotected.
Per cent nitrogen	2.75	2.02	2.46	2.22	3.19	2.46

of leaves in the two sets was more conspicuous in the years 1929 and 1931 than that in 1930. It has always been mentioned that in 1930 the protected plants suffered a heavy loss of flower-buds and fruits during the storm on the 28th October. On this account, the period of bolling was shifted towards mid-December which almost coincided with that of the unprotected plants. Hence the difference between the nitrogen content of leaves in the two sets was less pronounced this year.

(i) ETHER-EXTRACT, FIBRE AND TOTAL HYDROLYSABLE CARBOHYDRATES.

The nature and the extent of changes in ether-extract, fibre and total hydrolysable carbohydrates (Table Nos. 178 to 195 in the Appendix) of the protected plants are almost of the same order as those noted in the unprotected. The difference between the two sets, however, lies in the fact that in the former, conversion of hydrolysable carbohydrates of roots into fibre and of boll into fibre and ether-soluble material occurs earlier as a result of the earliness of the crop.

(j) RATIO OF TOTAL HYDROLYSABLE CARBOHYDRATES TO TOTAL NITROGEN.

With regard to the ratio of total hydrolysable carbohydrates to total nitrogen in the protected plants (Table Nos. 196 to 198 in the Appendix), it may be stated that the rainy season has a depressing effect upon this ratio. As the conditions for photosynthesis improve, it rises steadily with advance in the season as occurs in the unprotected plants, the reproductive phase being initiated at higher values.

The change from the vegetative to the reproductive phase of growth and later the success of fruiting forms are essentially governed by the soluble and therefore active substances in the plant. Kraus and Kraybill and other investigators on this subject, seem to have omitted this fact out of account. Their ratios of total hydrolysable carbohydrates to total nitrogen and those here presented, represent practically the relative proportions of inert substances belonging to the two groups and fail therefore to give a correct idea of the state of affairs within.

To understand more fully how one phase is superceded by another and the nature of shedding, an analysis of the soluble forms of carbohydrates and nitrogen in the leaf-sap of cotton was undertaken in the year 1931. The results obtained

(Table No. 133) indicated that the ratio rose suddenly from 0.12 to 6.31 within a few days after cessation of the monsoon and remained steady thereafter till the commencement of the bolling period during which a slight rise in the ratio was noted.

TABLE No. 133.
A study of the leaf-sap of the cotton plant.
(Protected).
1931-32.

Dates.	Density.	Total solids in 100 c. cs. at 30° C in grammes.	Ash in 100 c.cs. at 30° C in grammes.	Organic matter in 100 c.cs. at 30° C in grammes.	Nitrogen percentage on total solids.
1st September ..	1.0290	5.624	2.172	3.452	1.5238
8th September ..	1.0328	6.632	2.652	3.980	1.6827
16th September ..	1.0354	7.070	2.746	4.324	1.6365
22nd September ..	1.0339	6.424	2.484	3.940	1.8727
28th September ..	1.0378	7.330	2.890	4.440	1.5934
6th October ..	1.0332	6.360	..	..	1.9308
19th October ..	1.0359	7.048	..	..	1.7267
26th October ..	1.0396	7.850	2.844	5.006	1.5720
2nd November ..	1.0428	..	..	..	..
9th November ..	1.0429	6.970	3.300	3.670	1.6886
16th November ..	1.0436	8.160	3.330	4.830	1.4497
23rd November ..	1.0470	8.870	3.480	5.390	1.3844
30th November ..	1.0482	8.930	3.640	5.290	1.4401
7th December ..	1.0523	9.482	3.370	6.112	1.3341
14th December ..	1.0334	8.950	3.530	5.420	1.4089
21st December ..	1.0521	9.371	3.915	5.456	1.2634
28th December ..	1.0555	9.890	4.120	5.770	1.1961
4th January ..	1.0570	10.580	4.208	6.372	0.8157
12th January ..	1.0639	11.590	5.000	6.590	0.9430
18th January ..	1.0653	..	..	..	..
25th January ..	1.0666	12.417	5.185	7.232	1.0356
1st February ..	1.0712	13.460	5.420	8.040	0.9264
8th February ..	1.0720	14.440	5.570	8.870	0.9356

TABLE No. 133—(contd.)
A study of the leaf-sap of the cotton plant.
 (Protected).
 1931-32.

Dates.	Nitrogen percentage on organic matter.	Per cent sugars on total solids.	Ratio of sugars to nitrogen.	Density of total solids.	Stage of plant growth.	Remarks.
1st September ..	2.5826	0.0711	0.046	2.06		Previous week raining, cloudy weather during rains.
8th September ..	2.8042	0.0965	0.057	1.98		Bright sunshine.
16th September ..	2.6758	0.1669	0.102	2.00		Do.
22nd September ..	3.0533	0.1759	0.094	2.11		Rain, cloudy weather during previous 4 days.
28th September ..	2.6071	0.2087	0.131	2.07		Cloudy weather.
6th October ..	..	0.2296	0.119	2.08		Do. and rain on the previous day.
19th October ..	..	10.9009	6.313	2.04	Commence- ment of bud success.	Bright sunshine, heavy rains in the previous week & close of monsoon.
..
26th October ..	2.4650	9.7007	6.170	2.02		Bright sunshine.
2nd November ..	..	..	..	..		Cloudy weather.
9th November ..	3.2071	9.8436	5.828	2.60		
16th November ..	2.4493	8.7843	6.057	2.15		
23rd November ..	2.2783	8.4331	6.092	2.01		
30th November ..	2.4310	8.2041	5.697	2.17		
7th December ..	2.0697	7.7262	5.790	2.21		
14th December ..	2.3266	5.7541	4.085	1.59		Cloudy weather on previous 4 days; samples after 3 hours sunshine.
21st December ..	1.1701	7.2094	5.707	2.25		
28th December ..	2.0503	7.6744	6.415	2.23		
4th January ..	1.3371	7.0879	8.690	1.80		
12th January ..	1.6568	6.0078	6.371	2.23		
18th January ..	..	..	..	..
25th January ..	1.7782	7.8304	7.560	2.14		
1st February ..	1.5510	7.0854	7.647	2.12		
8th February ..	1.5231	5.3719	5.742	1.99		

Analogous results were obtained during the previous year but they are not given here as the method adopted for the estimation of sugars in minute quantities was not quite suitable. Thus, the ratio of the reactive substances belonging to the two groups is more significant and decidedly a better index of recording the internal activity of the plant.

The study of the soluble constituents of the leaf-sap has proved to be of no small benefit in that it has thrown light on the condition of the sap during period of boiling. The percentage nitrogen of the sap either expressed on total solids or organic matter appreciably falls from 2.05 to 1.55 (organic basis) and remains constant throughout till the crop matures. A progressive fall in the percentage is averted owing probably to the dissociation of nitrogenous substances in the leaf.

Among other things which the study reveals, mention may incidentally be made of the steady rise in density of the sap due to increase of both the organic and the inorganic matter, apparent density* of the total solids remaining almost the same at about two at all stages of the plant.

(k) SHEDDING OF FLOWER-BUDS AND BOLLS.

The chemical study of the cotton plant carried out under three sets of conditions—the protected, unprotected and the manured unprotected—indicates in the main that shedding of flower-buds and young bolls in cotton is closely associated with nutritional factors amongst which nitrogen appears to be immediately concerned in limiting the success of fruiting forms. With the initiation of the reproductive phase, the need for nitrogen is increasingly felt by the plant. A struggle for the daily supply of available nitrogen ensues between the flower-buds on the one hand and all the vegetative organs on the other. The struggle becomes more intense with the advent of bolls in which the vegetative organs ultimately fail. After the cessation of the vegetative growth, the bolls and the other reproductive organs compete among themselves.

While this is the state of affairs, the plant reaches one of the most critical periods in its history. Fresh quantities of nitrogen which it was absorbing from the soil up to this time, now steadily dwindle owing to the commencement of leaf-fall while the demand for nitrogen on the part of bolls rapidly increases with advance in the season. To tide over this critical period, the plant practises the utmost economy of which it is capable and withdraws nitrogen, in preference to carbohydrates, from leaves during the process of yellowing and also from such organs as the flower-buds and bolls which it is not able to retain.

These observations receive support in the results of field experiments where plants were manured with nitrogen during the boiling phase and increased retention of bolls on the basis of total flower-buds produced, was obtained (page 204).

* (100 c.c. sap x density)—weight of total solids=X, the water in 100 c.c. of the sap.
 100 c.c. sap—X—the volume increase.
 $\frac{\text{Total solids}}{\text{Vol. increase}} = \text{Apparent density of solids.}$

SUMMARY.

This chapter reports a chemical study of the cotton plant under three sets of conditions, namely, the unprotected, manured unprotected and the protected. The study was undertaken with the object of ascertaining the causes of bud and boll shedding and of finding out the factors which promote a better success of flower-buds into mature bolls in the protected plants.

UNPROTECTED PLANTS.

The unprotected plant produces about 200 grammes of dry matter out of which forty per cent. is in the reproductive forms. Owing to rapid commencement of boll growth, the dry matter growth of the vegetative parts ceases. It is suggested that all the available plant-food is monopolized by the bolls.

Among the inorganic substances of agricultural importance, potash occupies the foremost place. Nearly fifty per cent. of it is present in bolls. The quantity of lime taken up is almost as great as that of potash. Both lime and potash accumulate mostly in the leaves. The quantity of phosphoric acid is comparatively small and half of it is found in the bolls.

The plant absorbs about two grammes of nitrogen during the season. More than fifty per cent. of this quantity is utilized for reproductive purposes, mature bolls and shed reproductive forms containing forty-three and twelve per cent. respectively. Most of the total nitrogen in the plant is in an insoluble albuminoid form. Its percentage decreases with increase in dry matter; the percentage of the soluble nitrogen remains fairly constant at all stages of growth. Among the soluble forms, amid-nitrogen predominates.

On the basis of size, shed buds and bolls are poorer in nitrogen than those growing on the plant. During bolling, translocation of leaf-nitrogen occurs. The bolls feed upon the nitrogen absorbed by the plant as well as on that withdrawn from leaves.

The plant exercises selective absorption. It takes up more inorganic matter than nitrogen during early and late stages of growth. During the intervening stage, both inorganic matter and nitrogen are absorbed almost in the same proportion. On the whole, the proportion of nitrogen to inorganic matter (nitrogen/inorganic matter) steadily falls with advance in the season, indicating less availability of nitrogen with advance in the season.

A detailed account of ether extract, fibre and total hydrolysable carbohydrates is presented. When the bolls rapidly increase in dry matter, a part of the total hydrolysable carbohydrates are rapidly converted into fibre and other soluble material mostly consisting of oil. During purely vegetative phase, the proportion of total hydrolysable carbohydrates to total nitrogen is very low. The reproductive phase is initiated when the ratio attains higher values.

The cotton plant under the usual conditions of cultivation and spacing produces per acre 2,132 pounds of dry matter and absorbs 219 pounds of inorganic matter consisting of seventy-eight pounds of potash, seventy-four pounds of lime, twenty-two pounds of nitrogen and eighteen pounds of phosphoric acid.

MANURED UNPROTECTED PLANTS.

The plant responds to added nitrogen when it is applied along with water. Watering is necessary to make the manure mobile. During a period of about a month, nitrogen accumulates in the plant. Its effect on the increase in dry matter is noticed after this period. Manuring more than doubles the dry matter growth and the yield of the plant.

PROTECTED PLANTS.

Total production of dry matter in the protected plant amounts to about 200 grammes. Out of this more than forty-five per cent. is utilised in the productive growth. The predominance of the vegetative or the reproductive growth is correlated with seasonal influences. Ash, potash and phosphoric acid in the protected plants show almost the same behaviour as that in the unprotected. Potash appears to be the major constituent of the boll and most of it is found in the burs. Lime comes next. Nearly twenty per cent. of the total quantity in the boll is found in seeds while the remaining is almost equally divided between the burs and the lint. Seeds are particularly rich in phosphoric acid.

The total quantity of nitrogen absorbed by the plant is over 2.33 grammes, out of which more than fifty-five per cent. is used in the reproductive channel. With the initiation of reproductive phase, the plant is in a state of nitrogen hunger. This condition becomes most critical when absorption of nitrogen from the soil is seriously retarded owing to the commencement of leaf-fall, while the demand for nitrogen by the growing bolls rapidly increases. Under these circumstances, the plant withdraws nitrogen in preference to carbohydrates, from leaves during the process of leaf-yellowing and also from such organs as flower-buds and bolls prior to their shedding. The quantity of nitrogen withdrawn from flower-buds and bolls amounts to about 0.16 grammes and is equal to four mature bolls. More than fifty per cent. of the total nitrogen content of leaves—a quantity sufficient for the growth of sixteen mature bolls—is returned to the plant.

Evidence indicates that in cotton, nitrogen appears to be the factor primarily concerned in limiting the success of fruiting forms and that shedding seems to be a continuous re-adjustment of flower-buds and bolls to the limited food-resources of the plant.

The better retention of bolls in the protected plants as compared with that in the unprotected, is associated with a better chemical condition at the time of boll formation. The protected plants are comparatively young and more vigorous during the period of boll growth.

CHAPTER VI.

GROWTH BEHAVIOUR OF THE COTTON PLANT UNDER MODIFIED CONDITIONS.

Before starting the chemical work on cotton, evidence resulting mainly from the nature of boll shedding—almost complete shedding of bolls formed from later flowers—and from other experiments such as flower-pruning, stem ringing, etc., accumulated to show that nutritional factors were involved in the success of fruiting forms. With a view to assessing the role of these factors on shedding and the final yield, growth behaviour of the cotton plant under modified conditions of environment was studied. These conditions pertained to the soil, air and the plant itself and fell broadly under five heads, namely, (A) improvement of water supply in the soil, (B) improvement of plant-food supply in the soil, (C) subjecting the plant to various manipulations, (D) change in the aerial environment by delaying sowing and (E) miscellaneous. It is proposed to describe and discuss the experimental work carried out under each of these heads in the present chapter.

A. IMPROVEMENT OF WATER SUPPLY IN THE SOIL.

Shortage of water in the plant has been considered by many workers both in America and Egypt to be the cause of bud and boll shedding. Balls (1912), Lloyd (1920) and King (1922) laid great stress on the deficiency of water in the plant as an important causal factor of shedding in cotton. Lloyd (1926) was so much convinced about it that, in his paper that he read in 1926 before the International Conference of Horticulturists on Flower and Fruit Sterility, he declared, "it may be taken as settled that a widespread cause leading directly or indirectly to abscission of buds, flowers and bolls in the cotton plant is water-stress." Coit and Hodgston (1919) who studied the causes of "June drop" in Washington Naval Oranges, also ascribed a large part of the early shedding to daily water deficit in the young fruits.

Experimental work to study the effects of water applied to the soil during the flowering and boll-development periods was, therefore, undertaken from the year 1926-27, to see whether the huge boll-shedding in the Broach cotton plant was the result of deficiency of available water in the feeding zones of the soil. This was done by increasing the supply by direct application of water in lower layers of the soil by a special device to be presently described.

(a) *Method of applying water.*

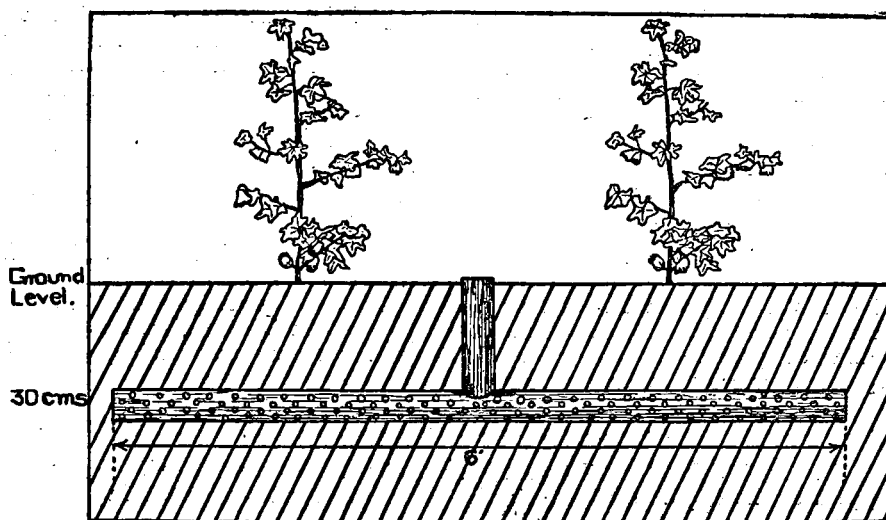
As cotton is sown on small ridges made in the off season, the position of the crop-rows is fixed up in advance. On both the sides of the ridge, trenches of required depths at which water is proposed to be delivered are dug and galvanised iron tubes each of three inches in diameter and six feet in length with two vertical tube-attachments (Figure No. 9) are laid horizontally at the bottom. These tubes

are perforated on the lower side and are covered over with a layer of brick-bats all round to prevent choking of their holes by the clayey portion of the soil. The height of the vertical attachments is so adjusted that their openings come into a level of 22.5 cms. below the surface of the soil. After closing with lids the openings of the vertical attachments, the trenches are filled up and the field area is brought to its original level. Cotton thus grown on the ridges receives all the usual cultural operations without disturbing the under-laid tubes.

At the time of watering, the soil over the vertical attachments is removed and additional tubes are inserted so as to bring the openings in level with the ground. Water is given to the plants through these openings with the aid of a large funnel. This method proved most successful and had the advantage over pot

FIGURE No. 9.

Perforated galvanized iron tube used for under-ground irrigation.



experiment in the fact that the experiment was carried out under field conditions.

(b) *Preliminary experiments.*

In 1926-27, the first year of the experiment, the irrigation tubes were laid in at the depths of 30, 60 and 90 cms., five plants being under observation in each case. The first watering was given at the commencement of flowering (30th October) and two more waterings were given on 30th November and 19th January. The quantity of water applied was three acre-inches every time. The treated rows

were located sufficiently apart by about 21 feet from one another so as to avoid the possibility of water applied in one row affecting the plants in the other two. The results of these experiments are given in Table No. 202 in the Appendix.

Three acre-inches of water at each application was found to be excessive for easy absorption into the soil. In the following year, therefore, the dose was reduced to two acre-inches and the number of waterings raised from three to five. In addition to the three different levels at which water was delivered into the soil, the time of commencing the application was also varied to three different stages of plant growth, namely, (1) flower-bud development, i.e., few days after the close of monsoon, (2) flowering and (3) mid-flowering. There were thus nine treatments—three timings and three depths. The results are given in Table Nos. 203, 204, 205 in the Appendix.

From the viewpoint of the time required for complete soaking of the applied water, even the two-acre-inch dose was found to be too much at each watering. In the third year, therefore, the dose was further brought down to one-acre-inch and the whole series of nine treatments repeated. The results are set out in the Table Nos. 206, 207 and 208 in the Appendix.

These preliminary trials conducted over a period of three years, indicated that although moisture supply in the feeding zones of the soil was improved during the reproductive phase of plant growth, the usual extent of bud and boll shedding remained almost unaffected. Nevertheless during the first two years, beneficial effects of applied water were noticeable in another direction. Application of water from the close of the monsoon during the vegetative phase, stimulated the plant to produce more vegetative-buds, flower-buds, flowers and bolls. These beneficial results did not, however, appear in the third year suggesting that the utilization of water was conditioned by other factors.

It was, therefore, proposed to continue the water application experiments with a view to confirming the findings of the preliminary experiments and also to study the moisture requirements at the different phases of plant growth. This was done by maintaining a constant increased supply of moisture to various degrees during the periods of active plant growth and flowering and finding out the optimum degree of soil moisture required for the different phases.

(c) *Experiments on water requirement.*

In 1929-30, therefore, the modified experiment was commenced. Water was applied at the depth of 60 cms. in the soil through under-laid tubes, in small and equal doses twice a week so as to make up half, one, one-and-a-half and two acre-inches of water per month. Such frequent watering was intended to ensure a constant additional supply. In calculating the quantity of water at each time, plants in the two side rows which received the benefit of the water on one of their sides were taken into account and the quantity increased accordingly. In addition to growth counts on treated plants, fortnightly determinations of moisture in the soil were made in three equal layers commencing from the depth of 22.5 cms. to the depth of 90 cms. Each row had twenty plants, the first ten being used for growth counts and the other ten for drawing soil samples. Two check rows, one between the first two sets and the other between the third and the fourth sets were maintained. The results of plant performance are given in Table No. 134.

TABLE No. 134.

Effect of bi-weekly application of water at the depth of 60 cms. in equal doses to make up the following quantities per month. Irrigation commenced from mid-October and continued for three months.

Unprotected plants.

1929-30.

Average of 10 plants in each set.

Organs produced.	Average performance of ten plants in each set.					
	I. ½ inch.	II. Control.	III. 1 inch.	IV. 1½ inches.	V. Control.	VI. 2 inches.
Plant-growth at commencement of the treatment.						
Vegetative-buds ..	296.1	221.0	321.4	258.6	205.4	280.4
Flower-buds	191.8	128.8	200.5	147.0	99.2	174.5
Final performance at the end of the season.						
Vegetative-buds ..	477.6	369.7	533.1	519.8	360.7	514.7
Flower-buds	601.7	457.3	663.9	627.5	440.8	639.6
Flowers	99.4	76.5	114.2	116.5	81.4	113.2
Bolls	38.0	26.2	38.8	40.2	28.4	42.6
Percentage success of:—						
Bud to flower ..	16.5	16.7	17.2	18.5	18.4	17.7
Flower to boll ..	38.1	34.1	33.8	34.5	34.9	37.6
Bud to boll.. ..	6.1	5.7	5.8	6.4	6.4	6.7
Weight (air-dry) in grammes of:—						
Seed-cotton ..	75.3	51.1	80.7	79.7	55.0	82.4
Dry plant body ..	93.4	59.9	104.1	92.1	54.5	87.6
Ratio $\frac{\text{Seed-cotton}}{\text{Plant body}}$	0.81	0.85	0.77	0.86	1.00	0.94

TABLE No. 134—(contd.)

Analysis of variance for number of bolls in treatments I, III, IV and VI.

Due to	Degrees of freedom.	Sum of squares.	Mean square.
Between treatments	3	121.99	40.66
Within treatments	35	6065.6	173.303
Total	38	6187.59	..

The standard error of comparison of two treatments means =5.89

The value of "t" (for P=0.05 and n=35) =2.02

* The value for a significant difference between any two treatments means =11.96

CONCLUSION :—The differences between any two treatments means are *not significant*.

The results of these experiments confirm the findings of the preliminary trials that the increase in available moisture in the soil does not lower the rates of bud and boll-shedding, but, it increases the production of vegetative-buds, flower-buds, flowers and bolls.

It is not, however, certain whether all this increased production was due to the added water. For some unknown reason, plants in the rows to be treated had grown more vigorously than those in the check row before the commencement of the treatment as will be seen from figures in the table. On this account, the final performance of the control and the treated plants are not strictly comparable. The effect of added water will have, therefore, to be judged by comparing treated rows among themselves. Such a comparison shows that so far as the production of vegetative-buds, flower-buds and flowers is concerned, there was no rise from the half-acre-inch treatment to two-acre-inch treatment. The number of bolls per plant, however, showed a definite rise with increase in the quantity of water added. For every addition of half-acre-inch of water, the plant responded by producing one extra boll. The difference between the two extreme treatments was thus over four bolls per plant. This difference, however, was not statistically significant.

A tentative conclusion may, however, be drawn in favour of the beneficial effects of water on boll production. Although plants in the control row were not initially as vigorous as those to be treated, they gave more or less the same number of bolls per plant, as those untreated in the remaining area of the field. The treatment had, therefore, to its credit a large part of the increase in final boll-production. Secondly, there was a regular trend for the number of bolls to increase with increase in the added water.

In the following year the experiment was repeated with only two treatments, namely, one-acre-inch and two-acre-inch application of water given after the manner of the previous year. Periodical growth counts and fortnightly moisture determinations in the three lower layers of the soil were made. The final results of plant performance are given in Table No. 135

TABLE NO. 135.

Effect of bi-weekly application of water at the depth of 60 cms. in equal doses to make up the following quantities per month. Irrigation commenced from mid-October and continued for three months.

Unprotected plants.

1930-31.

Average of ten plants in each set.

Organs produced.	One acre-inch.	Control.	Two acre-inches.
Plant-growth at commencement of the treatment.			
Vegetative-buds	214	209	204
Flower-buds	143	133	138
Final performance at the end of the season.			
Vegetative-buds	409.8	356.7	399.5
Flower-buds	472.7	361.4	405.1
Flowers	109.9	89.1	112.5
Bolls	36.1	32.7	42.3
Percentage success of:—			
Bud to flower	23.2	24.7	27.8
Flower to boll	32.8	36.7	37.6
Bud to boll.. .. .	7.6	9.0	10.4
Weight (air-dry) in grammes of:—			
Seed-cotton	72.1	58.7	83.4
Dry plant body	83.8	67.5	85.8
Ratio $\frac{\text{Seed-cotton}}{\text{Plant body}}$	0.86	0.83	0.97

TABLE NO. 135—(contd.)
Analysis of variance for number of bolls.

Due to	Degrees of freedom.	Sum of squares.	Mean square.
Between treatments	2	473.87	236.935
Within treatments	27	3379.1	125.12
Total	29	3852.97	..

The standard error of comparison of two treatments means =5.003

The value of "t" (for $P=0.05$ and $n=27$) =2.05

∴ The value for a significant difference between any two treatments means =10.26

CONCLUSION :—The differences between any two treatments are *not significant*.

This year, growth of plants in all the rows was almost equal before the commencement of water application. The results can, therefore, be directly compared with the control. The applied water again failed to reduce bud and boll shedding. It however proved beneficial for increasing the production of various organs on the plant. The number of bolls rose up as the quantity of water was increased, though not proportionately. The difference in the number of bolls per plant in the control and the two-acre-inch-treatment was nine, but it was not significant statistically as will be evident from the figures in the foregoing table. The fact that the number of bolls per plant tends to increase with increased quantity of water was again evident this year.

A beginning was made this year to study the effect of water application to plants protected against the spotted boll-worm. As these plants feed comparatively shallow, the tubes were laid in at the depth of forty-five cms. Water was applied bi-weekly in small and equal doses to make up two-acre-inches per month and the results compared with plants having under-laid tubes without irrigation to equalise the effect, if any, of these tubes. The protected plants finish their life history about four weeks earlier and hence water was applied only for two months commencing from mid-October. The results are given in Table Nos. 209 and 210 in the Appendix. They bring out that the added water resulted in increasing the production of vegetative-buds, flowers and bolls but not of flower-buds, with the consequence that the rates of retention of buds and bolls was improved. The average increase in the number of bolls per plant was ten but this was not statistically significant. These results were, therefore, in conformity with those observed in the unprotected plants.

Reverting to the study of the unprotected plants, it will be seen that, in the two years, the increase in the number of bolls with application of water equal to one-acre-inch per month was very small but with two-acre-inches it was appreciable. The latter result, therefore, required confirmation. In 1931-32, therefore, the number of plants under water treatment was increased from ten to sixty and only one quantity of two-acre-inches irrigation tried. To ascertain whether the under-laid tubes have any beneficial effect on productivity, another row of sixty plants was, therefore, set aside with tubes laid in the soil. A third row of sixty plants

served as control. The results are set out in Table No. 136. They show that the growth of plants in the three sets was more or less equal at the commencement of water application. The water treatment did not increase the production of

TABLE No. 136.

Average performance of the plant under bi-weekly irrigation to make up two inches of water per month.

Unprotected plants.

1931-32.

Average of 60 plants.

Organs produced.					Only tubes.	No tubes.	2 acre-inches.
Plant growth at commencement of the treatment.							
Vegetative buds	..	..	..	..	140	134	158
Flower-buds	..	..	..	..	53	46	57
Final plant performance at the end of season.							
Vegetative buds	..	..	..	..	411.3	403.8	433.9
Flower-buds	..	..	..	..	270.2	280.8	284.2
Flowers	..	..	..	..	87.9	85.8	89.1
Bolls	..	..	..	..	37.9	36.4	40.8
Percentage success of:—							
Bud to flower	..	..	..	..	32.5	30.6	31.4
Flower to boll	..	..	..	..	43.2	42.4	45.7
Bud to boll	..	..	..	..	14.0	13.0	14.4
Weight (air-dry) in grammes of:—							
Seed-cotton	..	..	..	..	75.2	73.0	81.0
Dry plant body	..	..	..	..	44.1	46.5	51.1
Ratio	Seed-cotton	..	..	..	1.70	1.57	1.59
	Plant body	..	..	..

TABLE NO. 136—(contd.)

Analysis of variance for number of bolls.

Due to	Degrees of freedom.	Sum of squares.	Mean square.
Between treatments	2	592.66	296.33
Within treatments	174	26548.73	152.57
Total	176	27141.39	..

The standard error of comparison of two treatments means = 2.27

The value of "t" (for $P=0.05$ and $N=174$) = 1.96

The value for a significant difference between any two treatments means = 4.45

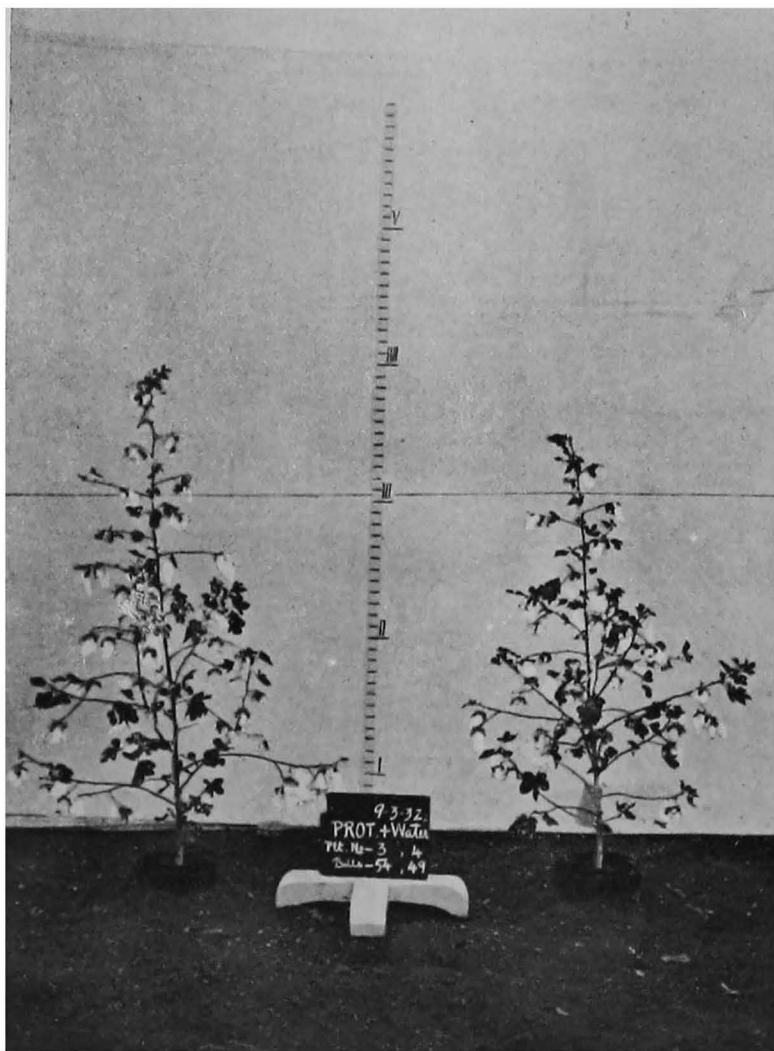
CONCLUSION:—The difference between no-tubes and two-acre-inches of water is just significant. The other treatments are not significant.

vegetative and flower buds to the same extent as in the previous two years but there was an increase. The number of bolls per plant, however, did show a rise of five and was just significant, owing to the larger number of plants under treatment (see the statistical test of significance in the above table). The effect of the tubes was only slight. As in the previous year, the applied water did not reduce bud and boll-shedding. The response of protected plants to water treatment, this year, was poor (Plate Nos. 7 and 7A and Table No. 210 in the Appendix).

The results of all these years may now be summed up. (1) Improvement of available moisture in feeding zones of the soil by frequent application of water in increasing quantities to two-acre-inches per month, consistently failed to reduce bud and boll-shedding. In the Broach cotton tract, therefore, deficiency of available water in the soil is not the causal factor of the incessant shedding of buds and young fruits. (2) Application of water from the close of the monsoon enhances boll production which is, however, not statistically significant owing perhaps to the small number of plants under treatment. A distinct tendency of increased boll production is noticeable with the application of larger quantities of water.

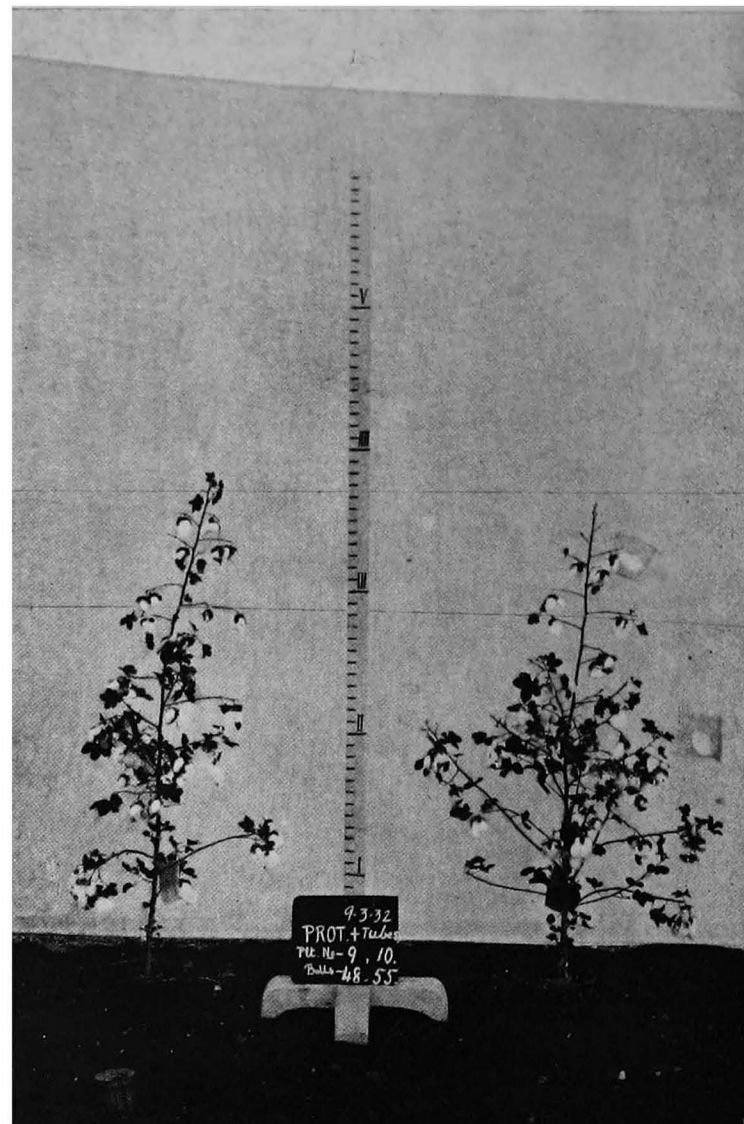
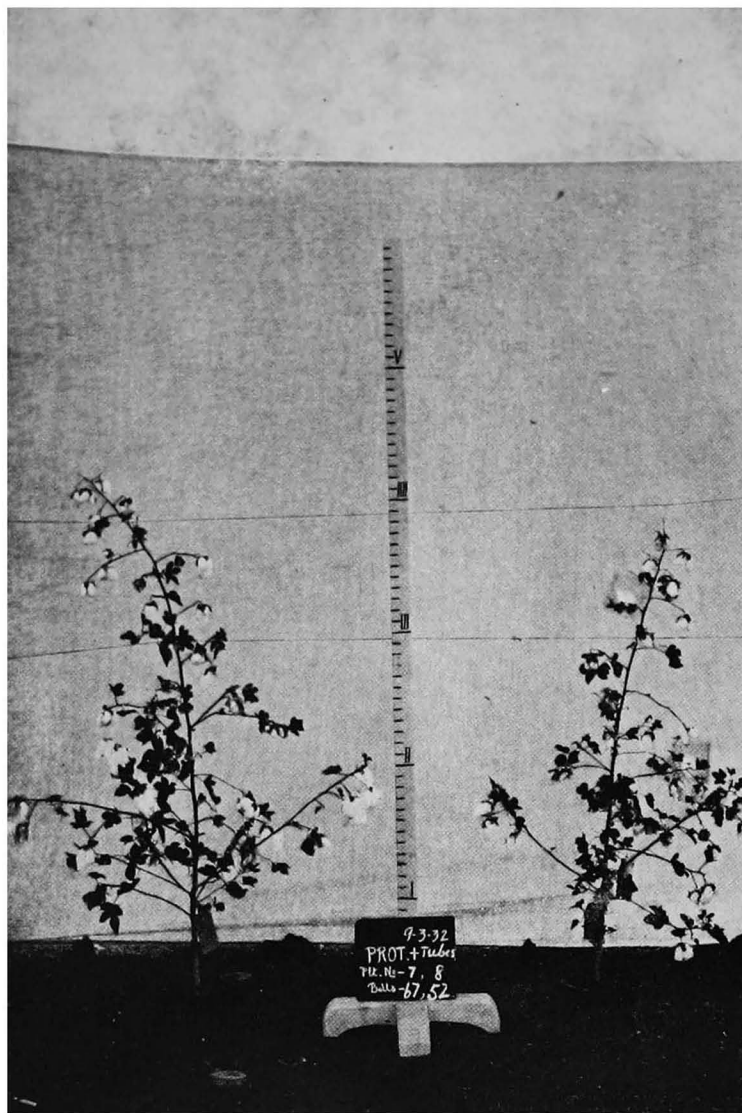
These results are contrary to those mentioned by Lloyd (1920) and King (1922). Lloyd quotes Dr. Barre's results in which the latter observed reduction in the shedding of squares and bolls as a result of irrigation. He says that the total shedding in these plants was little more than half that of the non-irrigated plants. King (1922, page 21) reports from Arizona that the plants which were irrigated at approximately ten-day intervals during the principal fruiting season, fruited very heavily with little loss from shedding. On the other hand, Presscot (1924, page 23) who studied the effects of varying quantities of water on growth behaviour and shedding in cotton in Egypt observes that higher shedding of squares resulting from heavy watering is quite marked in both the seasons.

PLATE NO. 7.
Protected plants treated with water.
1931-32.



For Control see Plate No. 7A.

PLATE NO. 7A.
Protected plants receiving no water
1931-32.



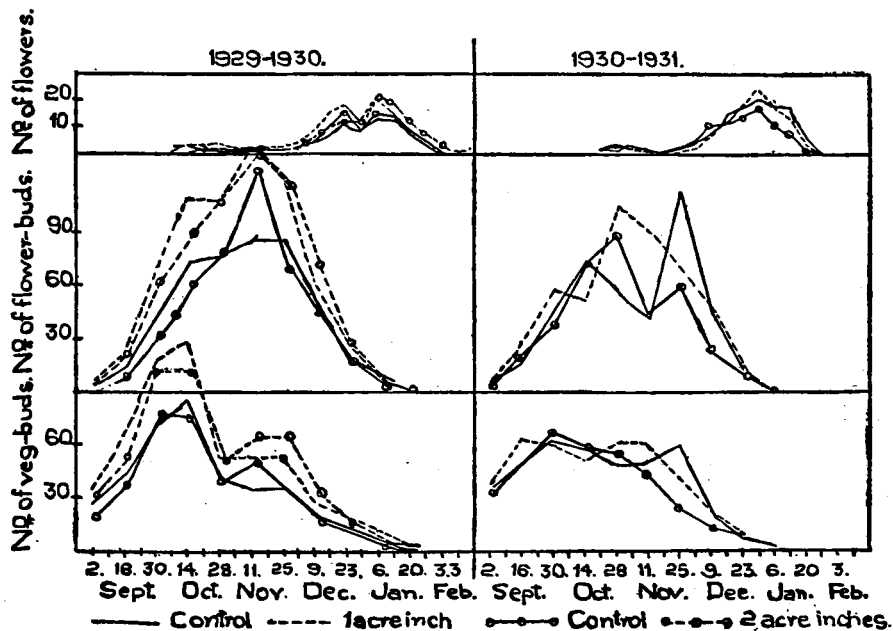
Control to Plate No. 7.

Effect of added water on the mode of plant growth.

Periodical growth counts on plants in the underground irrigation experiments are shown in Graph No. 52 as the average of ten plants in each set for the years 1929-30 and 1930-31 (Table Nos. 211, 212, 213, 214 in the Appendix).

GRAPH No. 52.

Average periodical production of vegetative-buds, flower-buds and flowers in sets of plants receiving no water and water equal to one and two-acre-inches.



They show that application of water equal to one and two-acre-inches does not bring about any change either by way of acceleration or retardation of the periods of production of the various organs of the plant. These may, however, be affected if the quantities of water are increased. Presscot (1924, page 20) studied the effects of varying quantities of water on plant growth and observed that lateness was induced in flowering by heavy watering. This he attributed to heavy bud-shedding resulting from the effects of increased vegetative vigour of the plant consequent upon heavier irrigations.

(e) ABSORPTION OF WATER BY THE PLANT AT DIFFERENT STAGES OF GROWTH.

The question whether the cotton plant under Broach conditions will be benefited by increasing the supply of moisture in the soil may be considered from the viewpoint of its water requirement from stage to stage. In the case of a non-irrigated crop like the one under consideration, one of the measures of water requirement is the rate of moisture depletion in the soil under influence of the growing crop. Such data are available for a period of six years and have already been presented in Table Nos. 9 to 14 in the Appendix. Those for the years 1930-31 and 1931-32 have been shown, in addition, in Graph No. 6. These moisture determinations pertain to the period after the cessation of monsoons and are made at intervals of a fortnight in four equal layers of 22.5 cms. each, up to the depth of 90 cms. The graph also shows similar determinations for uncropped land. This enables the estimation of the drag of water by the plant alone.

A reference to these tables and to the Graph No. 6 will show that at the close of the monsoon the soil contains about 30 per cent. of total moisture in all layers. Much before the end of the crop-season, the moisture in all the layers goes down to about 20 per cent. and remains constant thereafter. A comparison with the moisture curves of the uncropped land shows that most of this depletion of moisture is caused by the root activity of the plant. The rate of decline of moisture-content differs in different periods of the crop season and in different soil layers. Percentage moisture falls from 30 to about 23 within a month from the time the roots enter each of the four layers and by about the end of November, *i.e.*, the first two months after the close of the monsoon, the roots penetrate all the depth up to 90 cms. and bring down the percentage moisture to about 23. In the following two months, this goes down to about 20 to 21 only. This means that the rate of moisture depletion is much faster in the first two months from the close of monsoon. The end of November marks the phase of commencement of flowering and the decline of vegetative phase.

These considerations indicate that the plant exerts a greater pull and absorbs much more water in the first two months after the close of the monsoon than in the latter two. It means that the water requirements of the plant in its vegetative phase is much more than in the flowering or boll development phases. Such a position is rather difficult to explain. The transpiring surface of the plant till the end of November is comparatively small than that during December and January. As such, the tax for water should be normally greater in the latter two months. The fact, however, that the physical forces in the surrounding of the plant are more severe during the months of October and November than in the following two months (cold months) as shown by the evaporating power of the air in these months (Table No. 3 in the Appendix) may partly account for some additional demand for water in the first two months. Besides, the fact that in these months a large part of the inception of the various organs takes place may also partly account for a larger demand on soil water. The faster decline of moisture-content of the soil in the first two months may also be due to the ease with which water is extracted by the roots when the moisture-content in the soil is high. As the moisture content goes down, absorption may be rendered more difficult. This may be one of the reasons of the slow decline in the moisture content of the soil in the latter two

months. Should this, however, occur the plant should take up water if added during this phase. We may, therefore, proceed to the figures of moisture content under conditions of increased water supply made in the water requirement experiments of 1929-30 to 1931-32.

It has already been mentioned that fortnightly determinations of moisture in the lower three layers of the soil were made in all the treated and the untreated plots in the three years of the experiment of water application. The data are reproduced in Table Nos. 215 to 222 in the Appendix. They show that in 1929-30, when four different quantities of water were added, the total moisture in each of the three lower layers of the soil was more or less equal to that in the control in the first three treatments (Table No. 137). In the fourth treatment, however, in which two-acre-inches of water was given per month, the moisture per cent. in the two lower layers was always much more (Graph No. 53).

TABLE No. 137.

Average total moisture percentage in the two layers of 45 to 67½ cms. and 67½ to 90 cms. in plots receiving different quantities of water.

1929-30.

Period ending.	I. ½ inch water.	II. Control.	III. 1 inch water.	IV. 1½ inches water.	V. Control.	VI. 2 inches water.
12th September ..	28·37	27·17	..	27·10	..	..
26th September ..	27·56	27·12	..	25·24	..	..
11th October	26·10	27·12	27·50	26·54	26·23	26·92
25th October	23·27	25·91	25·65	24·69	25·22	25·66
8th November	20·53	23·67	23·52	22·22	22·57	22·80
22nd November	23·43	22·60	23·21	24·14	23·31	26·45
6th December	21·86	22·10	22·00	23·17	22·31	25·80
24th December	21·41	22·15	21·12	22·00	21·31	26·19
3rd January	21·95	21·41	22·81	22·36	21·90	25·97
17th January	21·03	20·68	21·27	21·71	20·68	25·61
31st January	22·82	20·34	23·42	22·76	21·36	29·82

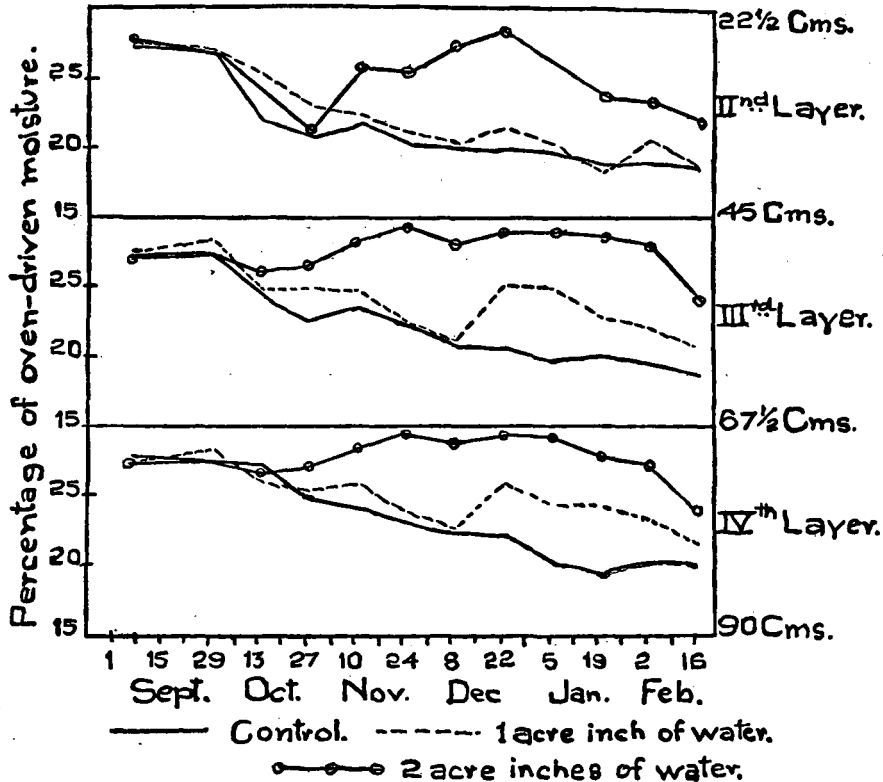
Application of water commenced from 14th October 1929 and ended on 23rd January, 1930.

The fact that the moisture of the soil remained unaffected up to the application of one-and-a-half inches of water per month, and that when the quantity was increased to 2 inches, it rose up, means that either the added water dissipated

GRAPH NO. 53-A.

Percentage of total moisture in different layers of the soil in plots receiving one and two-acre-inches of water per month and in the control.

1930-1931.



plot receiving two inches of water, the percentage of moisture in all the layers was again far greater than in the control at all the times in the season. More interesting however was the fact that the plot receiving even one inch of water showed higher moisture in the lower two layers, from about the beginning of December onwards throughout the remaining part of the season. This means that the water requirement of the plant during the period of flowering and boll development, *i.e.*, the reproductive phase, was lesser and hence the accumulation of the added water in the soil.

In the third year, only one quantity of water was given, namely, two-acre-inches per month. The moisture figures (Table Nos. 221 and 222 in the Appendix) were exactly in conformity with those of the previous two years, showing that the added water was not much utilised by the plant.

GENERAL CONCLUSIONS.

Water requirement of the plant during the vegetative phase is more than during the reproductive phase.

If supply of moisture in the soil is augmented by frequent addition of water commencing from the close of the monsoon, it is mainly utilised by the plant during the period of expansion of its vegetative parts and very little during the period of flowering and boll development.

The natural supply of moisture in the soil does not become limiting during the reproductive phase. If more moisture is made available to the plant during the vegetative phase, it leads to increased production of various organs and consequently to increased number of bolls.

Addition of water up to two-acre-inches per month does not affect the normal mode of growth by accelerating or delaying certain phases.

Deficiency of moisture in the soil is not the causal factor of the incessant bud and boll shedding in the Broach cotton tract.

B. IMPROVEMENT OF PLANT-FOOD SUPPLY IN THE SOIL.

With the progress of investigation on the causes of bud and boll shedding, increasing evidence was obtained to show that the shedding—particularly of bolls—was the result of inadequate supply of nutrition to the plant. Ewing (1918) studied boll shedding in several varieties of cotton and found that the cotton plant produced far too great a number of flowers which it had no capacity to maintain and that there was in each variety an auto-regulation of bolls brought about by shedding. The studies of Mason (1922) led him to think that “the greater liability of young bolls, produced during the latter portion of the flowering period, to undergo abscission resulted from their inability to obtain assimilates necessary for development in the presence of a larger number of more mature bolls.”

Work was, therefore, started to see if boll shedding could be prevented or at least substantially reduced by augmenting the supply of plant-food in the soil. This work steadily branched into many directions as it involved considerations both from the theoretical and the practical points of view. Quite a large number of experiments were carried out on this subject, which may be classified under two main groups, namely, the application of manures with water and the application of manures without water. We shall first take up the former class of experiments and then proceed to the study of the latter.

I. (A) APPLICATION OF NITROGEN WITH WATER.

Preliminary experiments were started in 1926-27 and were continued for three years. In the first year, nitrogen was applied in the form of nitrate of soda at the rate of 116 lbs. per acre. This was administered in three doses of twenty-three, seventy and again twenty-three lbs. of nitrogen with three-acre-inches of water every time. Application was made through under-laid tubes already described at three different levels in the soil, namely, thirty, sixty and ninety cms. to three different sets of five plants each. The control plants received only water.

The first dose was given at the commencement of flowering ; the second, a month hence ; and the third, six weeks after the second. The results of plant performance under these conditions are given in Table No. 223 in the Appendix. They indicate that the application of nitrogen increased substantially the number of flower-buds, flowers and bolls and improved, though to a small extent, the rate of success of flower-buds into flowers and of flowers into bolls. The net result was that the number of mature bolls per plant increased from 36 to 53.

It was thought that still better results could be obtained if the plant was fed just when the suspected deficiency of nutrition leading to boll shedding would operate. In the following year (1927-28), therefore, the experiment was repeated with certain modifications. The time of the first application was delayed to a stage when flowering had well advanced but the usual heavy shedding of bolls had not commenced. Further, the application at the depth of 90 cms. was dropped as the results of the previous year were not encouraging. The quantities of nitrogen and water were also reduced this year to seventy lbs. and two-acre-inches respectively. The fertilizer, nitrate of soda, and water were administered in three equal doses at intervals of a fortnight. A fourth application of water alone was further given to ensure full use of the fertilizer. The results are given in Table No. 224 in the Appendix. They came up to expectations and showed that the proportion of flowers from buds incepted and of bolls from flowers formed was improved by the treatment. The total production of flowers and bolls on the plant also increased substantially. The application commencing from the middle of the flowering period, however, did not increase the number of flower-buds to an appreciable extent, as happened in the previous year when it was commenced at the start of flowering.

During the next year (1928-29), the experiment was again carried out but was vitiated as the treated rows happened to be situated on what afterwards proved to be a strip of badly drained land having a hard pan beneath. The growth of the treated plants became stunted and later they suffered from red-mites. The effect of the applied nitrogen was, however, clearly visible in the dark colour which the plants developed within a few days. The final performance of the plant was similar to that of the previous two years. (Table No. 225 in the Appendix.)

The results of all these experiments carried out for a period of three years led to the following provisional conclusions :—

- (1) Addition of nitrogen to the soil stimulates the production of flower-buds, early applications always leading to a higher bud production.
- (2) Improvement of nitrogen supply in the soil increases the retention of buds and bolls, indicating that a less retention of these organs usually witnessed under normal conditions is probably due to a deficiency of soil nitrogen.

(a) *Application of nitrogen with water in small and frequent doses.*

The indications obtained in the foregoing section suggested that if a greater supply of available nitrogen in the soil was maintained by its frequent application in small doses from an earlier stage of growth it would lead to a still greater production of flower-buds and their retention and development into flowers and bolls

in larger numbers. Accordingly from 1929-30, the applications of nitrogen were commenced much earlier, *i.e.*, from mid-October when flower-buds begin to set successfully on the plant, and were continued for three months. Nitrogen and water were applied, twice a week, through under-laid tubes at the level of sixty cms.—the best of the three depths tried. There were thus thirty applications. The nitrogen in this case was given in the form of ammonium sulphate and the total quantity of nitrogen was divided into thirty equal fractions for application one at each time. Water was similarly given to make up two-acre-inches per month. These experiments were carried out on unprotected plants for three years from 1929-30 to 1931-32. In the first year, four quantities of nitrogen, namely, forty, sixty, eighty and hundred pounds per acre were tried on four different sets of plants. In the second and third year, trials with only the two extreme quantities were continued. The number of plants in each set in the first two years was ten. In the third year, the number under the treatment of forty pounds nitrogen, and control was raised to sixty and that under the hundred-pound treatment was twenty. Another set of sixty plants was added this year in which forty pounds of nitrogen per acre was applied in a similar way but the application was started at a late stage, namely, some days before the commencement of heavy boll-shedding as was done in 1927-28. In all the years, plants in the control row received only water without any nitrogen.

Periodical growth counts were maintained on all the plants each year. In addition, oven-driven moisture and nitrous and nitric nitrogen were estimated every fortnight in three soil layers of 22.5 cms. each, omitting the first layer from the surface. For the purpose of drawing samples for these estimations, the treatments were extended to another set of ten plants in the same row continuous with the ten plants under counts. The idea was to avoid any disturbance to the plants under counts caused by soil sampling.

During 1930-31 and 1931-32, these experiments were also tried with plants grown free from the spotted boll-worm. As these plants feed shallower, the tubes were laid in at the depth of 45 cms. instead of 60 cms. Further, only one quantity of 40 lbs. nitrogen per acre was tried, the control receiving water alone. The quantity of water applied was two-acre-inches per month. The applications were bi-weekly commencing from mid-October and were continued only for two months as the protected plants complete their life-cycle earlier by about a month than the unprotected. In 1931-32, the effects of applying nitrogen from the midst of flowering period were studied in addition. Growth counts were maintained but the estimations of soil moisture and nitrogen were not made. The results of all these experiments may now be studied.

(b) *Effect of nitrogen on the production of various organs.*

Nitrogen applied with water to the unprotected plants from the bud-growing stage increased consistently and considerably, during the three years, the number of vegetative buds, flower-buds, flowers and bolls (Table Nos. 226, 227 and 228 in the Appendix). Their magnitude however varied in the three years. The average production and increase over the control, worked out for two quantities common to the three years, are shown in Table No. 138. The figures indicate that the magnitude of production of each of the organs increased with increasing quantities of nitrogen.

TABLE No. 138.

Production and increase of various organs in unprotected plants treated with 40 and 100 lbs. of nitrogen from the bud-development stage.

(Average of three years.)

Name of the organ.	Average production in control.	Average production and increase over control by applying.						Increased return per pound of added nitrogen in application of.	
		40 pounds nitrogen.			100 pounds nitrogen.			40 lbs. nitrogen.	100 lbs. nitrogen.
		Production.	Increase.		Production.	Increase.			
			Number.	Per cent.		Number.	Per cent.		
Vegetative buds ..	449	696	247	55.0	949	500	111.4	6.17	5.00
Flower-buds	443	716	273	61.6	967	524	118.3	6.82	5.24
Flowers	105	202	97	92.4	281	176	167.6	2.42	1.76
Bolls	42	74	32	76.2	97	55	131.0	0.80	0.55
Seed-cotton in grms. (Sun-dry).	82	160	78	95.1	217	135	164.6	1.95	1.35
Seed-cotton per boll in grms. (Sun-dry).	1.95	2.16	0.21	10.8	2.23	0.28	14.4	..	..

The yield was doubled with 40 lbs. and increased 2.6 times with 100 lbs. nitrogen. The rate of increase, however, was not proportional to the quantities of nitrogen given as will be evident from the figures of increase of return per pound of nitrogen in the last two columns.

Figures of percentage increase in the various organs are instructive. Nitrogen given with water from the stage of bud-development no doubt increased to a large extent both the vegetative and the reproductive buds but what is more notable was the fact that it also raised the number of flowers over the control by ninety-two and hundred-and-sixty-seven per cent. with the application of forty and hundred pounds of nitrogen respectively. This means that nitrogen helped a proportionately larger number of flower-buds to grow into flowers. Percentage increase in the number of bolls was lower than that of flowers. But the final yield of seed-cotton per boll was more in the nitrogen plot than in the control. Thus, nitrogen promoted a better development of bolls and increased also the yield per boll. Whereas the yield of seed-cotton was 1.95 grammes in the control plants, it was 2.16 and 2.23 grammes in plants receiving forty and hundred pounds of nitrogen respectively.

These results clearly show that in the Broach cotton tract nitrogen is a limiting factor for a better expression of plant growth.

Similar were the effects of applied nitrogen on protected plants also as would be seen from the data in Table No. 229 in the Appendix. The actual values for increases in the number of various organs are abstracted below from this table.

TABLE No. 139.

Production and increase of various organs in protected plants treated with 40 lbs. of nitrogen from the bud-development stage.

(Average of two years.)

Name of organ.	Average production in control.	Average production and increase due to 40 pounds of nitrogen over control.			Increased return per pound of nitrogen.
		Production	Increase.		
			Number.	Per cent.	
Vegetative-buds	296	512	216	73.0	5.40
Flower-buds	302	607	305	101.0	7.62
Flowers	123	270	147	119.5	3.67
Bolls	53	103	50	94.3	1.25
Seed-cotton in grammes (Sun-dry)..	85	206	121	142.4	3.02
Seed-cotton per boll in grammes (Sun-dry).	1.60	2.0	0.40	25.0	..

These figures show that the same gradation of percentage increase in various organs was maintained as observed in the unprotected plants. The magnitude of production was, however, appreciably greater. With the application of forty pounds nitrogen, flower-buds and flowers increased by sixty-two and ninety-two per cent. respectively in the unprotected plants while the increase in these organs amounted to 101 and 119 per cent. in plants protected from the spotted boll-worm. The number of bolls in the former set increased by seventy-six per cent. and in the latter by ninety-four per cent. More remarkable, however, was the rise in the yield of seed cotton per boll or, in other words, the size of the boll, which was equal to twenty-five per cent. in the protected plants as against eleven in the unprotected. On this account, the return per pound of nitrogen was far greater in the protected plants. It may be recollected that the protected plants are normally more efficient in the production of all organs and also in respect of the final yield than those grown under spotted boll-worm conditions. These differences are maintained even under treatment of nitrogenous fertilizers.

These results show in no uncertain manner that if the spotted boll-worm is completely controlled, the plant will not only give a higher yield as it does under ordinary conditions but it will also respond better to a nitrogenous-manurial treatment leaving a far greater margin of profit. This behaviour of the plant has a great physiological significance. It shows that if the plant becomes less efficient due to any cause, it continues to remain so even in its response to beneficial treatments.

(c) *Effect of nitrogen on the rate of bud and boll success.*

A reference to Table Nos. 226 to 229 in the Appendix in which the figures of percentage success of buds and bolls in the treated and untreated plants are given for the three years and the percentage of bud and boll success worked out therefrom as reproduced below, will show that addition of nitrogen during the periods of bud development and flowering caused a definite improvement in the rate of flowers succeeding from flower-buds. The ratio of flowers to bolls, however, went down. These effects were consistently observed in both the protected and the unprotected plants.

TABLE No. 140.

Percentage success of buds and bolls in the unprotected and protected plants treated with nitrogen and water.

Percentage success of	Unprotected plants.			Protected plants.	
	Average of three years.			Average of two years.	
	Two inch water per month with nitrogen equal to			Two inch water per month with nitrogen equal to	
	Nil. (Control).	40 lbs.	100 lbs.	Nil. (Control).	40 lbs.
Bud to flower	23.7	28.2	29.0	40.7	44.5
Flower to boll	40.0	36.6	34.5	43.4	38.1
Bud to boll	9.5	10.3	10.0	17.5	17.0

The results of the preliminary experiments already described indicated that flowers succeeded into bolls in larger proportion if nitrogen was applied at a late stage, *i.e.*, during the boll-development period. This point was again put to test in the year 1931-32 on both the protected and the unprotected plants. When the application was commenced early the whole quantity of nitrogen was given in thirty bi-weekly doses. In the late application it was given in fifteen doses. This meant doubling the dose in the latter case. In the protected plants these figures were twenty and ten respectively. The results are given in Table No. 141.

TABLE NO. 141.

Comparison of the effects of early and late application of equal quantities of nitrogen with water, in small and equal doses twice a week.

(Average per plant.)

1931-32.

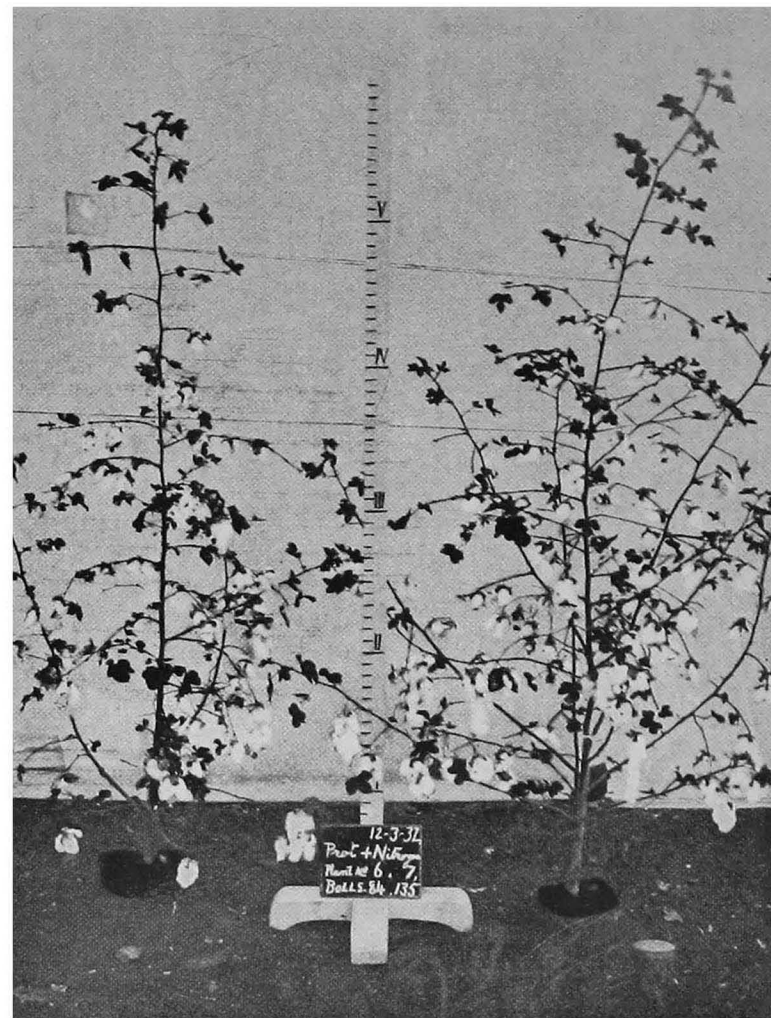
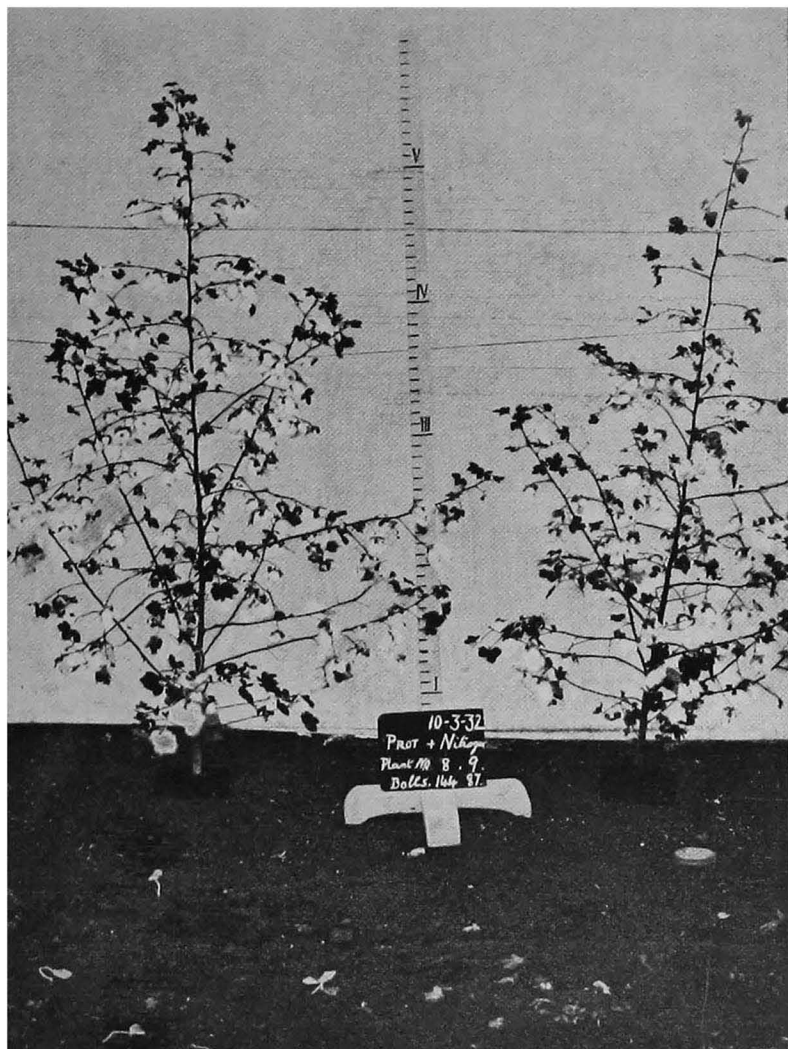
Name of organ.	Protected plants.			Unprotected plants.		
	Control.	Application of 40 pounds nitrogen.		Control.	Application of 40 pounds nitrogen.	
		From stage of bud-development	From stage of boll-development.		From stage of bud-development	From stage of boll-development
Number of plants under study.	10	20	20	60	60	60
Vegetative buds ..	296.2	580.7	443.9	433.9	704.3	437.6
Flower-buds	295.6	704.5	346.1	284.2	505.7	268.0
Flowers	127.7	311.0	153.2	89.1	184.3	97.8
Bolls	50.5	108.7	81.5	40.8	77.2	55.8
Seed-cotton in grms. (Sun-dry).	91.8	222.0	168.8	81.0	160.3	119.4
Yield of seed cotton per boll (Sun-dry) ..	1.80	2.02	2.08	1.99	2.08	2.14
Percentage success of:—						
Bud to flower ..	43.2	44.1	44.3	31.4	36.4	36.5
Flower to boll ..	39.5	35.3	53.2	45.7	41.9	57.0
Bud to boll ..	17.1	15.6	23.5	14.4	15.3	20.8

Late applications of nitrogen brought about a distinct increase in the percentage success of flowers into mature bolls and to some extent also of flower-buds growing into flowers. In the former case, there was a net increase of twelve per cent. over the control and an increase of fifteen to eighteen per cent. over the earlier treated plants. The final percentage of bud to boll also improved appreciably. *The effect of nitrogen on improving both the retention and the development of flower-buds and bolls is, thus, governed by the stage of growth when nitrogen is made available to the plant. If it is given from the stage of bud-development, it increases the percentage success of buds into flowers; if applied later during the stage of boll development, bolls succeed in larger proportion and even the yield of seed-cotton per boll and nitrogen content of seed are enhanced.* In the following table are

* On an average forty-six flowers per plant out of the total of 153 opened in the case of the protected plants and thirty in the unprotected plants out of ninety-eight before the commencement of treatment.

PLATE NO. 8.

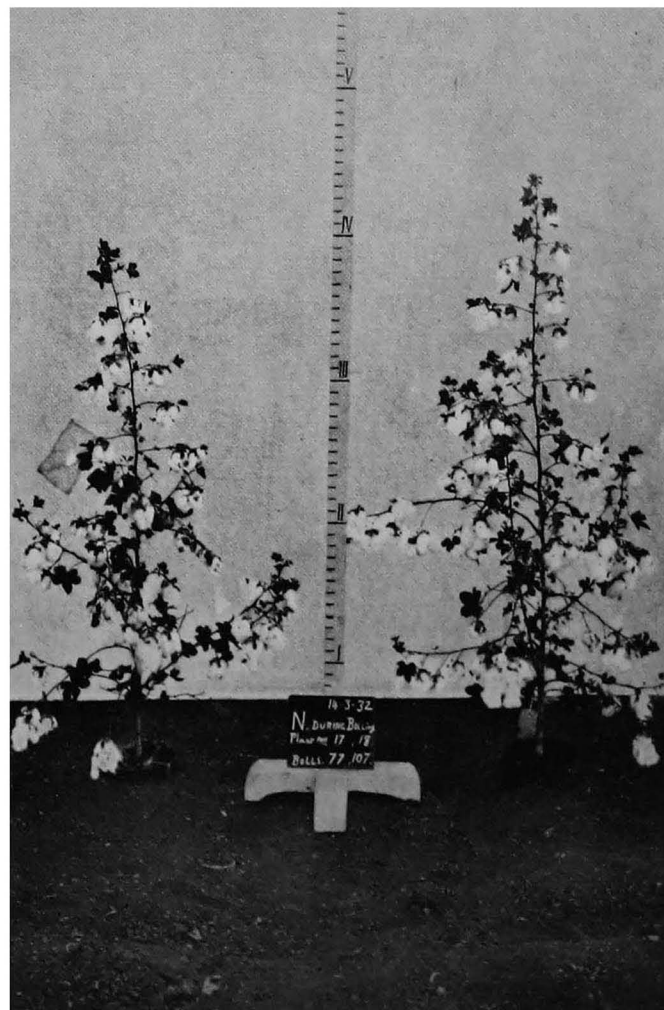
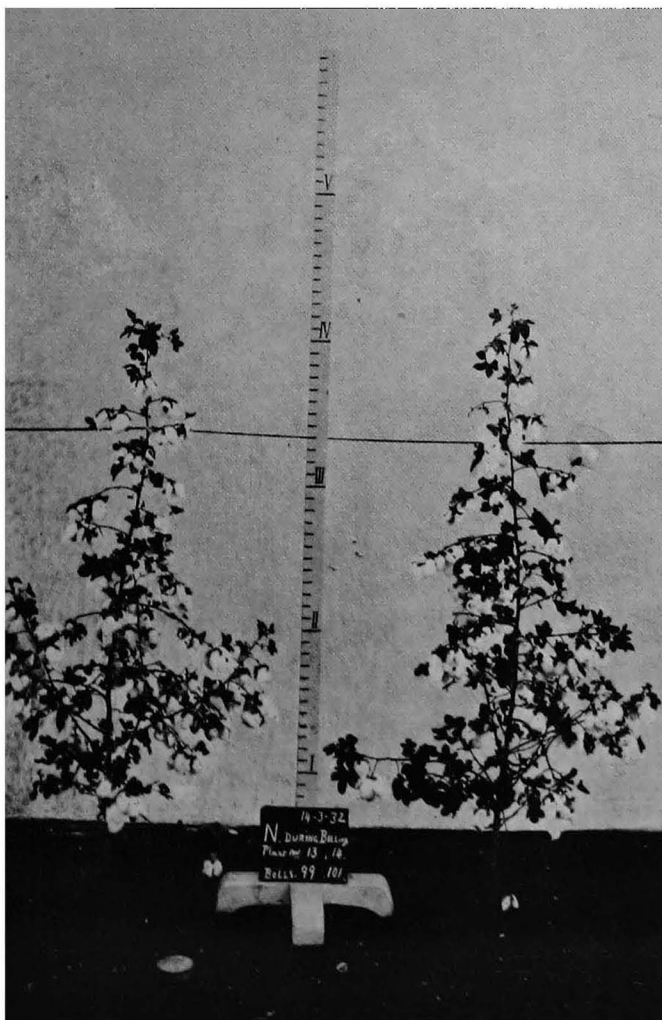
*Protected plants treated with water and nitrogen applied from the flower-bud stage.
1931-32.*



For Control see Plate No. 7.

PLATE No. 9.

*Protected plants treated with water and nitrogen applied from the bolling stage.
1931-32.*



For Control see Plate No. 7.

shown percentage figures of nitrogen in cotton seeds of plants treated with nitrogen and water.

TABLE No. 142.

Percentage nitrogen in seeds of cotton plants receiving nitrogen at two different stages.

Percentage nitrogen in seeds of cotton plants receiving			
No water.	Water only.	Water with nitrogen from bud development period.	Water with nitrogen from boll development period.
2.74	2.63	2.74	3.29

The average results of the performance of plants receiving forty pounds of nitrogen with water in small and equal doses given in Table No. 141 above are exceedingly instructive. They show that the same quantity of nitrogen given from an earlier stage of growth gave far greater returns than its later applications. The yield of seed-cotton in the unprotected plants increased by ninety-eight per cent. over the control by earlier commencement, while an increase of only forty-seven per cent. was obtained by later commencement. In the protected plants the corresponding figures for the early and late applications were hundred-and-forty-two and eighty-four per cent. respectively. Earlier application of nitrogen promoted plant expansion and increased the production of flower-buds. (Plate Nos. 8 and 9.) Greater production of flower-buds led to a greater formation of flowers, thereby doubling the usual number. The percentage success of flowers into bolls was, however, slightly lowered. Nevertheless, the number of mature bolls per plant increased by virtue of the larger number of flowers formed.

In the late application series, on the other hand, the scope left for a greater production of flower-buds was indeed very small. The added nitrogen mainly helped the existing flower-buds and bolls to be retained in larger proportion though not to the extent of making up the production of the larger number of buds with the usual degree of success obtainable by an earlier application. This shows that a mere increase in the percentage success of buds and bolls with a lesser number of these forms is illusive and of no advantage whatever.

Thus, a better success of buds into flowers and of flowers into bolls and thereby of buds into bolls can be obtained if nitrogen is supplied to the plant during the boll development period when the vegetative growth practically ceases. If it is supplied during the stages of bud-development and flowering, it stimulates the production of flower-buds and their successful setting in larger proportion.

In the earlier treated plants, flower-buds and flowers increased considerably and maintained the same ratio of success of buds growing into mature bolls as occurred in the untreated plants (Control). Although this may mean no improvement in the rate of success, the same rate on higher production is responsible for enhancing appreciably the number of ripe bolls on the plants.

The deficiency of nitrogen is thus an important limiting factor curtailing the number of buds and bolls.

(d) *Effect of continuing the supply of nitrogen for various periods.*

With a view to studying this question, an experiment was carried out in 1930-31 in which protected plants were given nitrogen with water in bi-weekly applications through underlaid tubes for four periods of one, two, three and four months. The applications were started simultaneously in all the sets of plants from mid-October when flower-buds had already set growing. The quantity of nitrogen given per month was at the rate of twenty-five pounds per acre while that of water was two acre-inches per month. Thus, the first set received twenty-five pounds of nitrogen in one month, the second received fifty in two months, the third had seventy-five in three months and the fourth got hundred pounds of nitrogen in four months. In each set, bud-histories were maintained on a group of five plants. Spacing was reduced to nine inches in the row, the rows remaining three feet apart as usual. The plants in control rows had underlaid tubes but they received neither water nor nitrogen. The results of this experiment are embodied in the following table.

TABLE NO. 143.

Effect of nitrogen applied with water for different periods.

Protected plants.

(Average of 5 plants. Spacing 3 feet by 9 inches.)

	Set I.	Set II.	Set III.	Set IV.	Set V.	Set VI.
Quantity of nitrogen	25 lbs.	Control.	50 lbs.	75 lbs.	Control.	100 lbs.
Duration of application in months.	One.		Two.	Three.		Four.
Average production at the commencement of the experiment. (Counts taken on 10th October.)						
Vegetative buds ..	32.0	36.8	48.6	42.0	33.4	40.0
Flower-buds	21.2	22.2	33.4	24.8	19.4	23.4
Flowers	0.0	0.0	0.0	0.0	0.0	0.0
Average production at the end of four weeks from the commencement of treatment. (Counts taken on 7th November when the first flush of flowering was over in the control.)						
Vegetative buds ..	88.0	52.0	123.2	116.2	55.4	97.8
Flower-buds	102.2	43.4	115.2	108.8	43.4	89.6
Flowers	9.4*	14.2	15.6	9.2	9.8	8.6

* Treatment discontinued hereafter.

TABLE No. 143—(contd.)
Effect of nitrogen applied with water for different periods.
 Protected plants.
 (Average of 5 plants. Spacing 3 feet by 9 inches.)

	Set I.	Set II.	Set III.	Set IV.	Set V.	Set VI.
Quantity of nitrogen	25 lbs.	Control.	50 lbs.	75 lbs.	Control.	100 lbs.
Duration of application in months.	One.		Two.	Three.		Four.
Average production at the end of eight weeks from the commencement of treatment. (Counts taken on 5th December when the second flush of flowering was at its height in the control.)						
Vegetative buds ..	132.0	63.0	217.0	223.8	67.6	191.6
Flower-buds	175.4	50.2	243.4	282.4	54.4	225.2
Flowers	23.6	16.2	26.6*	20.8	11.6	18.6
Average production at the end of twelve weeks from the commencement of treatment. (Counts taken on 2nd January 1931, i.e., end of flowering period in the control.)						
Vegetative buds ..	133.4	63.0	229.2	275.4	68.6	225.6
Flower-buds	178.0	50.2	278.4	365.0	54.4	276.2
Flowers	70.2	19.0	89.0	89.8*	16.4	79.6

* Treatment discontinued hereafter.

Counts taken before the commencement of the treatment show that plants were more or less equal in vigour in all sets except those in the third.

Counts taken after four weeks from the commencement of treatment show that so far as the formation of vegetative buds is concerned, the response to the same quantity of nitrogen differed in the different sets. Judged on the basis of flower-bud formation, however, all the sets receiving nitrogen showed more or less equal performance except the last one. The treatment was discontinued in the first set from this time.

Counts taken eight weeks after the commencement of the treatment show that in the first set when the nitrogen treatment had been discontinued the production of both the vegetative and flower-buds declined. The other three sets received the same quantity of nitrogen with water and added increments since the previous count but the plants in the last set again failed to come up to the standard of the two middle sets. The reason of this disparity could not be properly traced and may be ascribed to the individuality of the plants themselves. The treatment was discontinued at this stage in the second set.

Counts taken at the end of twelve weeks show that in the first set the production of vegetative buds and flower-buds practically ceased. In the second treated set, it appreciably declined. In the third and the fourth treated sets which were still receiving nitrogen and water, the production continued though at a declined rate. The number of flowers was more or less equal in all the treated sets except the first, in spite of the fact that the treatment in the second had ceased a month before. This means that although flower-bud formation in the third and the fourth treated sets had gone up, flowering was less intense in them. The inference would be that the expansion of plant-scaffolding did not result into a correspondingly higher rate of the success of flower-buds into flowers. The treatment of the third treated set was discontinued from this time. Final performance of plants in the different sets is given in Table No. 144.

TABLE No. 144.
Effect of nitrogen applied with water for different periods.
Protected plants.
1930-31.
(Spacing 3 feet. by 9 inches.) (Average of 5 plants.)

	Set I.	Set II.	Set III.	Set IV.	Set V.	Set VI.
Quantity of nitrogen.	25 lbs.	Control	50 lbs.	75 lbs.	Control.	100 lbs.
Duration of application in months.	One.	..	Two	Three	..	Four
Final performance.						
Vegetative buds ..	133.4	63.0	229.2	276.0	68.6	225.6
Flower-buds	176.0	50.2	278.6	365.2	54.4	276.2
Flowers	70.6	19.0	106.0	139.4	16.4	112.2
Bolls	16.4	6.0	24.6	37.6	6.6	32.8
Seed-cotton per boll (Sun-dry).	1.95	2.05	2.07	2.19	2.09	2.22
Weight (Sun-dry) in grms. of total seed-cotton.	32.0	12.3	51.0	82.2	13.8	72.8
Dry weight of plant skeleton in grms. ..	26.4	7.2	46.8	58.2	7.8	46.4
Ratio Seed-cotton Plant body ..	1.21	1.71	1.09	1.41	1.77	1.57
Percentage success of:—						
Bud to flower ..	39.6	37.8	38.0	38.2	30.2	40.6
Flower to boll ..	23.2	31.6	23.2	27.0	40.2	29.2
Bud to boll ..	9.2	11.9	8.8	10.3	12.2	11.9

The average performance of plants in the different sets at the end of the season confirms the previous finding that nitrogen increases the production of all the organs on the plant. There was a rising gradation in the production of different organs as the duration of application was increased up to three months. Plants in the fourth treated set lagged behind in performance from the end of the first month of application and they continued to be inferior throughout. Nevertheless, the production increased with the application of increased quantities of nitrogen and water.

The proportion of flower-buds succeeding into flowers was more or less the same in all the treated plots. Percentage success of flowers into mature bolls, however, only improved when the treatment was continued for three and four months, *i.e.*, during the bolling period. Further with increased continuation of the application of nitrogen and water the yield of seed-cotton per boll steadily increased.

The above mentioned two effects lend support to the observation that the plant uses the applied nitrogen in different channels of growth according to the stage at which it is made available.

(e) *Return per pound of nitrogen.*

The actual values for returns per pound of nitrogen calculated on the basis of increases over the average production of control plants in the two sets are given in Table No. 145. They show that the return of seed-cotton per pound of applied nitrogen, increased in direct proportion up to the application of 75 pounds of nitrogen. In the case of vegetative buds and flower-buds, however, the returns steadily diminished.

TABLE No. 145.

Return per pound of nitrogen of various organs in different sets of plants receiving different quantities of nitrogen with water.

1930-31.

Organs.	Return per pound of nitrogen in plants receiving nitrogen equal to			
	25 lbs.	50 lbs.	75 lbs.	100 lbs.
Vegetative-buds	2.70	3.27	2.80	1.59
Flower-buds	5.03	4.52	4.17	2.23
Flowers	2.12	1.76	1.62	0.94
Bolls	0.40	0.36	0.42	0.26
Seed-cotton	0.76	0.76	0.92	0.59

(f) *Effects on plant development.*

In Graph Nos. 54 and 54A are shown curves of the weekly production of vegetative-buds and flower-buds and of flowers succeeding out of the respective weeks' flower-buds (relative flowers) and of bolls succeeding from flowers of respective weeks (relative bolls.) The curve of successful bolls thus shows the flower-buds from which they have arisen. It is necessary to remember that the flowering and bolling curves are not with reference to the actual time of flowering and boll-setting. They are relative to flower-bud formation only. The actual weekly values are given in Table Nos. 230 and 231 in the Appendix.

These curves are very instructive. They show that the production of vegetative buds and flower-buds or, in other words, the expansion of the plant was not only intensified by increasing the duration of nitrogen application but was also prolonged for over two weeks when the application was continued for a period of two months. Further continuation of the treatment did not, however, prolong the span of production of vegetative buds and flower-buds. These results bring into prominence the important fact that hereafter the use of the applied nitrogen was made towards the growth and development of the existing reproductive forms which, in consequence, succeeded in greater proportions. They also indicate that the growing buds and bolls exerted a retarding influence on further expansion of the plant.

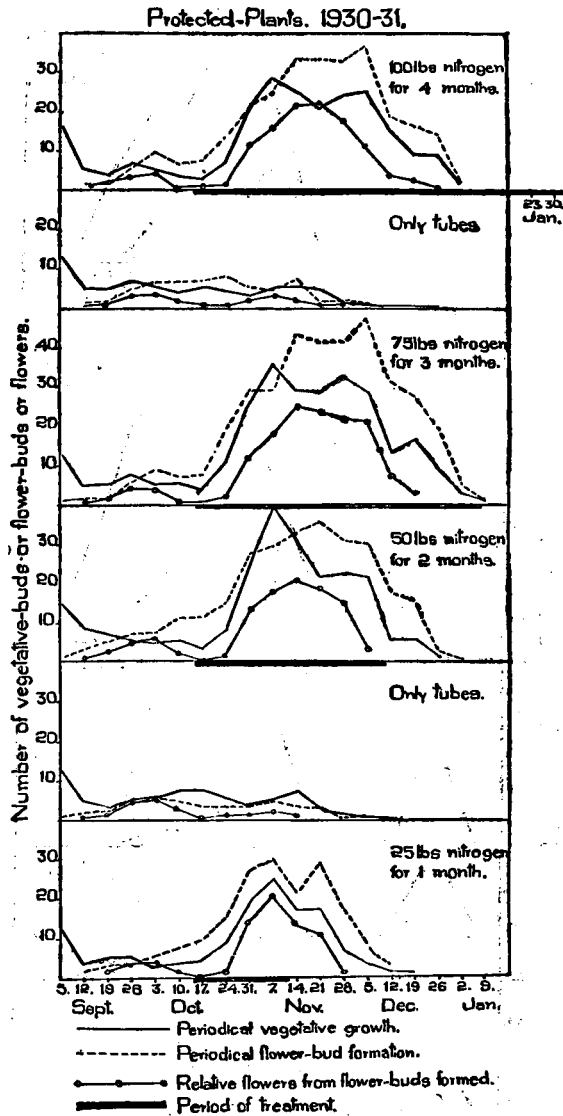
The curves for relative flowers show that the success of flower-buds was prolonged with prolonged application of nitrogen. In the first set, flower-buds succeeded up to 21st November; in the second, up to 28th November; and in the third and fourth, up to the 12th December.

On the other hand, the curves for relative bolls show that the flowers from the first flush in all the treated sets failed to develop into bolls and were shed, when in the untreated plants nearly two-thirds of the mature bolls were obtained from the first flush of flowers. This means that the application of nitrogen was responsible for the complete failure of all the flowers of the first flush. This reads like a contradiction to what has been repeatedly said so far, namely, the application of nitrogen promotes the success of bolls.

This contradiction is, however, apparent and is explained if the effects of the applied nitrogen are followed up in their logical sequence. It has been stated above that the first effect of the applied nitrogen is to stimulate and intensify the production of vegetative buds and flower-buds. In the absence of any extra nitrogen and water to the control plants, the growth steadily passed into reproductive phase resulting in development of the already set buds into flowers and further of flowers into bolls. Similarly in the treated plants the already set flower-buds did grow into flowers but the rapid intake of the added nitrogen and water disturbed the normal physiological balance of nutrition in the plant making it unsuited for the setting of fruits from the first flush of flowers. We have already referred to the relation of carbohydrate-nitrogen ratio in the cell sap and its influence on the type of the resulting growth (pages 178-181). The behaviour of the treated plants in the present experiments provides an instance in support of the view that a lower ratio promotes vegetative growth. The rapid intake of nitrogen by the plant made its sap, in all probability, more nitrogenous and therefore less

GRAPH No. 54.

Weekly total formation of vegetative buds, flower-buds, and relative flowers in sets of five plants receiving nitrogen and water for various periods.

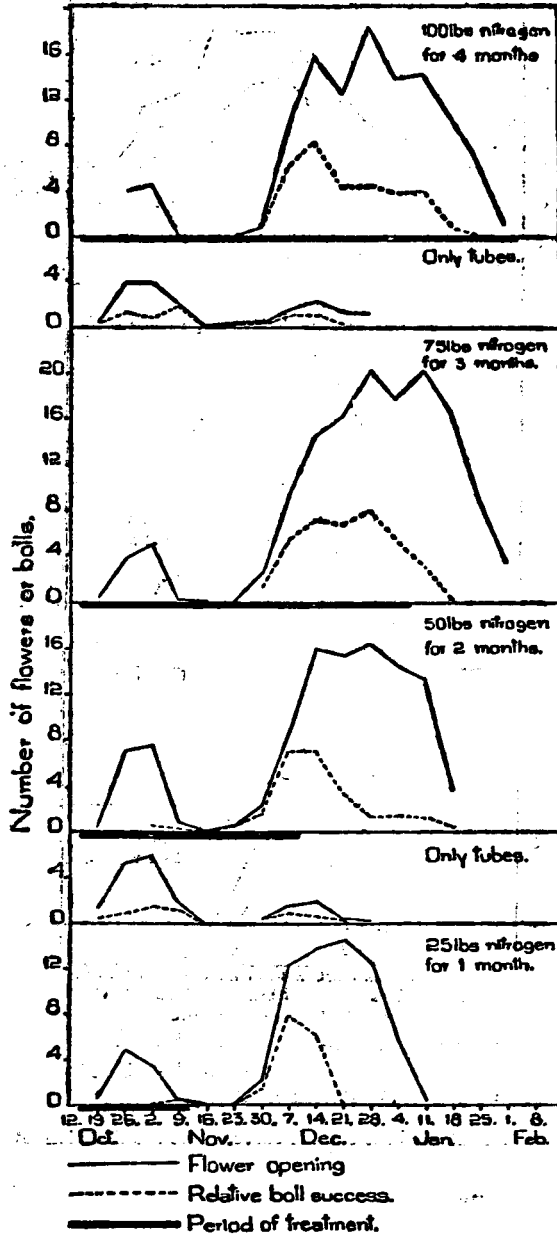


NOTE.—The thick line at the base of each curve shows the duration of the treatments in the different sets.

GRAPH NO. 54-A.

Weekly total flowers opened and relative successful bolls in sets of five plants receiving nitrogen and water for various periods.

Protected-Plants 1930-31.



favourable for reproductive growth until the increasing products of photo-synthesis consequent upon the activities of the increasing leaf surface under bright sunshine, re-established the necessary ratio. The failure of bolls from the first flush of flowering, therefore, does not contradict the previous findings. For, the added nitrogen was useful later in stimulating the plant to produce more fruits from the second flush of flowers. This again emphasises the fact that the use to which the applied nitrogen is put by the plant is conditioned by the stage of growth.

It may be asked whether a similar failure of bolls caused by the indirect effects of nitrogen and water application occurred in the unprotected plants already referred to. The fact was that the unprotected plants had only one flowering flush which more or less coincided with the second flush of the protected plants. As such, there were no bolls on the plant of the first flush on which to observe the effect. It may also be asked why a similar adverse effect on boll-setting was not observed when the commencement of nitrogen application with water was made late in the flowering season. The reason is that the plant, at that time, had the maximum of leaf surface and an excess of carbohydrate production. The added nitrogen was not therefore enough to cause any marked change in the ratio of carbohydrate to nitrogen.

This view is further supported by the fact that the continued application of nitrogen resulted in slightly lowering the success of bolls arising from earlier flowers of the second flush and prolonged the period of boll-success. This will be very clear by a reference to the foregoing graph and to Table No. 231 in the Appendix, in which the weekly percentages of bolls succeeding from weekly flowers (relative boll-success) are given for all the six sets under study.

These experiments of nitrogen-cum-water treatment given for different periods have yielded most valuable results from physiological point of view. They give further confirmation to the view that nitrogen is an important limiting factor for the full expression of the production and development of all organs of the cotton plant. Longer duration intensifies production of flower-buds and their success into flowers over a longer period and also promotes the flowers to succeed into bolls for a longer period. Finally, the effect of continuing the treatment during the bolling period is seen on the increase of seed-cotton per boll.

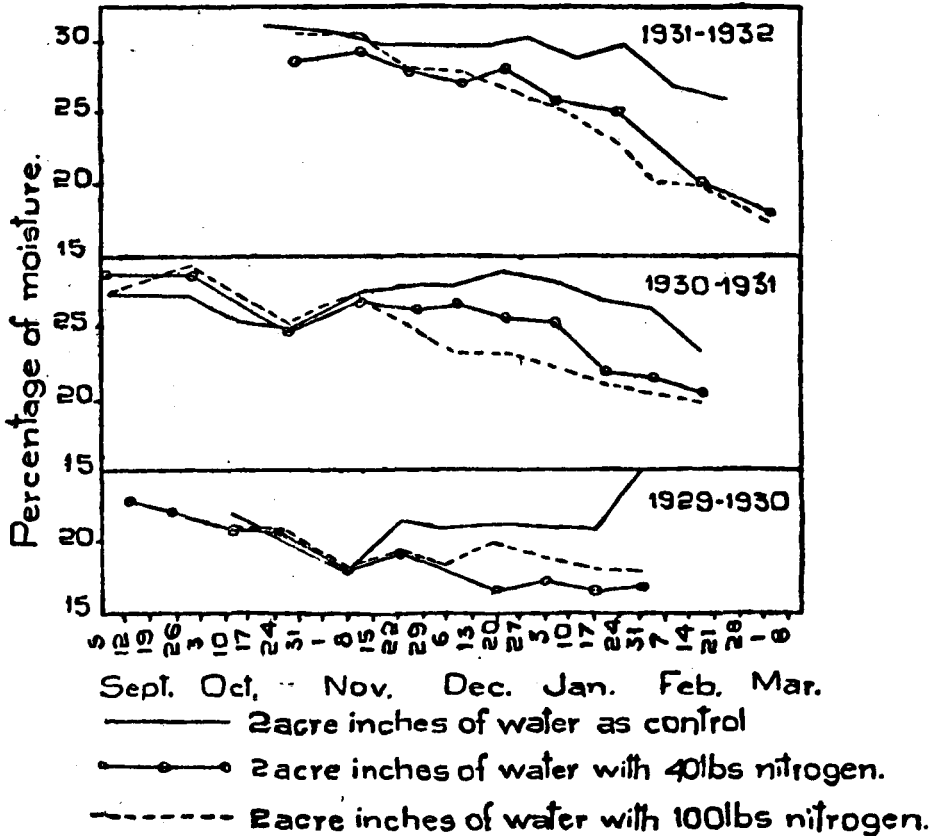
More interesting and instructive is, however, the relation of nitrogen content of the plant to the nature of growth. Addition of nitrogen with water to the soil during the bud-development stage changes the internal chemical ratios so as to make the elaborated food in the plant more suited for vegetative growth until the resulting growth by its increased photo-synthetic activity is able to restore the necessary composition of nutritional fluid in the plant and make it conducive to reproductive growth.

(g) Periodical moisture content of the soil in the nitrogen-cum-water experiments.

Fortnightly determinations of soil moisture were made in the treated plots during the three years of the experiment. These were made in three layers of 22.5 cms. each with the exception of the surface layer. The results are given in Table Nos. 232 to 243 in the Appendix and are reproduced below graphically (Graph No. 55) as the average of the three layers.

GRAPH No. 55.

Percentage of soil moisture expressed on oven-dry basis for the depth of 22.5 to 90 cms.



These curves are similar year after year. They show that in the control plot which received only water, the moisture content of the soil was very high and constant throughout the season. Moisture content of the plot receiving forty pounds of nitrogen with water, was generally less but was pretty high till the end of November in 1929-30, till the end of December in 1930-31 and till the third week of January in 1931-32. Hereafter, it declined rather rapidly. Moisture content of the soil receiving hundred pounds of nitrogen with water, was more or less of the same order as that in the forty pounds nitrogen plot but in the former case the decline commenced a fortnight to a month earlier.

It has been shown that plants receiving forty pounds of nitrogen were much larger in expanse than those in the control and those receiving hundred pounds nitrogen were still larger. It appears that in the control plot the added water was over and above the current needs of the plant and so it remained unused in the soil. When, however, larger plants were grown with the aid of nitrogen a greater pull on soil moisture was exerted. This was, however, noticed in the latter part of the season. This behaviour of the plants is contrary to that shown by the ordinary crop which taxes the soil for moisture comparatively more during the vegetative phase. The manured plants, on the other hand, reduce the moisture content during the reproductive stage and this can only be explained on the ground of the large size they attain, requiring larger quantities of water for transpiration.

Hence, although the moisture in the soil is more than sufficient for the normal growth of the cotton crop (page 192), evidence shows that it may become deficient if plants attain larger size by nitrogen manuring.

WATER REQUIREMENT OF THE PLANT MANURED WITH NITROGEN.

Some light on the water requirement of the plant receiving nitrogen is thrown by the results of experiments in which a constant quantity of nitrogen was given with two different quantities of water. The applications were made through under-laid tubes, twice a week in small and equal doses. The quantity of nitrogen used was eighty pounds per acre in the form of sulphate of ammonia with water equal to one and three acre-inches per month. The average results of these experiments are given in the following table.

TABLE No. 146.

Effect of varying the quantity of water with eighty pounds nitrogen per acre.

Unprotected plants.

Average results.

	1929-30.		1930-31.		1931-32.	
	80 lbs. nitrogen with		80 lbs. nitrogen with		80 lbs. nitrogen with	
	One acre-inch water per month.	Three acre-inches water per month.	One acre-inch water per month.	Three acre-inches water per month.	One acre-inch water per month.	Three acre-inches water per month.
Number of plants under treatment.	20	20	19	20	19	20
Flowers	228.2	241.2	198.4	275.4	189.3	264.1
Bolls	75.0	80.0	64.8	95.8	75.7	104.3
Seed-cotton in grms. (Sun-dry).	158.5	172.0	146.9	217.6	167.7	214.3
Yield per boll (Sun-dry)	2.11	2.15	2.27	2.27	2.20	2.05

The results in the three years were consistent in showing that the quantity of nitrogen being constant at eighty pounds per acre, an application of three or more acre-inches of water per month gives an appreciably larger yield of bolls and seed-cotton per plant. This means that for the full use of nitrogen applied in as high a quantity as 80 pounds, more water must be used.

(h) *Nitrous, nitric and ammoniacal nitrogen in the soil.*

Fortnightly determinations of nitrous, nitric and ammoniacal nitrogen in different layers of the soil, were made during the years 1929-30 and 1930-31. These were confined to plants receiving varying quantities of nitrogen and water through underlaid tubes and also to those in the control which received neither water nor nitrogen. The results obtained are presented in Table Nos. 244 to 279 in the Appendix. They differed in the two years. In 1929-30, the ammoniacal nitrogen in all the treated plots was distinctly higher than in the control. This did not, however, occur in the second year. With regard to nitrous and nitric forms, the plot receiving 100 pounds of nitrogen showed some difference over the control or over the forty-pounds-application plot, but it was of a very small order. These figures, therefore, do not bring out any useful information.

GENERAL CONCLUSIONS.

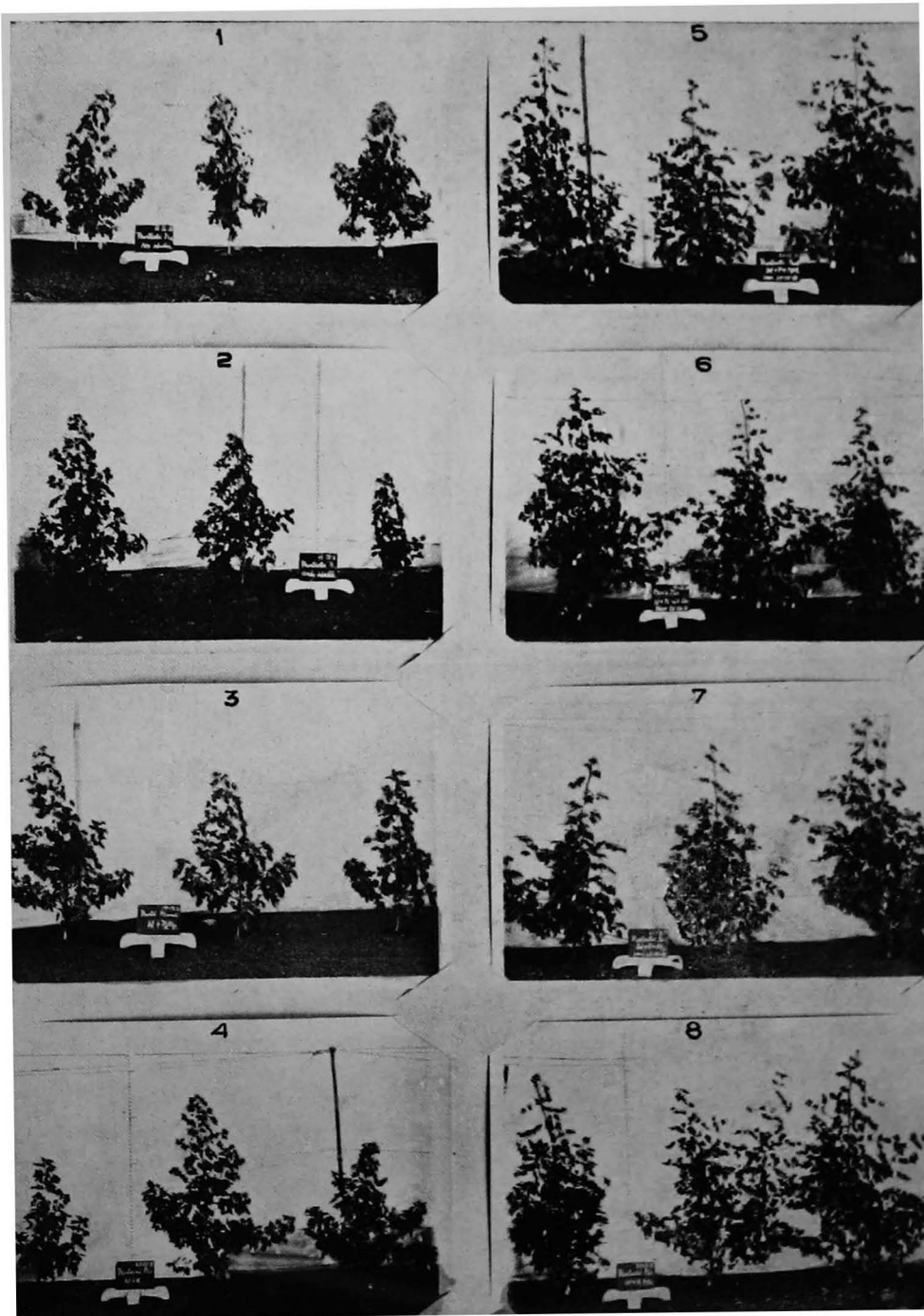
The various experiments on nitrogen application described so far lead to the following conclusions :—

1. In the Broach cotton soils, nitrogen becomes limiting at each stage, for a better production and development of various organs of the cotton plant.
2. The way in which applied nitrogen is used by the plant is determined by the stage of growth. If the application is commenced during the bud-development phase and continued throughout the flowering period, it increases the production of flower-buds and flowers and bolls without reducing in any manner the extent of shedding. If, on the other hand, nitrogen is made available at a later stage, *i.e.*, during the bolling period only, it enhances the number of flowers and bolls and increases the yield of seed-cotton per boll. In this latter case, the extent of shedding is also reduced. Further, the percentage nitrogen of the seed is also improved by the late application.
3. The same quantity of nitrogen gives widely varying results depending upon the stage of plant growth. With early applications of 40 pounds of nitrogen per acre, the yield of seed-cotton is doubled while with late applications of the same quantity of nitrogen, the yield is increased by only 50 per cent.
4. The protected plants which are normally more efficient than the unprotected in respect of yield (by forty per cent.), retain their superiority even under conditions of nitrogenous manuring. For the same quantity of applied nitrogen, the yield returns are higher in their case. Complete exclusion of the spotted boll-worm, therefore, will not only add materially to the normal yields of cotton but will also give proportionately larger returns and hence larger profits, if manured with nitrogen.

PLATE No. 10.

Effect of the application of nitrogen, potash and phosphoric acid, singly and in combination, on protected plants. Photo taken two months after the commencement of the treatment.

- (1) No water. (2) Only water. (3) Water and phosphoric acid. (4) Water and potash. (5) Water with potash, phosphoric acid and nitrogen. (6) Water and nitrogen. (7) Water and phosphoric acid with nitrogen. (8) Water and potash with nitrogen.



5. Yields go on increasing up to hundred pounds of nitrogen administered with water in the feeding layers of the soil. The data indicate that larger quantities may give still higher yields. The figures of 1929-30, in which 40, 60, 80, and 100 pounds of nitrogen were given and those of the following two years in which only forty and hundred pounds nitrogen were tried, show however that diminishing returns per pound of nitrogen begin after forty pounds of nitrogen.

I. (B) APPLICATION OF POTASH AND PHOSPHORIC ACID WITH WATER.

Preliminary trials made in the years from 1926-27 to 1928-29 with applications of potash and phosphoric acid in combination with nitrogen and water had shown that the results obtained were no better than those when nitrogen was used alone. Tests with potash and phosphoric acid were undertaken singly and also in combination with nitrogen in the years 1930-31 and 1931-32. This was done on protected plants. Ten plants were used in each set and at the depth of forty-five cms. applications were made twice a week with water at the rate of two acre-inches per month from mid-October for two months. Potash was given as sulphate of potash and phosphoric acid as sodium phosphate. Nitrogen was given as sulphate of ammonia.

The results for the two years are submitted in Table Nos. 280, 281 and 282 in the Appendix.

In the first year, the application of phosphoric acid showed no advantage but in the second year, there was an average increase of seven bolls per plant. This result does not appear to be significant as the added phosphoric acid did not affect plant growth to any appreciable extent. Given in combination with nitrogen, phosphoric acid showed no additional advantage.

(a) *Effect of the application of potash.*

The results with the application of potash were also not very encouraging. In 1930-31, there was decidedly no advantage. In 1931-32, the added fertilizer yielded on an average six more bolls. This increased number seems, however, to be the result of the plants in this set being initially superior.

Given in combination with nitrogen, potash does not lead to increased returns.

(b) *Effect of the application of full fertilizer.*

This was tried in the year 1931-32. The results are given in Table No. 282 in the Appendix. They show that the addition of phosphoric acid and potash to nitrogen does not increase the number of bolls on the plant (Plate No. 10).

GENERAL CONCLUSIONS.

Potash and phosphoric acid do not become limiting in the Broach cotton soil. Their application in combination with nitrogen does not further add to the beneficial effects of nitrogen.

II. EFFECT OF MANURES AND FERTILIZERS GIVEN WITHOUT IRRIGATION.

As already mentioned in Chapter II, the Broach cotton tract has no irrigation facilities and the cotton crop has to be grown entirely on the natural supply of soil moisture obtained from rains. Hence, although the studies on fertilizers given in combination with water are extremely valuable for understanding the food requirements of the plant, they are of little use in practice in the absence of irrigation facilities. Efforts were, therefore, in progress side by side to study the effects of manuring under natural conditions of soil moisture.

Work on this subject was originally started with the object of increasing the supply of plant-food in lower layers of the soil where the cotton plant feeds during the bolling period. The idea was to see if boll-shedding could be prevented or reduced by this means. Work of a preliminary nature was commenced in 1925-26 and continued for three years. The intended manures and fertilizers were given at the depth of thirty to ninety cms. in trenches dug between rows of plants in September or October at the close of the monsoon. The manures or fertilizers were spread in these trenches which were subsequently refilled. Both organic and inorganic manures were tried : among the former were safflower cake, castor cake, farm yard manure, and green manure with *ikad* (*Sesbania aculeata*) ; in the latter were included nitrate of soda, sulphate of potash and sodium di-phosphate and sulphate of ammonia.

The results of the preliminary trials indicated that by applying manurial substances in trenches, percentage success of flowers into bolls increased to some extent. The production of flower-buds, flowers and bolls also increased substantially. Nitrogen was by far the most effective element of plant-food. Addition of phosphoric acid or potash to nitrogen did not enhance the beneficial effects obtained by nitrogen alone. Further, of the organic and inorganic forms of nitrogen, it was the latter form that was found to be more effective. Both sulphate of ammonia and nitrate of soda were equally good in their effects.

Manuring in deep trenches, however, is not possible for adoption into practice. From 1928-29, therefore, the tube plough which works to a depth of about ten cms. was selected and used as a suitable implement for giving fertilizers in furrows. Applications on ridges were made by means of a two-coultured-drill which delivered the fertilizer on both sides, fifteen cms. away from the plants.

Another observation that emerged from the preliminary trials was that for a better use of manures and fertilizers given in October, water became limiting. The only way to secure more water was to apply the fertilizer during the rainy season. From 1928-29, therefore, a new series was started in which fifty pounds of nitrogen per acre were administered in the form of sodium nitrate in three plots at three different times, namely, at the first opportunity after sowing in July, towards the end of August, and at the close of the monsoon in October.

This experiment was tried on a plot scale, in four replications. Each plot was two cents in area excluding a row of plants all round. The crop was grown on ridges spaced four feet apart with plants at distances of three feet on the ridge. In the first block, periodical growth counts were maintained on sets of ten plants

in each plot. Besides, sets of five plants were protected against the spotted boll-worm to study the effect of the fertilizer on them. As protected plants give more yield, the yield data from the first block were not comparable with those of the other three blocks.

The results (Table No. 283 in the Appendix) showed that nitrate of soda produced equally good effect on the production of flower-buds, flowers and bolls when given in July or August. It also increased the success of buds into flowers by four and seven per cent. respectively. This beneficial effect was also noticed in the October application.

The yield figures of plots for the three replications are given in Table No. 284 in the Appendix. They show that the same quantity of nitrogen, namely, fifty pounds per acre, gave different degrees of increase. Yields rose by ninety-six, seventy and thirty-eight per cent. over the control with July, August and October applications respectively, all of which were statistically significant.

In the following year (1929-30), the same series was repeated in a like manner. The only change made from this year onwards was the substitution of sulphate of ammonia for sodium nitrate. The results obtained confirmed the finding of the preliminary trials that the effect of the fertilizer depends on the amount of moisture in the soil after its application. The distribution of rainfall this year was abnormal and very little effective rain was received after application of sulphate of ammonia even in July. Out of the forty-eight inches of rainfall of that year, as much as forty-four fell in the last week of June and in the first fortnight of July. On this account, the seedlings of the first sowing were completely damaged and resowing was resorted to on 15th July. The results are given in Table Nos. 285 and 286 in the Appendix. They show that in none of the plots receiving the fertilizer was there any significant increase over the control in respect of yield.

It is necessary to mention that the fertilizer was not lost but remained in the soil and became available to the following crop of jowar grown in rotation with cotton. The residual effect on this crop was noticeable from the beginning and in the end it was found that the increase both in grain and fodder (straw) over the control was about 40 and 240 per cent. respectively. This increase, however, left no profit but was just sufficient to meet the cost of the manure applied.

At the end of the crop season of 1929-30, it was tentatively concluded that,

(1) the cotton plant responds to nitrogenous treatment by increasing the yield of seed-cotton, and that

(2) with the same quantity of nitrogenous fertilizer, the yield varies according to the time of application, earlier application giving better returns.

The next question was, therefore, to ascertain the optimum quantity of the fertilizer and the best position with reference to time of its application. The three questions, namely, the quantity, time and position of application of the nitrogenous fertilizer (sulphate of ammonia), were therefore combined into a single experiment after Fisher (1926). Three quantities of nitrogen—twenty, thirty and forty pounds of nitrogen, two timings of application—July and August, and two positions of

application—ridge and furrow,—were the variants. There were thus twelve treatments as under,

20 J. R.	20 J. F.	20 A. R.	20 A. F.
30 J. R.	30 J. F.	30 A. R.	30 A. F.
40 J. R.	40 J. F.	40 A. R.	40 A. F.

where the figures 20, 30 and 40 refer to the quantity of nitrogen in pounds per acre and where J. means July, A. means August, R. means ridge and F. means furrow.

This experiment was carried out for two years, 1930-31 and 1931-32, on a plot scale in four replications with randomised treatments. In 1930-31, there were four controls in each block. These were reduced to only one in 1931-32. The area used for the experiment in 1931-32 was the same as that in 1929-30 which came in rotation. In this area, there were only twelve plots in each block. On this account, the treatment of 30 A.F. was required to be deleted to make room for a control plot. Sowing was always done on ridges spaced four feet apart, the plants being situated on the ridge at three feet distances. The fertilizer mixed with dry soil to increase the volume for facilitating even distribution, was applied on the ridge with the help of a two-coultered drill and in furrows with the help of a tube plough.

Rainfall after the applications in July and August in both the years was favourable. Precipitation in 1931-32 was rather too heavy and prolonged, the total rainfall being 53·38 inches. In 1930-31, it was 41·28 inches. Fortnightly distribution of rainfall in the two years is shown in Table No. 147.

TABLE No. 147.

Fortnightly rainfall in inches during the years 1930 and 1931.

Year.	July.		August.		September.		October.	
	I.	II.	I.	II.	I.	II.	I.	II.
1930	10·41	5·54	2·19	0·26	5·34	0·06	0·95	0·10
1931	16·67	9·12	10·34	4·70	0·38	3·50	8·26	0·06

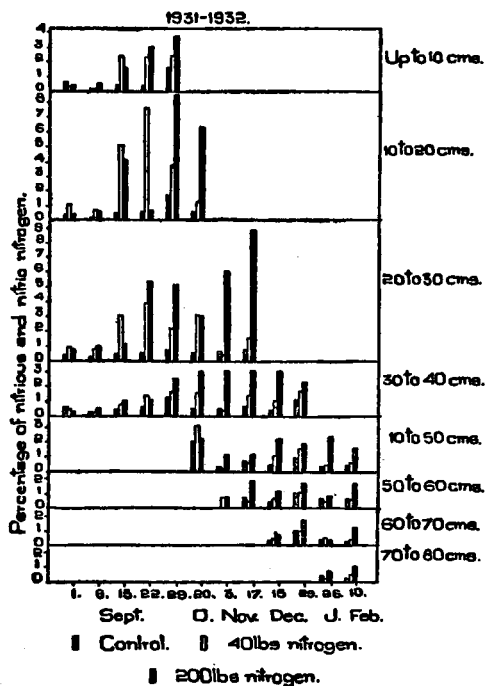
Before discussing the results of the above experiment, it will be of advantage to ascertain the downward movement of applied nitrogen. An attempt to find out the depth to which the nitrogen applied in July, moves into the soil under the influence of rainfall, was made in the year 1931-32. Different quantities of nitrogen were applied in a plot situated in continuation with the replication series. No crop was grown on this land and forty and two hundred pounds of nitrogen as sulphate of ammonia were applied on 15th July 1931 in the furrows at the depth of ten cms. Determinations on soil-moisture, ammoniacal, nitrous and nitric nitrogen were made in successive layers of ten cms. each, below the place of application. Similar estimations were also carried out in a control plot. Samples from four layers were analysed at a time. As the nitrogen moved downwards, the determinations were gradually shifted to lower layers. The estimations were weekly in September and at longer intervals thereafter. The results

are given in Table Nos. 287, 288 and 289 in the Appendix and in Graph No. 56. The results show that,

- (1) Addition of sulphate of ammonia to a fallow plot even in quantities up to 200 pounds of nitrogen per acre did not affect the moisture content of the soil.
- (2) The ammoniacal nitrogen in the various layers was also not affected.

GRAPH No. 56.

Percentage of nitrous and nitric nitrogen in several layers of the soil in the uncropped plots treated with 40 and 200 pounds of nitrogen per acre.



(3) The most marked effects of the applied nitrogen were noticed on the quantities of nitrous and nitric nitrogen. These were always more in the forty-pound-application plot than in the control and were still higher in the plot receiving 200 pounds application. This means that the ammoniacal nitrogen was nitrified and was diffused down into lower layers.

(4) The increase in nitrous and nitric nitrogen in the treated plot began from about the middle of September, i.e., eight weeks after the application.

(5) Increase in nitrous and nitric nitrogen in the treated plots was noticeable in layers up to 40 cms. from the soil surface during the month of October. From November onwards it steadily descended and reached the depth of 80 cms.

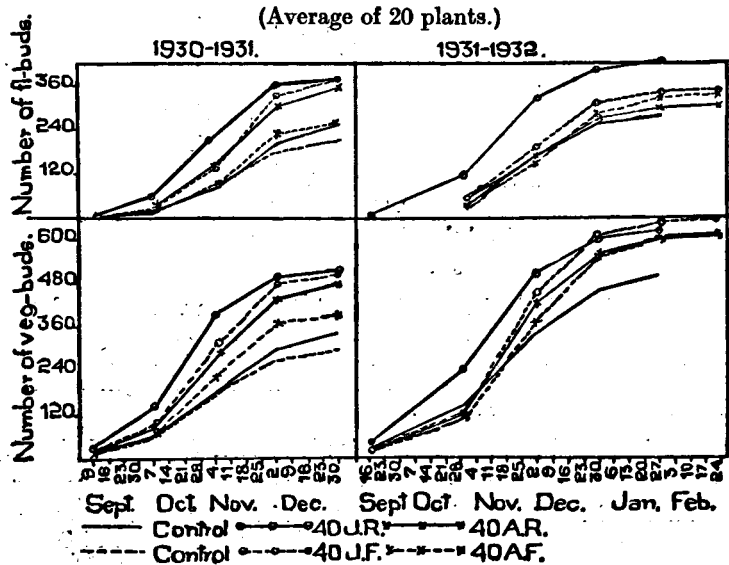
In a year, therefore, having a rainfall like that of 1931-32, nitrogen applied as sulphate of ammonia may travel down into the soil up to a depth of 80 cms., if applied in large quantities of 200 pounds nitrogen per acre. With 40 pounds application, it may go down up to about 50 cms. only and become available to the crop at later stages of growth.

We may now return to the experiment proper. Growth counts were restricted in both the years to plants receiving the highest quantity of the fertilizer, namely, 40 pounds nitrogen in the first replication. There were four such plots and the fifth was the control. Twenty plants in two rows of ten each, were earmarked for growth counts. The object of these counts was to observe the effect of the fertilizer on the production of buds and bolls and the extent to which they were retained. The average results for the two years are given separately in Table Nos. 290 and 291 in the Appendix. In both the years, the applied nitrogen in all the four plots increased the production of vegetative buds, flower-buds, flowers and bolls. The effects of July-application were more marked and consistent. These beneficial effects, however, failed to improve the rate of success of buds into flowers or of flowers into bolls. There was, in fact, a tendency for the percentage success of buds into bolls to decrease particularly in the July-application. The higher yield of bolls obtained in all the treatments was, therefore, only a result of larger plants.

Of more interest are the figures of progressive production of vegetative buds and flower-buds. These are presented in Table Nos. 292 and 293 in the Appendix and are reproduced below in the Graph No. 57.

GRAPH NO. 57.

Progressive production of vegetative buds and flower-buds in plants receiving forty pounds of nitrogen at different times in the season and in different positions.



It will be evident from the above graph that the period and extent of the intense production of vegetative buds and flower-buds differed in the different treatments. The earliest availability of the applied nitrogen was seen in plants receiving the fertilizer on the ridge in the month of July. Observations showed that these plants stood out markedly in their growth from the general unmanured crop, within a month from the date of application, and continued to do so till about the end of November. The reason of the earliest availability of nitrogen was the fact that the fertilizer was administered only 15 cms. away from the plants on both sides of the row so that it was within their easy reach during the seedling stage. The effect of the fertilizer continued till the end of October or November, depending upon the nature of the season.

When the fertilizer was given in furrows in July, its effect did not become visible for over ten weeks after the application. This was, because, the applied nitrogen remained at a distance of two feet from the plants. But once the roots got extended and reached this distance, the growth of these plants steadily intensified to a maximum value reached two to three weeks later than in plants under the ridge-application. These plants also remained dark green for a longer time.

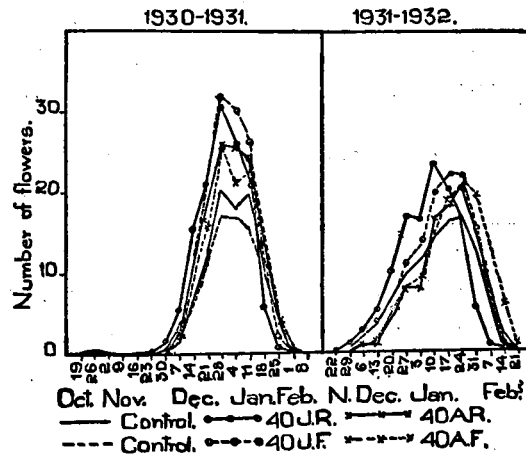
Application made in August on the ridge, became effective, more or less at the same time as the July-furrow application. Given in August in furrows, the availability of nitrogen was still delayed.

Weekly flowering of plants in these plots is shown in Graph No. 58 and Table Nos. 294 and 295 in the Appendix. It will be seen from this graph that flowering became intense by July-application and the crop got ready for harvest earlier by a week to ten days in July-ridge-plots. In 1931-32, flowering was delayed by a week to a fortnight by August-applications.

GRAPH No. 58.

Weekly flowering per plant in plots receiving forty pounds of nitrogen at different times and at different positions.

(Average of twenty plants.)



These differences in the effect of nitrogen applied at different positions and at different times in the season suggest that the time of intensified growth can be altered within reasonable limits and that the crop can be hastened to ripen earlier by a week to ten days if necessary. Applying the fertilizer near the young seedlings in July makes it available to the plant from quite an early stage and ensures the growth of a larger plant. The effects of later applications and those made in furrows two feet away from the plants, are governed by the amount of rainfall. The best plan, therefore, seems to be that the fertilizer be given in July near the seedlings.

The yield figures for the different treatments are also instructive. These are reproduced together with their statistical significance in Table Nos. 296 and 297 in the Appendix. Average yield of the four replications is extracted from those statements in Table No. 148.

TABLE No. 148.

Average yield of seed-cotton in pounds per plot.

(Area of each plot was three cents.)

1930-31.

Quantity of nitrogen applied per acre.	July ridge.		July furrow.		August ridge.		August furrow.	
	Yield in lbs.	Increase over control. %	Yield in lbs.	Increase over control. %	Yield in lbs.	Increase over control. %	Yield in lbs.	Increase over control. %
20 pounds ..	16.91	19	19.20	36	16.22	15	16.88	19
30 ..	19.31	36	17.61	24	17.47	23	17.29	22
40 ..	20.04	42	20.20	43	20.18	43	19.02	34
Control ..	14.16	..	14.16	..	14.16	..	14.16	..

(Area of each plot was five cents.)

1931-32.

20 pounds ..	31.47	20.9	29.82	14.6	29.92	15.0	29.42	13.1
30 ..	33.90	30.3	31.00	19.1	36.00	39.4	Not tried.	
40 ..	36.78	41.4	37.32	43.4	31.12	19.6	30.12	15.8
Control ..	26.02	..	26.02	..	26.02	..	26.02	..

The results were consistent in both the years in showing that nitrogen was effective in increasing the yield of seed-cotton. The magnitude of increase, however was

more in the July-applications than in the August ones. Further, the yield rose up with the increase in the quantity of nitrogen applied. Taking the July results into consideration, it is seen that the applications on the ridge gave better results even for lower quantities of nitrogen. With forty pounds, an increase in yield of about forty per cent. was obtained in both the ridge and furrow July-treatments.

In 1931-32, the increase in yield was consistently significant in all the eleven treatments over the control. In 1930-31, they were not so in plots receiving twenty pounds nitrogen in July-ridge, twenty pounds nitrogen in August-ridge, and twenty pounds nitrogen in August-furrow.

The return of seed-cotton per acre for each pound of nitrogen applied in these experiments is shown in Table No. 149.

TABLE No. 149.

Return of seed-cotton per acre, per pound of nitrogen.

(Average of four replications.)

1930-31.

Nitrogen applied per acre.	J. R.		J. F.		A. R.		A. F.	
	Per acre.	Per pound of nitrogen.	Per acre.	Per pound of nitrogen.	Per acre.	Per pound of nitrogen.	Per acre.	Per pound of nitrogen.
20 pounds ..	93	4.65	170	8.5	70	3.5	91	4.55
30 ,, ..	174	5.8	117	3.9	112	3.73	106	3.53
40 ,, ..	198	4.95	234	5.85	203	5.07	164	4.1

1931-32.

20 pounds ..	110	5.5	77	3.85	79	3.95	69	5.45
30 ,, ..	159	5.3	101	3.37	201	6.7	..	..
40 ,, ..	217	5.42	228	5.7	103	2.57	83	2.07

J=July. A=August. R=Ridge. F=Furrow.

The general trend of the return of seed-cotton per pound of nitrogen was consistently steady between four to five pounds, when nitrogen was applied in July on the ridge. In the other applications, the figures for seed-cotton varied a good deal. Nevertheless, they also show that in the July-ridge-application, diminishing returns per pound of added nitrogen did not commence even up to forty pounds.

GENERAL CONCLUSIONS.

Sulphate of ammonia is a quickly acting form of nitrogen in the Broach tract. For realizing the maximum benefit, the nitrogenous fertilizer must be applied in July, early enough to get sufficient rain water to make it available to the plant.

It is best to deliver the fertilizer on the two sides of plant rows at a distance of about fifteen cms. so that it begins to be available to the young seedlings within a short time. Applications made in furrows two feet away from the row of plants become available later when the plant has extended its roots to that distance.

Applications made near the row of plants are effective even in smaller quantities like twenty pounds of nitrogen per acre. In furrow-applications, *i.e.*, those made two feet away from the plant, they are less effective in smaller quantities as twenty and thirty pounds. With larger quantity like forty pounds of nitrogen, however, the increase in yield is more or less equal in closer or wider applications.

When given in July on ridge, *i.e.*, near the plants, every pound of the added nitrogen is able to increase the yield of seed-cotton by four to five pounds per acre. This rate of increase in yield is obtained with smaller as well as with bigger quantities up to forty pounds nitrogen per acre. It would pay to use larger quantities as there is a saving in the cost of application.

In case of the failure of rains, the cotton crop gets no advantage of the applied nitrogen. It is, however, not lost but remains in the soil and becomes available to the succeeding crop (jowar) grown in rotation. The increase in the yield of this crop is just sufficient to meet the cost of the fertilizer.

The soils in the Broach cotton tract are definitely poor in nitrogen and but for their great depths which are tapped by the deep-rooted cotton plant, the yields would have been much lower than what they are at present. The other ingredients of plantfood (potash, phosphoric acid and lime) including moisture, are sufficient in these soils to sustain a much bigger yield—at least a fifty per cent. bigger yield. The results of 1928-29 show that they are present in quantities sufficient even for sustaining a crop of double the present size.

These results are of great practical importance as it is possible to build up the nitrogen fertility of the soil by means which would be within the easy reach of every cultivator. Some light on the way in which the fertility of the soil could be improved is thrown by the results of preliminary experiments on green manuring to be presently described.

GREEN MANURING.

Mention has already been made of the preliminary trials with green manuring in the years 1925-26 and 1926-27. Further attention was given to green manuring especially because it does not cost any out-of-pocket expenditure to the cultivator, if he is prepared to spend the necessary labour for it. *Sesbania aculeata*, which was used for green manuring is a common weed in this tract, which grows luxuriantly even under wet conditions in cotton fields. This plant has long been in use for green manuring in Madras and Bengal. During the first two years, the necessary quantity of green manure was brought from surrounding grass-lands. This source though quite adequate for experimental purposes, would be insufficient for use on a large scale. The first step was, therefore, to grow a crop of *Sesbania aculeata*, locally known as *ikad*, in situ with cotton for using the same as green manure

on the same land. This was done in 1927-28 by sowing broadcast the seed along with cotton.

The green manure crop grown in situ, grew luxuriantly but the cotton plants got smothered and grew lanky. The green-manure crop was uprooted and incorporated with the soil in furrows. Being thus exposed to the sun, the cotton plants dropped all their leaves owing to a sudden change in their environment. New growth was steadily put on, though its every phase was seriously delayed. The plants failed to grow to their normal stature and remained small in their size. The yield was, therefore, less than that of the control plants.

In another plot, green-manure (*Sesbania aculeata*) brought from outside area was used during the last week of September at the rate of 10,000 pounds per acre. This was incorporated with the soil at the depth of 45 to 67.5 cms., in the midst of furrows made six feet apart. Determinations of soil moisture, nitrous and nitric nitrogen in this layer were made every fortnight commencing from 19th December, that is, after twelve weeks from the time of application. The results of soil analyses in the furrows are given in Table No. 150. Similar data for the control plot are

TABLE NO. 150.

Nitrogen and moisture contents in the soil at the depth of 45 to 67.5 cms.

(Results expressed on oven-dry basis.)

Period ending	Plot receiving green manure.		Control.	
	Moisture per cent.	Nitrous and nitric nitrogen in m. grms. per 100 grms. of the soil.	Moisture per cent.	Nitrous and nitric nitrogen in m. grms. per 100 grms. of the soil.
19th December, 1927 ..	26.09	0.161	24.33	0.118
2nd January, 1928 ..	23.93	0.205	22.88	0.183
16th January	25.31	0.307	25.63	0.091
30th January	26.10	0.133	24.84	0.059
13th February	23.75	0.106	23.09	0.058
27th February	24.18	0.246	23.89	0.143
12th March	20.93	0.338	21.65	0.077

also reported in the same table. Nitrous and nitric nitrogen were at a higher level in the plot receiving the green manure. The moisture percentage in this plot was, however, almost the same as that in the control. The cotton crop treated with green manure developed dark green colour and yielded more flower-buds, flowers and bolls per plant. On an average the number of mature bolls per plant increased by seventeen per cent.

An attempt was made this year to ascertain the relative merits of some plants suited for green manuring. Four leguminous plants were selected. These were,

Sann (*Crotolaria juncea*), *Udid* (*Phaseolus radiatus*), wild indigo (*Indigofera granulosa*) and *ikad* (*Sesbania aculeata*). These were grown in a separate plot. The crop of sann was not healthy and the plants were less succulent and more fibrous. Udid also did not grow well. Wild indigo grew rather slowly. This crop, however, was quite healthy and developed root-nodules extensively. *Sesbania aculeata* (*ikad*) was found to be the fastest grower in the lot. Excepting Sann, the remaining three crops were uprooted and transferred to three different plots in the experimental area where they were incorporated with the soil in furrows between ridges carrying the cotton crop. All these three types of green manure showed beneficial effect on the yield of the cotton crop as will be seen from the results given in Table No. 298 in the Appendix. The last two types of plants (indigo and *ikad*) are more suited for green manuring in the Broach tract, as they produce more organic matter in the same period of growth.

Attention was concentrated in the following year (1928-29) on two main issues, namely, (a) growing green manure crop in situ without injuring the cotton plants by crowding and shading, and (b) making the green matter more effective. The green manure crop was raised this year in strips of two feet, in furrows between the ridges spaced four feet apart on which cotton was grown. The green manure crop was thus one foot away from the cotton plants. It was also uprooted earlier (16th August) than in the previous year before it was too tall to shade the cotton rows. The weight of green matter obtained was about 5,000 pounds per acre, the whole of which was incorporated with the soil in furrows made by a McCormick cultivator.

The disadvantages of raising the green manure in situ experienced in 1927-28 did not appear this year. The cotton plants grew quite normally in all respects.

Observations in the preceding year indicated that the green manure crop competed during its growth with cotton seedlings. With a view to overcoming this difficulty, the cotton rows were fertilized with a small dose of nitrogen at the rate of $12\frac{1}{2}$ pounds of nitrogen per acre as sulphate of ammonia.

An attempt to increase the usefulness of the added green matter was also made this year by (1) charging the green manure with a dressing of twenty-five pounds of nitrogen alone per acre as nitrate of soda and (2) by adding the same quantity of nitrogen in combination with fifty pounds of phosphoric acid per acre as superphosphate. These quantities of nitrogen were in addition to the twelve-and-a-half pounds given to the plants during the seedling stage.

These treatments were tried on a plot scale in three replications. The area of each plot was three cents excluding a row of plants all round. The results of yield are given in Table Nos. 283 and 299 in the Appendix. Although the addition of twenty-five pounds of nitrogen to green manure enhanced the yield appreciably over the plants without any treatment, it was not possible to draw any conclusion in the absence of a suitable control receiving a dose of twenty-five pounds of nitrogen alone. The addition of phosphoric acid to nitrogen in combination with green manure, showed no advantage whatever.

Further work on green manuring, particularly with reference to the methods for its quick decomposition so as to make it more effective during the year of its application, involves a critical laboratory and field study. It was not possible for us to devote more attention to this subject owing to increased work in other directions. The problem of building up steadily the nitrogen fertility of the soil by green-manuring, is a problem that needs a long-range-research. Investigations

on the lines referred to above, hold out a great promise of success. This expectation is based on the results of an experiment on the application of farm-yard manure in cotton years, conducted by the Bombay Agricultural Department at the Agricultural Station, Surat. Plants were grown at a distance of every two feet on ridges 14 inches high, the ridges themselves being five feet apart. Farm-yard manure was applied in furrows prior to sowing. The results are reproduced below from the records of the Agricultural Station, Surat.

TABLE NO. 151.*

Yield of cotton in lbs. per acre, showing the cumulative effect of addition of farm-yard manure in cotton years.

(Average of duplicate plots.)

Cotton year.	Plot A.	Plot D.	Per cent increase.
	Addition of ten tons of farm-yard manure per acre in alternate years.	Control. (Without manure)	
1932-33	757	660	14.7
1924-25	1,153	1,000	15.3
1926-27	585	431	35.7
1928-29	1,137	635	79.0

These results show that with regular additions of farm-yard manure at the rate of ten tons per acre in alternate years, the yields of cotton go on steadily increasing from fifteen per cent. to seventy-nine per cent. They, further, suggest that addition of organic matter in the form of green manure activated by some means, may also steadily increase the fertility of the soil.

The supply of farm-yard manure in any tract is bound to be limited and hence other sources of organic matter such as green manure, compost, poudrette, etc., must be tapped. Most of the organic matter belonging to these sources is, at present, generally neglected.

C. SUBJECTING THE PLANT TO VARIOUS MANIPULATIONS.

With a view to study its growth behaviour and final performance under a variety of conditions, the cotton plant was subjected to such manipulations as de-foliation, de-budding, de-floration, de-fruited, stem-ringing, root-pruning, etc. These experiments will now be given in the order named.

I. DE-FOLIATION.

During the first year of the investigation on the causes of bud and boll-shedding, de-foliation was carried out to various degrees on the unprotected plants. The details of this experiment and the results obtained therefrom are given below.

(a) Complete de-foliation.

All leaves on a set of five plants were removed on the 8th February 1924, when the spotted boll-worm was the least active. The plants were situated in one of the border rows of a field plot and had in all 485 buds together, at the time of

* The authors are indebted to the authorities concerned for the privilege of using the data.

de-foliation (Table No. 300 in the Appendix.). The result of the wholesale removal of leaves was seen during the period between the third and the sixth day from the date of the operation when 430 forms (88.6 per cent.) dropped down. Observation showed that all the flower-buds without exception and all the young bolls were cast off by the plant. It was only the bolls comparatively advanced in their growth that survived and remained apparently unaffected.

(b) *Partial de-foliation.*

Partial removal of leaves was carried out in several ways by removing leaves from such parts of the plant as the upper half, lower half, side half, etc. In each case five plants in border rows were selected and partially de-foliated on the 18th February, 1924. The results (Table No. 152) obtained indicated that the extent of

TABLE No. 152.

Performance of unprotected plants under de-foliation.

(Total of five plants.)

Operation.	Number of reproductive organs on the operated or un-operated parts.	Sheds after the operation.	Per cent shedding.
Removal of all leaves from a side-half of the plant.	263	200	76.04
The other not operated half ..	171	69	40.35
Removal of all leaves from the upper half of the plant.	393	278	70.73
The lower unoperated half ..	222	96	43.24
Removal of all leaves from the lower half of the plant.	182	138	75.82
The upper unoperated half ..	237	96	40.51

bud and boll shedding was appreciably higher in the de-foliated than in the non-de-foliated parts of the plant.

There is thus a close relationship between leaf surface and the success of fruiting forms. Complete or partial de-foliation leads to a corresponding reduction in the daily output of elaborated plant food and occasions a heavy shedding of buds and fruits. These observations are in harmony with those made by Eaton (1931). According to him, the number of bolls that can mature on the plant is not only related to favourable conditions of environment but is also directly related to the leaf area of the plant. The above results indicate in no uncertain manner that the plant endeavours to meet internal food-deficiency by decreasing the number of feeding forms.

II. DE-BUDDING.

De-budding experiments were carried out on protected plants in the years 1930-31 and 1931-32. After cessation of rains, all the flower-buds that were visible on the plants were removed once a week. In both the years, de-budding was carried out for four different periods in four sets of ten plants each. In 1930-31, however, the last set had only five plants owing to an accident to the other five.

The effects of this operation on the periodical and total production of flower-buds are shown in Table No. 153.

TABLE No. 153.

Periodical and total average production of flower-buds on plants subjected to de-budding for various weeks.

1930-31.

Pruning done for weeks.	Set I. (Control).	Set II. 3 weeks.	Set III. 6 weeks.	Set IV. 11 weeks.	Set V. 15 weeks.	Set VI. 19 weeks.
Pruning done up to	..	..	31st Oct.	4th Dec.	1st Jan.	29th Jan.
Period ending						
3rd October ..	25.6	Not tried.	24.3	22.3	24.1	30.0
31st October ..	137.0	Do.	95.7	122.3	102.3	97.6
18th November ..	86.9	Do.	132.9	212.6	200.9	151.0
26th December ..	5.1	Do.	75.5	159.6	179.6	186.0
23rd January ..	..	Do.	0.2	60.9	157.3	139.2
20th February ..	..	Do.	..	..	12.0	162.2
20th March ..	..	Do.	..	..	..	19.6
Total buds produced ..	254.6	Do.	328.6	577.7	676.2	785.6
Total buds pruned ..	..	Do.	86.1	273.0	479.6	532.0
Difference ..	254.6	Do.	242.5	304.7	196.6	253.6

1931-32.

Flower-bud pruning done for weeks.	Set I. (Control).	Set II. 3 weeks.	Set III. 6 weeks.	Set IV. 10 weeks.	Set V. 14 weeks.	Set VI.
Flower-bud pruning done up to		12th Nov.	3rd Dec.	31st Dec.	28th Jan.	
Period ending						
1st October ..	5.9	2.3	0.9	0.9	1.3	Not tried.
22nd October ..	33.5	28.7	18.2	17.1	19.9	Do.
29th October ..	27.9	14.4	13.8	17.8	26.6	Do.
5th November ..	23.1	27.5	23.2	16.0	16.7	Do.
12th November ..	37.1	34.8	29.3	29.5	36.2	Do.
19th November ..	41.5	55.9	44.3	40.0	53.2	Do.
3rd December ..	94.5	87.5	122.0	85.7	111.3	Do.
31st December ..	74.9	121.8	186.7	218.8	224.2	Do.
27th January ..	0.8	..	54.0	149.6	231.8	Do.
25th February ..	..	..	..	16.2	137.9	Do.
11th March... ..	..	..	..	..	20.9	Do.
Total buds produced ..	339.2	372.9	492.4	591.6	880.0	Do.
Total buds pruned ..	..	42.3	129.7	260.5	576.9	Do.
Difference ..	339.2	330.6	362.8	331.2	303.1	Do.

The results of both the years were consistent in many respects. Comparing first the final performance in the different sets, it is seen that total production of flower-buds went on rapidly increasing with the increase in the period of pruning. This means that if the plant is not allowed to retain and develop any of its flower-buds by artificial removal, it gives rise to new flower-buds and thereby recuperates the loss. The noteworthy feature of this recuperating power is that although an increasingly large number of flower-buds is removed in the different sets, the new production after stoppage of the operation in each set is almost the same and equal to that in the control. This is more striking in the year 1931-32. The results further indicate that de-budding lowers for some time the rate of new production of flower-buds as compared with that in the control. Later on, the rate rises and becomes more intense as the period of operation is prolonged.

Continued de-budding increases the production of flower-buds and incidentally that of the subtending leaves. As these leaves remain on the plant when the flower-buds are removed, the increased leaf-surface (Plate Nos. 11, 12, 13 and 14) leads to a greater output of elaborated plant food and raises, in consequence, the rate of flower-bud production.

(a) *Effect of de-budding on the production of vegetative buds.*

Total number of vegetative buds produced per plant in the different sets is shown in Table No. 154. Periodical production is shown in Table No. 301 in the Appendix.

TABLE No. 154.

Total number of vegetative buds in various sets of de-budded plants.

(Average results.)

1930-31.

	Set I. (Control).	Set II. 3 weeks.	Set III. 6 weeks.	Set IV. 11 weeks.	Set V. 15 weeks.	Set VI. 19 weeks.
Number of vegetative buds.	232.1	Not tried.	262.4	348.6	382.6	426.8
Ratio of vegetative buds to flower-buds.	0.91	Do.	0.80	0.60	0.57	0.54

1931-32.

	(Control).	3 weeks.	6 weeks.	10 weeks.	14 weeks.	
Number of vegetative-buds.	326.3	359.0	427.7	413.2	634.2	Not tried
Ratio of vegetative buds to flower-buds.	0.96	0.96	0.87	0.70	0.72	Do.

PLATE NO. 11.

Plant scaffolding in protected plants where flower-buds were removed weekly up to the end of November, 1931.



For Control see Plate No. 14.

PLATE NO. 12.

Plant scaffolding in protected plants where flower-buds were removed up to the end of December, 1931.



For Control see Plate No. 14.

PLATE NO. 13.

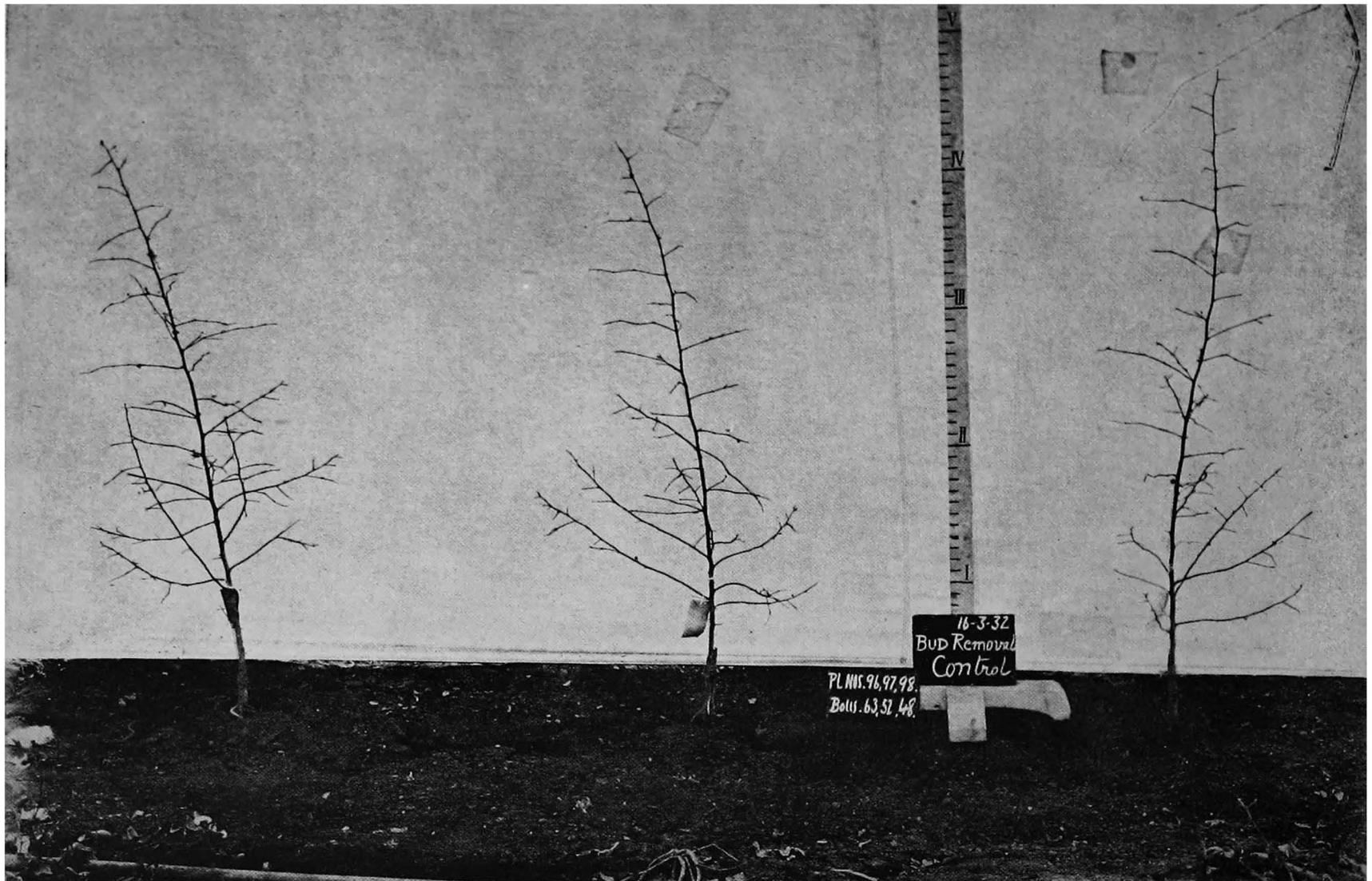
Plant scaffolding in protected plants where flower-buds were removed up to the end of January, 1932.



For Control see Plate No. 14.

PLATE NO. 14.

Plant scaffolding in protected plants, serving as control to those where flower-buds were removed up to the end of November, December and January, 1932.



As in the case of flower-buds, the number of vegetative buds also increases as the operation of de-budding is prolonged. The net result is to increase the number of leaves and thereby the daily output of elaborated plant-food.

An idea of the degree of stimulus given to the production of the two kinds of buds,—vegetative and reproductive—can be had from the figures of the ratio of the number of vegetative buds to flower-buds. The ratio tends to decline, indicating that the plant utilises its energy to a greater extent in the production of flower-buds as the operation of de-budding is prolonged.

(b) *Effect of de-budding on flower-production.*

Although a large number of flower-buds are incepted after the stoppage of de-budding, the plant is unable to retain all of them and develop into flowers. The number of flowers produced per plant in the different sets is given in Table No. 155.

TABLE No. 155.

Average production of flowers in plants subjected to de-budding for various periods.

1930-31.

	Set I. (Control).	Set II. 3 weeks.	Set III. 6 weeks.	Set IV. 11 weeks.	Set V. 15 weeks.	Set VI. 19 weeks.
Number of flowers per plant.	96.7	Not tried.	117.9	148.7	116.3	82.8

1931-32.

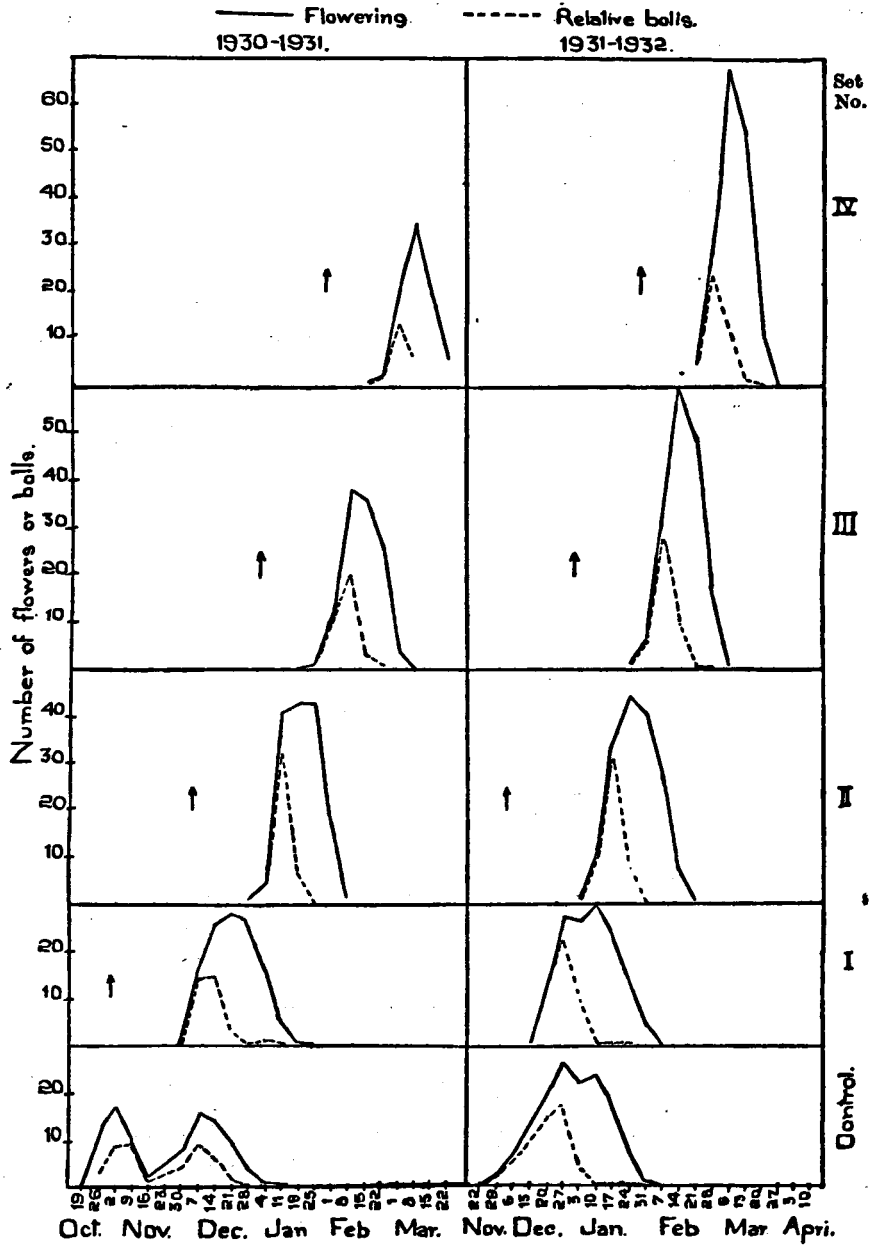
	(Control).	3 weeks.	6 weeks.	10 weeks.	14 weeks.	
Number of flowers per plant.	139.2	140.9	167.3	167.1	168.3	Not tried.

In both the years, removal of flower-buds for varying periods up to fourteen weeks, benefited the plant in the production of flowers, the number of which was always greater than that in the control. In 1930-31, however, when the operation was carried too long, *i.e.*, for nineteen weeks, the result was slightly unfavourable. In the same year, the number of flowers produced in the fifteen-weeks-set was less than in the eleven-weeks-set, but this seems to be due to the number of flower-buds being comparatively less in this set.

Records of daily flowering were maintained in all the sets in the two years of the experiment. Weekly averages based on these figures are reproduced in Table Nos. 302 and 303 in the Appendix. These are shown in the Graph No. 59. The general nature of the flowering curves in both the years in the different comparable sets was very similar. The rate of flowering got intensified and the flowering curves assumed steeper forms as the period of de-budding was prolonged. This was partly a reflection of the intensified flower-bud production in the respective sets and

GRAPH No. 59.

Weekly average production of flowers and relative bolls in protected plants subjected to de-budding for various periods.



partly a result of the comparatively shorter time taken by flower-buds to grow into flowers as the operation of de-budding was prolonged. This will be evident from the data in Table No. 156. From the same table and from the foregoing flowering curves,

TABLE No. 156.

Interval between stoppage of de-budding and commencement of flowering and the span of flowering period in the de-budding experiment.

1930-31.

	Set I. (Control).	Set II.	Set III.	Set IV.	Set V.	Set VI.
Interval in weeks between stoppage of de-budding and commencement of flowering.	..	Not tried.	5	4	4	3.
Span of flowering period in weeks ..	10	Do.	6	5	5	5

1931-32.

Interval in weeks between stoppage of de-budding and commencement of flowering.	..	5	5	4	3	Not tried.
Span of flowering period in weeks ..	9	7	6	5	5	Do.

it will be seen that the span of flowering became shorter as the period of bud-pruning was increased. These characteristics of the flowering curves again lend support to the view that the larger leaf surface created as a result of de-budding, increases the supply of elaborated plant-food in the plant and most of this is at the disposal of the newly set flower-buds and hence their growth in larger numbers.

Counts on flower-bud formation were of longer intervals and, therefore, weekly data on this subject are not available as in the case of flowers. Even then a comparison between flower-bud formation, flowering and successful boll setting from flowers of the respective weeks (Table Nos. 302 and 303 in the Appendix) shows that as the flowering and boll setting rise, flower-bud formation declines and in many cases ceases when most of the bolls are set on the plant. This indicates a competition for food in the plant.

(c) *Effect of de-budding on boll production and on the yield of seed-cotton per boll.*

The number of bolls and weight of seed-cotton produced per plant in the various sets are reproduced in Table No. 157 for the two years. The same table also contains information on the sun-dry weight of plant scaffolding.

Although the loss of flower-buds caused by pruning was made up by new production and although the number of flowers increased as a result of this operation, these beneficial effects did not extend further. There was on the contrary, a tendency for the boll production to go down. In no set was the number of bolls equal to that in the control. Further, the yield of seed-cotton per boll also declined as the

TABLE No. 157.

Final average performance of protected plants under flower-bud pruning experiments.

1930-31.

	Set I. (Control.)	Set II.	Set III.	Set IV.	Set V.	Set VI.
Number of bolls	46.3	Not tried.	33.4	43.4	34.8	20.6
Weight of seed-cotton in grms. ..	84.40	Do.	70.95	79.35	48.67	22.20
Weight of seed-cotton per boll in grms.	1.8	Do.	2.1	1.8	1.4	1.1
Weight of plant-skeleton in grms. ..	46.85	Do.	48.50	71.10	76.30	73.20
Ratio $\frac{\text{Seed-cotton}}{\text{Plant weight}}$	1.80	Do.	1.46	1.11	0.64	0.30

1931-32.

Number of bolls	54.7	45.5	51.0	43.1	41.1	Not tried.
Dry weight of seed-cotton in grms.	98.80	91.15	94.44	70.65	68.65	Do.
Weight of seed-cotton per boll in grms.	1.8	2.0	1.9	1.6	1.7	Do.
Dry weight of plant skeleton in grms.	55.95	58.75	72.28	80.85	120.20	Do.
Ratio $\frac{\text{Seed-cotton}}{\text{Plant weight}}$	1.77	1.55	1.31	0.87	0.57	Do.

de-budding operation was prolonged. These growth-behaviours indicate deficiency of food supply in the plant. This might be the result of the boll-development period being carried too far beyond the usual time, when both the soil and the aerial environment become unfavourable for formal growth.

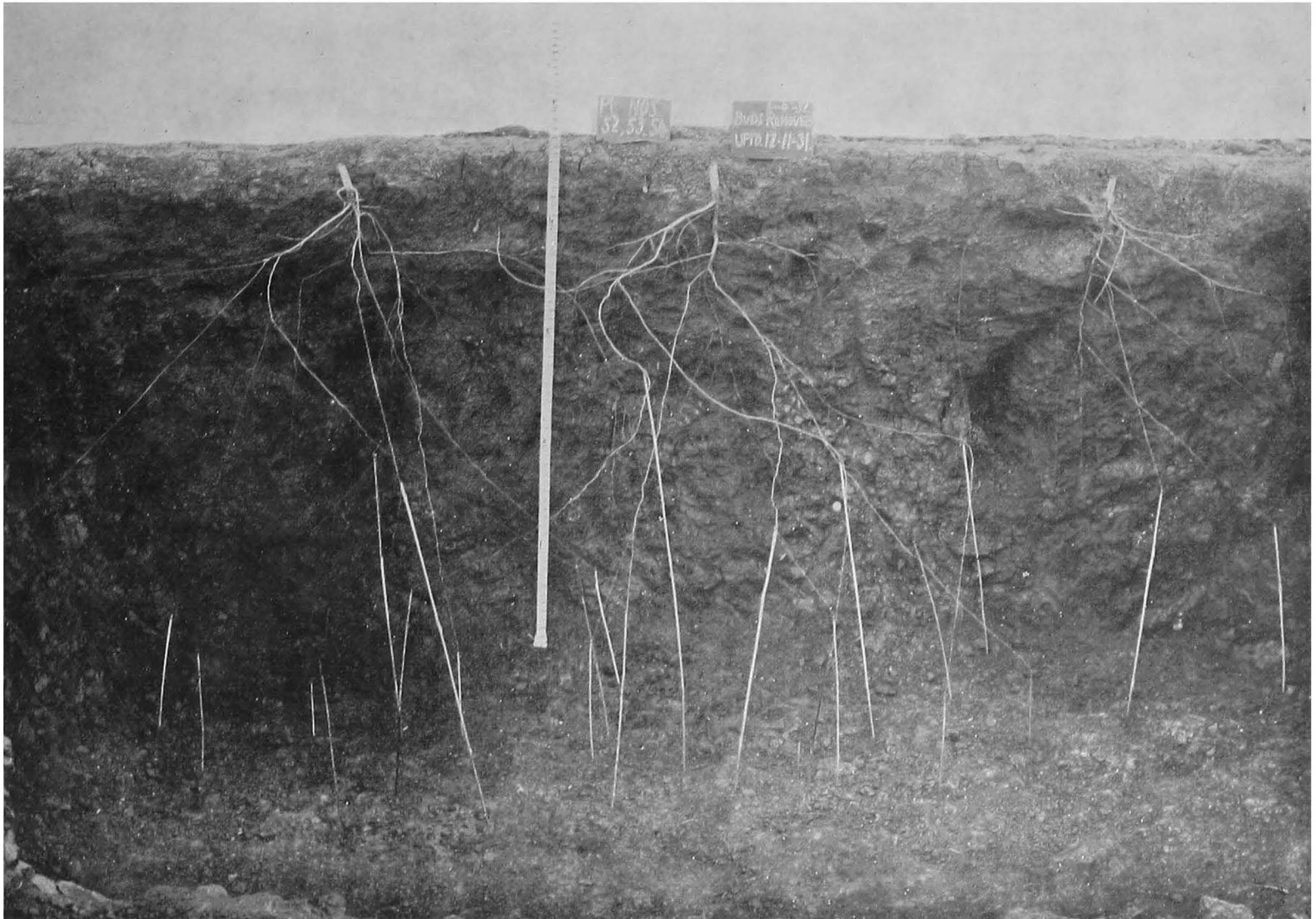
(d) *Effect of de-budding on root and shoot growth.*

Sun-dry weight of the plant skeleton given in Table No. 157 increased considerably as the period of de-budding was extended. This was more marked in the year 1931-32. It was however, natural, as during the process of recuperation of removed flower-buds the plant was obliged to increase its scaffolding. (Plate Nos. 11, 12, 13 and 14.)

These effects were also reflected on the growth of roots which steadily went deeper into the soil and grew thicker as the period of flower-bud pruning was prolonged. (Plate Nos. 15, 16, 17, 18 and 19.) It may be recollected that the weight of roots of plants grown under damage by the spotted boll-worms which augment flower-bud shedding is nearly double that of the protected plants (page 165) and that the roots of the former also penetrate deeper into the soil. The behaviour of roots of plants

PLATE No. 15.

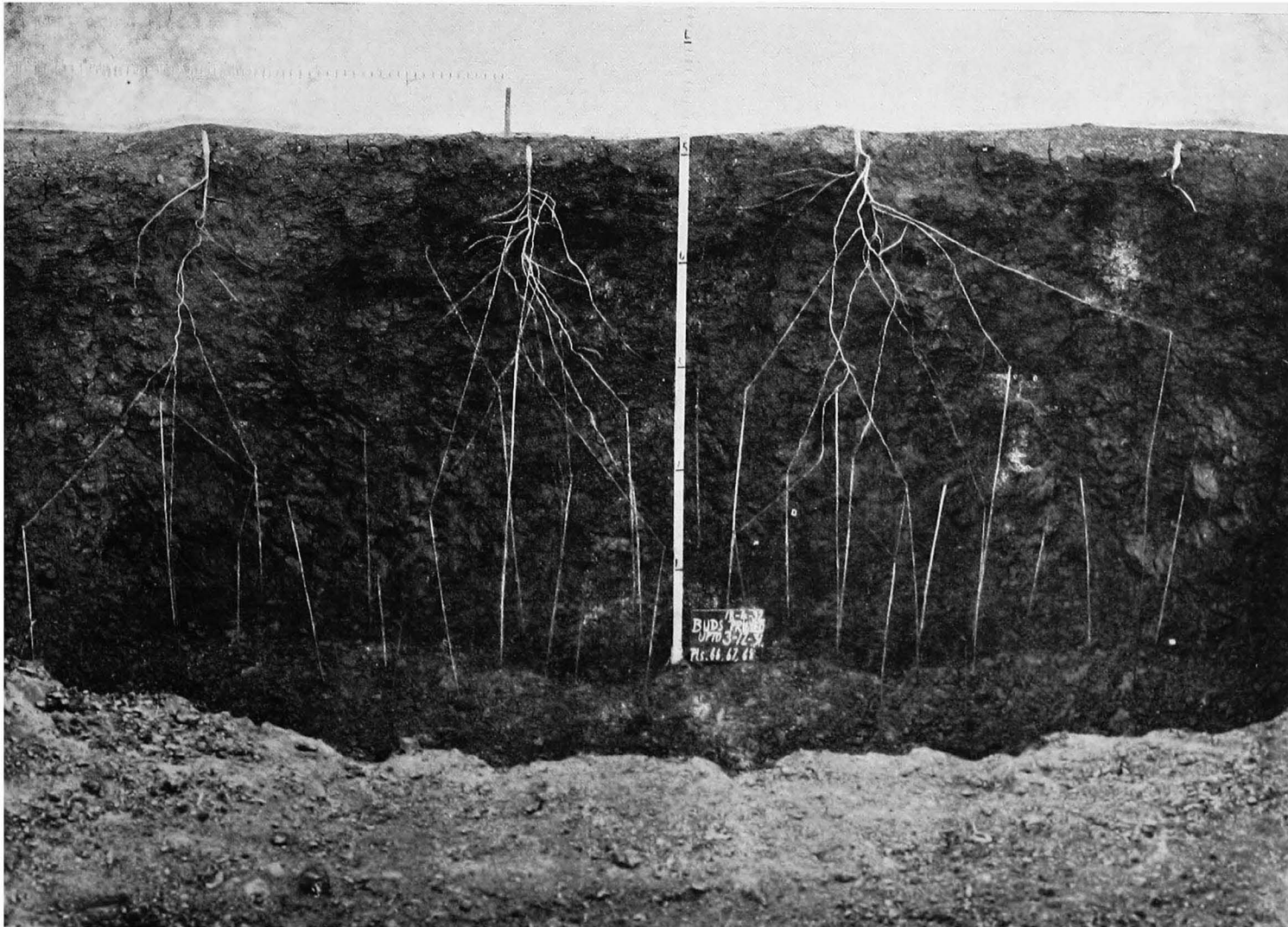
Root system of protected plants where flower-buds were removed weekly up to 12th November, 1931.



For Control see Plate No. 19.

PLATE No. 16.

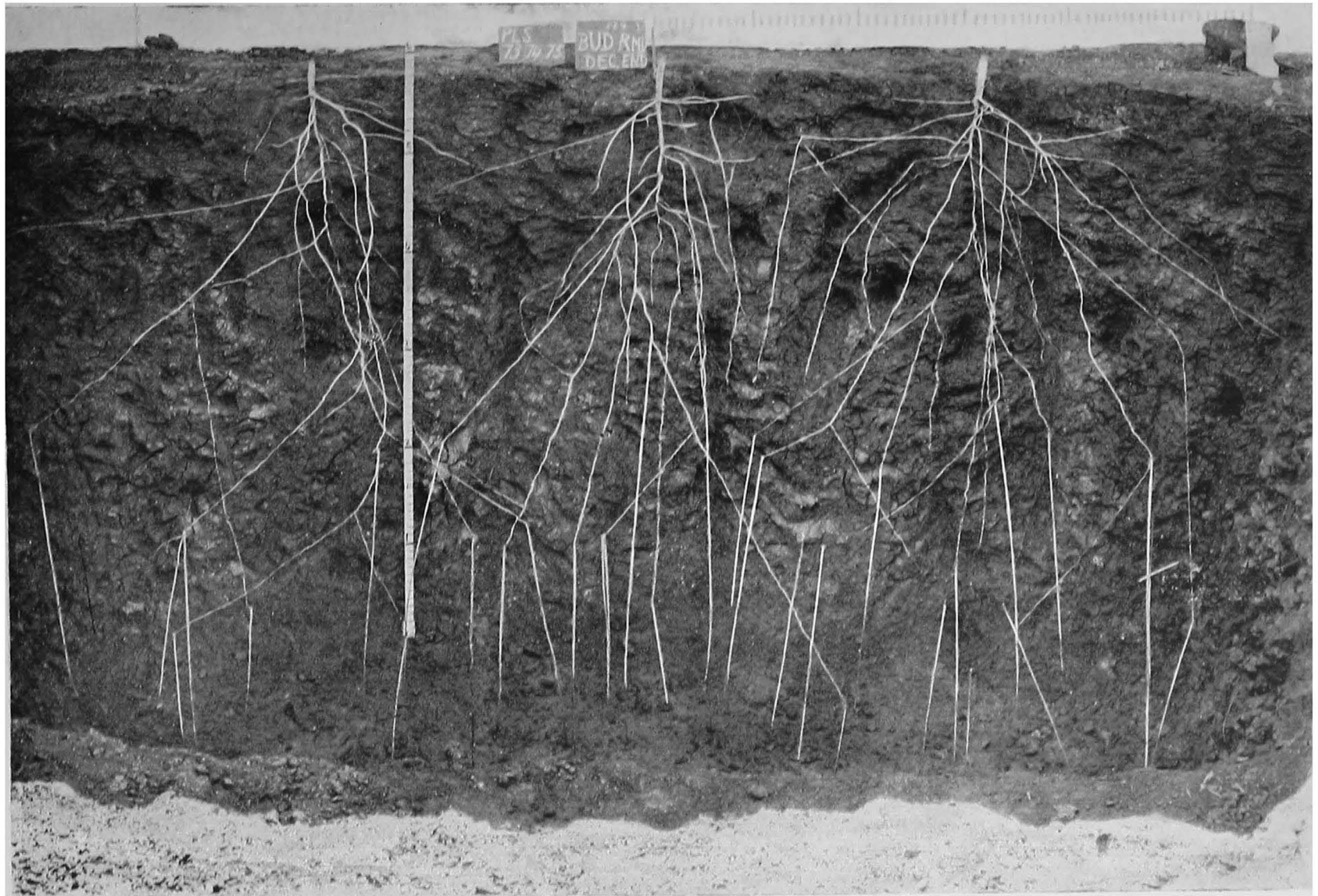
Root system of protected plants where flower-buds were removed weekly up to the end of November, 1931.



For Control see Plate No. 19.

PLATE No. 17.

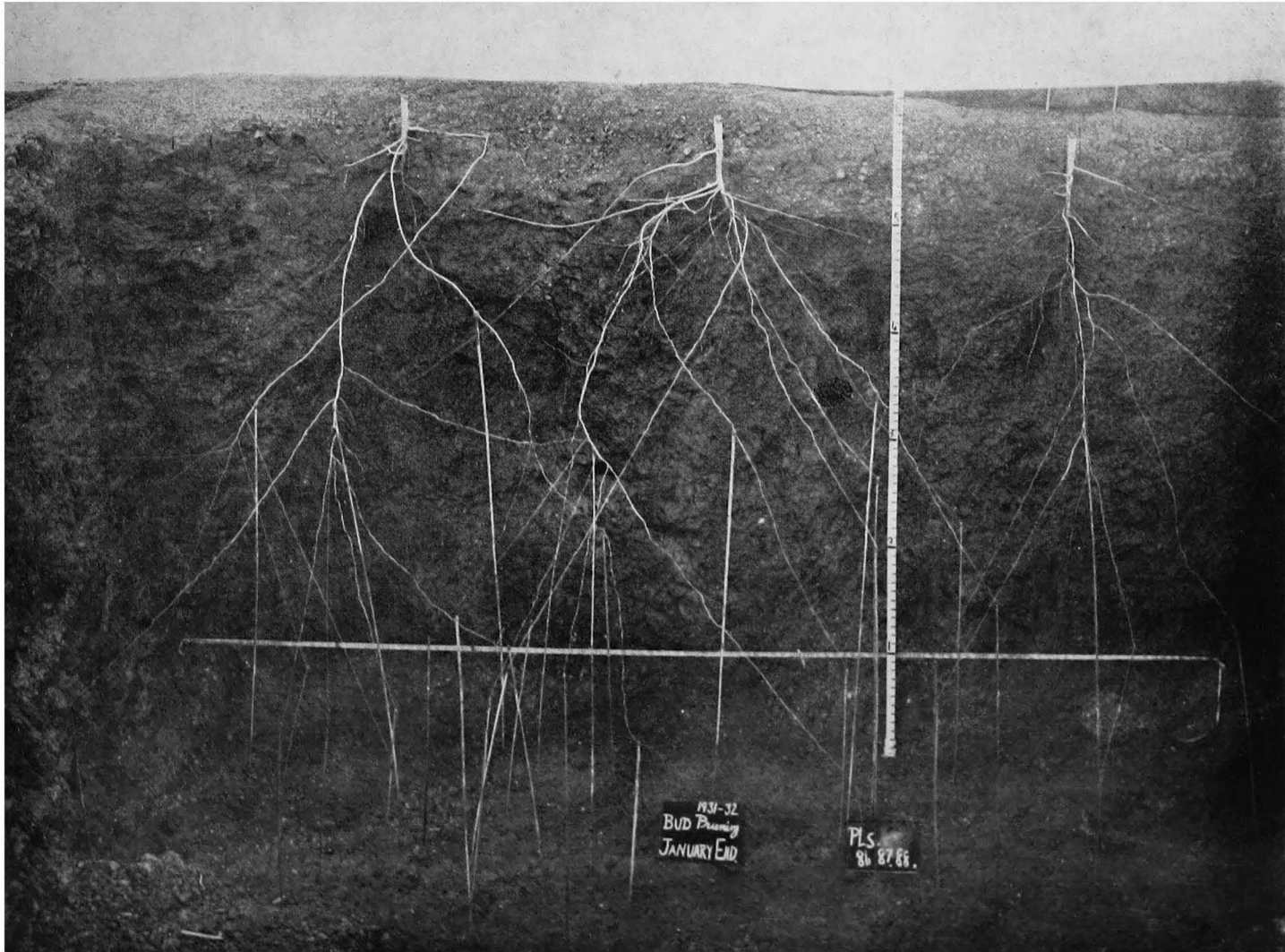
Root system of protected plants where flower-buds were removed weekly up to the end of December, 1931.



For Control see Plate No. 19.

PLATE No. 18.

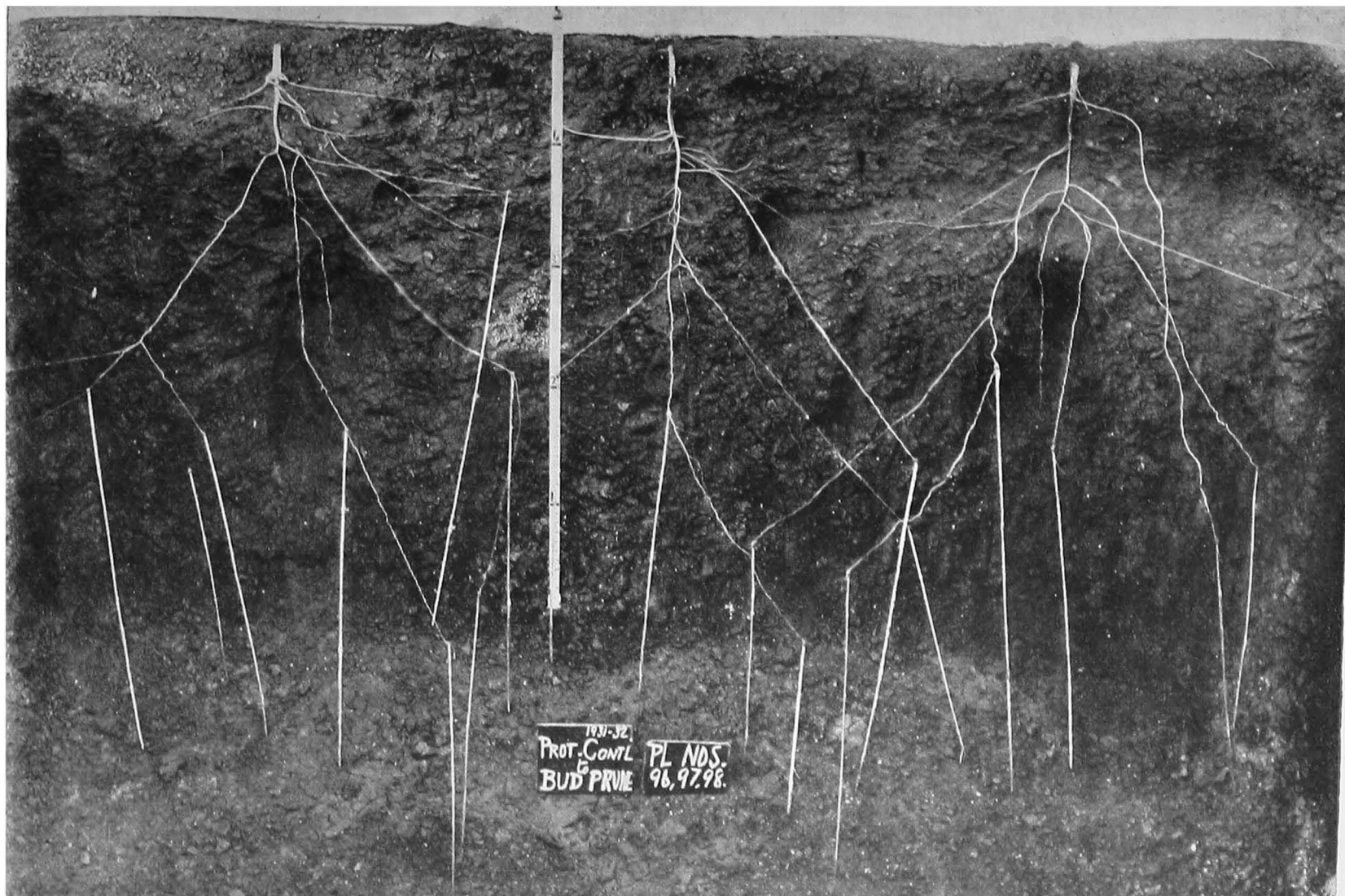
Root system of protected plants where flower-buds were removed weekly up to the end of January, 1932.



For Control see Plate No. 19.

PLATE No. 19.

Root system of protected plants serving as control to those in Plate Nos. 15, 16, 17 and 18.



under de-budding experiments is also of the same type. If flower-buds are not allowed to remain and grow on the plant either on account of their augmented shedding or artificial removal, the products of photo-synthesis are translocated to the roots and utilised for mechanical purposes. The roots thus gain in weight and thickness, and are stimulated to go deeper by the prolonged growth of the shoot, consequent upon bud-pruning or bud-shedding.

GENERAL CONCLUSIONS.

These de-budding experiments have yielded valuable results from physiological considerations as they reveal certain growth correlations in the cotton plant and throw light on internal conditions which determine the magnitude of production of flowers and bolls.

The results unmistakably point out that the span of the life-cycle of the cotton plant is chiefly governed by the presence or absence of growing flower-buds. If no flower-buds remain on the plant due to their artificial removal for various periods, the life of the plant is correspondingly prolonged. If on the other hand, flower-buds as they arise are not pruned, the plant completes its life-cycle earlier. Wholesale removal of flower-buds promotes expansion of plant scaffolding and further production of flower-buds. This behaviour suggests correlative influences of growth in the plant. Growing flower-buds seem to exert a retarding influence on plant expanse and flower-bud production. This becomes more evident by the fact that the number of flower-buds produced, from the time the operation of their wholesale removal is stopped, on plants subjected to de-budding for various periods is more or less equal to that in plants not so subjected. The association of the rising flowering curve and therefore also of the successfully setting bolls with declining curve of flower-bud formation in all the sets under experiment, has already been referred to. This indicates another correlative influence which is responsible for checking the use of food within the plant towards a constant expanse of plant scaffolding and the production of flower-buds.

Another important observation that emerges from these de-budding experiments is that the magnitude of production of flower-buds, flowers and bolls is a matter of the supply of food in the plant at every stage. As de-budding leads to increased supply owing to larger leaf surface and the absence of previously growing-flower-buds, comparatively a larger number of flower-buds develop into flowers, the need per flower being small and the new leaves being at that time in the best functioning condition. During boll-development, however, conditions for elaborating plant-food get less congenial owing to delayed flowering, at least in the too-prolonged-de-budded plants, and the number of bolls declines and especially the development of seed-cotton in them.

II. (A) IMITATION OF BOLL-WORM DAMAGE TO SHOOTS AND FLOWER-BUDS.

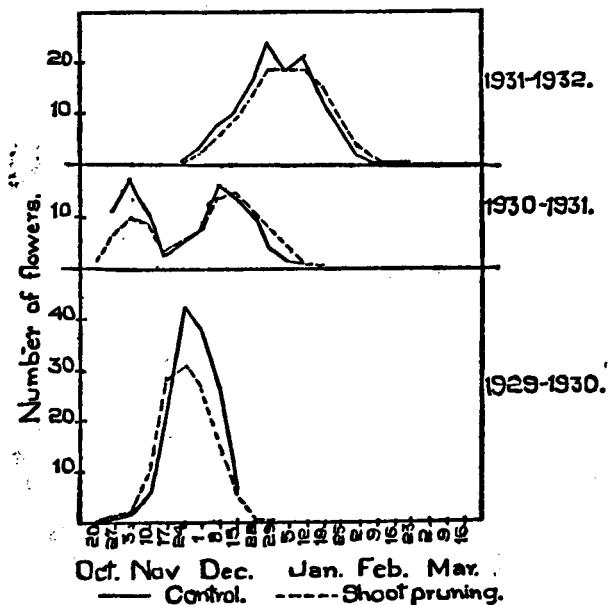
With a view to assessing the effects of damage to shoots and flower-buds by the spotted boll-worm, an experiment was started in 1929-30 and carried out for three years. Damage to shoots and to shoots and flower-buds conjointly, and to flower-buds alone was imitated on protected plants. There were ten plants in each set, the controls being separately provided. Before commencing the operation, protected plants were paired with those unprotected according to their vigour to minimise individual differences. The degree of damage on the paired unprotected plants was then imitated once a week on the protected plants selected for the purpose.

(a) *Effect of damage to shoots alone.*

The spotted boll-worm damages the plant in its shoot at 30 to 40 places. As imitation of this damage specially at all the minor points was not possible, pruning was restricted to the main shoot, limbs and auxiliaries of the first order. On an average more than nine shoots were pruned per plant. The results of the three years (Table Nos. 301 to 306 in the Appendix), though not consistent on a quantitative basis were sufficient to indicate that even with moderate degree of shoot pruning, there was a tendency for the number of vegetative buds to increase and for the number of flower-buds, flowers and bolls to decrease. The magnitude of flowering, however, was very small and in several cases might fall within the range of experimental error. It may be noted that damage to shoots alone to an extent to which it was carried out in the present experiments, did not delay flowering. (Graph No. 60 and Table Nos. 307 to 309.)

GRAPH No. 60.

Flowering in protected plants subjected and not subjected to shoot damage.

(b) *Effect of damage to flower-buds alone.*

Damage to flower-buds by the spotted boll-worm in the unprotected plants was imitated by removing flower-buds from the protected in such a manner as to make percentage shedding in the two sets equal at all times during the season. In addition to natural shedding, on an average 121, 113 and 160 flower-buds were pruned per plant from time to time in the years 1929, 1930 and 1931 respectively. The result of imitating the damage to flower-buds was to increase flower-bud production, the magnitude varying in the three years. This effect was similar to that of wholesale de-budding described before.

TABLE NO. 158.

Effect of imitating damage to flower-buds by the spotted boll-worm.

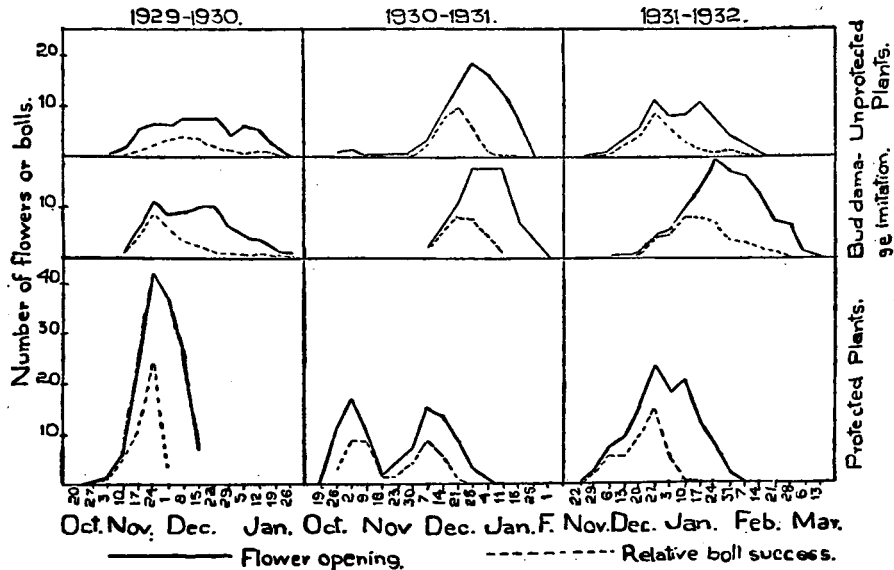
Year.	Increase or decrease over control per plant.									
	Vegetative buds.		Flower-buds.		Flowers.		Bolls.		Seed-cotton.	
	No.	%	No.	%	No.	%	No.	%	No.	%
1929-30	-19	-6.7	12	4.5	-73	-50.9	-16	-35.5	-32	-35.1
1930-31	-29	-12.5	61	23.9	-11	-11.9	-17	-37.8	-22	-27.1
1931-32	55	54.0	192	66.6	-5	-4.4	..	..	6	7.7

Pruning of flower-buds after the manner of the spotted boll-worm, however, did not enhance flower production as in the case of wholesale de-budding but on

GRAPH NO. 61.

Flowering and relative bolling in protected, unprotected and bud-damage-imitated plants.

(Average performance.)



the contrary decreased it considerably. In respect of the production of flowers and mature bolls, these plants resembled the performance of unprotected plants. This will be evident by a reference to the flowering curves of protected and unprotected plants and those of protected plants subjected to imitation of damage, shown in Graph No. 61 and Table Nos. 310 to 312 in the Appendix. Lowering in the efficiency of flower and boll production has, therefore, to be ascribed to differences in the manner of pruning. In the wholesale de-budding experiments the plant remains undisturbed once de-budding is stopped and further no flower-buds are left on the plant during the period of the operation. In the damage-imitation experiments, on the other hand, some flower-buds always escape pruning and grow steadily though bud-pruning happens to be in constant progress. It has already been stated that growing flower-buds exert a retarding influence on further expansion of the plant and also on the production of flower-buds. It is probably the effects of this retarding influence that seem to prevent increase in leaf surface proportional to the number of flower-buds removed.

(c) *Effect of damage to shoots and flower-buds conjointly.*

The effects of imitation of damage to shoots and flower-buds together were more or less of the same nature and intensity as those of imitation of damage to flower-buds alone.

CONCLUSION.

These experiments conclusively show that the main cause of the low efficiency of unprotected plants in regard to flower and boll production, is the continued damage to flower-buds, damage to shoots being of minor importance. It is indicated that partial escape of flower-buds from pruning retards full production of flower-buds and leaf surface in proportion to the magnitude of bud-pruning and reduces thereby the supply of elaborated food in the plant with the result that both flower and boll production decreases.

II. (B) EFFECT OF WHOLESALE DE-BUDDING ON A SINGLE DAY AT DIFFERENT STAGES OF PLANT GROWTH.

It is a common experience in the Broach tract that long periods of cloudy days terminating in rain, are followed by a heavy shedding. The year 1930-31, experienced such a condition in the last week of October when an unusually heavy shedding of flower-buds occurred. This heavy drop of buds caused a gap in the march of flowering and the flowering curve became bi-modal. (Graph No. 61.) The question therefore arose as to whether the augmented shedding which sometimes occurs owing to such and other causes, lowers the efficiency of the plant for flower and boll production and reduces thereby the final yield.

In 1931-32, therefore, experiments were carried out on protected plants in which three sets of ten plants each, were subjected to wholesale pruning of flower-buds on a single day. In the first set, all flower-buds were removed on 4th December when the plant had produced ten flowers. In the second set, the operation was done a fortnight later. These plants had opened on an average thirty-six flowers by this time. A fortnight hence, plants in the third set were subjected to wholesale de-budding, there being on an average eighty-one flowers per plant. The number of flower-buds removed in the three sets were 108, 101 and 58 respectively. The results are given in Table No. 159.

TABLE No. 159.

Effect of wholesale de-budding on a single day at different stages of plant growth.
(Average results of ten plants in each set.)

Date of wholesale de-budding.	Set I. (Control).	Set II. 4th Dec.	Set III. 18th Dec.	Set IV. 1st Jan.
Number of flower-buds per plant before the commencement of the experiment on 3-12-31.	264	241	210	221
Growth in terms of various organs on the day of operation in each set.				
Flower-buds { Control .. .. .	..	264.0	300.0	338.4
{ Treated .. .. .	..	241.3	260.4	282.9
Flowers { Control .. .. .	..	9.1	41.3	89.7
{ Treated .. .. .	..	10.4	36.0	81.5
Relative successful bolls { Control .. .. .	..	7.5	31.6	53.6
{ Treated .. .. .	..	9.4	28.0	48.2
New growth after the operation till the end of the season.				
Flower-buds removed at the operation .. .. .	..	107.8	101.4	51.7
New flower-buds formed .. .. .	..	154.8	81.0	0.6
New flowers formed .. .. .	..	129.2	53.1	0.2
New bolls formed from the above flowers .. .. .	..	47.7	29.1	0.2
Total final production per plant.				
Vegetative buds	326.3	343.8	317.1	283.1
Flower-buds	339.2	396.1	341.4	283.5
Flowers	139.0	139.6	89.1	81.7
Bolls	54.7	57.1	57.1	48.4
Seed-cotton in grms. (Sun-dry)	98.8	105.6	97.3	83.1
Sun-dry weight of plant scaffolding	56.0	68.1	49.7	48.7
Ratio of seed-cotton to body weight	1.77	1.55	1.96	1.71

The data in the above table show that control plants were slightly superior to treated ones at the beginning of the experiment, particularly in the third and fourth sets. The effect of the operation on different plant characters may now be discussed.

Effect on the production of flower-buds.

In the first set in which de-budding was done pretty early in the season (4th December), new production of flower-buds exceeded the number of buds removed. On this account, the total number of flower-buds produced in the season including those pruned was more than in the control. In the second set, recuperation was inadequate. Whereas the number of buds removed was 101, those produced anew numbered only eighty-one. In the third set, there was no recuperation although 51 buds were removed. This shows that the power of recuperation of flower-buds lost either by pruning or shedding, rapidly declines as the age of the plant advances. The factor which determines the degree of recuperation seems to be the number of growing bolls on the plant, on the day of removal. If the heavy loss occurs at the commencement of flowering, when the number of growing bolls on the plant

is very small as in the case of Set II, the plant produces more flower-buds than those removed. If the number of bolls on the plant is more and de-budding is done when the plant has produced nearly one-third of the total number of flowers during the season, recuperation of buds is moderate and inadequate to recoup the whole loss and so on. These experiments clearly bring out the correlative influence of growing bolls on the production of flower-buds, and consequently on the vegetative expansion of the plant.

Effect on flower production.

Flower-production is not adversely affected if de-budding is done at the commencement of flowering as in the first set. If it is done later, the number of flowers declines (139 *versus* 89), owing perhaps to a less recuperation of flower-buds.

Effect on boll production.

The number of mature bolls per plant in the different sets varied to some extent; but the differences were not statistically significant as will be seen from the following calculations. (See Table No. 313 in the Appendix.)

TABLE No. 160.

Test of significance of bolls per plant in the experiment of wholesale de-budding on a single day.

1931-32.

Flower-buds removed on	Set I. (Control.)	Set II. 4th Dec.	Set III. 18th Dec.	Set IV. 1st Jan.	Mean of all.	S.D.
Average number of bolls.	54.7	57.1	57.1	48.4	54.3	75.76

Analysis of variance.

Due to.	Degrees of freedom.	Sum of squares.	Mean square.
Between treatments	3	499.1	166.4
Within treatments	35	8702.3	248.6
Total	38	9201.4	..

The standard error of comparison of two treatment means = 7.05

Value of "t" (for P=0.05 and n=35) = 2.03

∴ The value for a significant difference between any two treatment means = 14.3

Conclusion.—None of the treatments are significant.

These results emphasise the nutritional dominance of the growing bolls. As the number of bolls on the plant when de-budding is carried out increases, the recuperative capacity of the plant steadily falls. Thus in the first set when only nine bolls were present at the time of de-budding, the plant gave rise to 129 new

flowers. In the second set, the plant had twenty-eight bolls when de-budding was done. In this case, the number of flowers formed after the operation, did not exceed fifty-three. In the last set, as many as forty-eight bolls were feeding on the plant at the time of de-budding and as a result further production of new reproductive forms practically ceased. The channel of utilization of growth-building material at every stage of plant growth is thus determined by the nutritional dominance of one organ or the other at that time.

CONCLUSION.

As the experiment was carried out only for one year it may provisionally be concluded that heavy bud-shedding at one time does not lead to the reduction of mature bolls.

III. (a) DE-FLOURATION.

De-flouration experiments were carried out in 1930-31 and 1931-32 exactly in the same manner as those on continued de-budding. Flowers were removed daily from protected plants for various weeks in the two years. In 1930-31, there were five plants in each set while in the following year, the number of plants was increased to ten in each set. The results of these experiments are given in Table No. 161.

TABLE No. 161.

Results of de-flouration experiment.

(Average production of flowers and bolls per plant.)

1930-31.

Number of weeks for which flowers were pruned.	Set I. (Control).	Set II. 2	Set III. 5	Set IV. 7
Date up to which flowers were pruned.		16th Nov.	7th Dec.	21st Dec.
Number of flowers pruned .. .. .	..	41.0	65.8	92.2
Number of flowers bloomed after stoppage of the operation.	..	118.2	111.6	85.2
Total number of flowers	108.2	159.2	177.4	177.4
Ripe bolls	42.8	30.8	38.6	36.4

1931-32.

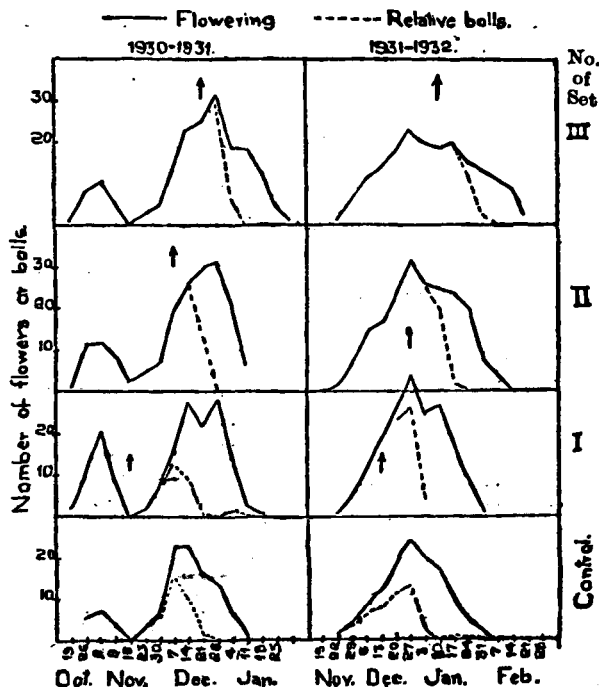
Number of weeks for which flowers were pruned.	Set I. (Control.)	Set II. 2	Set III. 4	Set IV. 6
Date up to which flowers were pruned.		13th Dec.	27th Dec.	10th Jan.
Number of flowers pruned .. .. .	..	35.8	91.0	109.3
Number of flowers after the stoppage of the operation.	..	134.7	105.3	68.1
Total number of flowers	121.8	170.5	196.7	177.4
Ripe bolls	47.2	52.3	47.0	33.8

It will be evident from the above table that de-floration for various periods leads to an increase in the total production of flowers. Further, there is a tendency for the number of flowers to increase as the period of operation is prolonged. This means that if flowers are pruned as they are formed, the plant recuperates the loss by new production, the extent of recuperation depending upon the stage of plant growth. It may be noted that the effect of continued de-floration on the production of bolls was other than identical in the two years. Whereas, in 1930-31, the number of mature bolls in all the sets had been lower than that in the control, they exhibited a tendency during the next year to remain constant and almost equal to the control in spite of the fact that pruning was carried on for four weeks that year. Probably, the effect of de-floration on boll production was governed by nutritional factors in the soil.

GRAPH No. 62.

Average weekly production of flowers and the number of mature bolls resulting therefrom (relative formation) in different sets of de-florated plants.

Protected Plants.



From the figures of daily flowering, curves of average weekly flowering in the several sets in the two years, are drawn in Graph No. 62 (Table Nos. 314 and 315 in the Appendix). It will be seen from these curves that under normal conditions, mature bolls are derived from the flowers of the first three to four weeks (Control plants). When these flowers are removed, the period of boll maturation shortens as pruning is prolonged, indicating that a rapid utilization of elaborated food occurs towards the growth and development of growing bolls on the plant.

III. (b) DE-FLORATION IN RELATION TO THE SUCCESS OF LATER FLOWERS.

De-floration experiments were carried out in the year 1925-26 in which flowers of the first and second half of the flowering season were removed in two sets of field plants. Similarly, in three sets of cage plants flowers were pruned during November, December and January respectively. The results of these experiments are given in Table Nos. 316 and 317 in the Appendix. They show that the absence of developing bolls on the plant in the early period, induces the later flowers to grow into mature bolls. In other words, the heavy shedding of bolls usually occurring during the latter part of the flowering season is brought about by food deficiency caused by developing bolls arising from the early flowers. This view is further supported by the results of experiments where all the bolls existing on the plant were plucked during the flowering season and the success of later flowers into mature bolls was attained. (Table Nos. 318 and 319 in the Appendix.)

IV. DE-FRUITING.

The effect of de-fruiting on the growth behaviour of unprotected plants was studied in the year 1925-26. For this purpose, two sets of ten plants each, were selected. One of the sets was located in the interior of a field plot while the other was in one of its border rows. Suitable controls were maintained for each set. All bolls from the plant in both the sets were removed on the 10th December, 1925. At this time, the plants in the interior and those in the border row had produced respectively sixty-three and fifty-two bolls on an average. It may be pointed out that the border plants generally flower late and are more vigorous than those in the inner rows, owing to extra feeding space available on one side.

The results of these experiments are produced in the Table No. 162. They

TABLE No. 162.

Final performance of unprotected plants subjected to de-fruiting on a single day.
(Average results of ten plants in each case.)

Treatment.	Bolls removed per plant.	Number of flowers opened after the operation of de-fruiting till the end of the season.	Number of bolls matured from the new flowers.	Per cent. success of flowers into bolls.
Plants situated in the border row.				
All bolls pruned on 10th December.	52	215.4	92.8	43.0
None of the bolls pruned .. (Control).	Nil.	191.7	57.2	29.8
Plants situated inside the plot.				
All bolls pruned on 10th December.	63	62.7	35.5	56.9
None of the bolls pruned .. (Control).	Nil.	51.3	5.0	9.7

show that the extent of boll production from flowers formed after the date of de-fruiting was considerably greater in the de-fruiting than in the control plants. This shows the influence of existing bolls that were present on the control plants

in inhibiting the growth of additional fruits from later flowers on them. Murneek (1926) worked on tomato and found similar correlative influences of the developing fruits in retarding the growth of other organs.

V. RINGING OF THE MAIN STEM.

Some light on the conditions favouring flower-bud development was thrown by the results of experiments carried out in 1925-26. A set of five cage plants was selected and the bark of the main stem was ringed on the 16th September, 1925, leaving about four limbs at the bottom. Out of the five plants, four broke down after the operation owing to wind and only one survived. In this plant, no flower-buds were growing successfully till the day of the operation, but they began to show development few days after ringing. This continued for about three weeks when many of the developed buds began to shed. By this time, the bark connection was re-established. In spite of this fact, flowers opened much earlier and in larger numbers. These results though of one plant are important inasmuch as they show that the usual movement of assimilates in the early stage of growth to parts below the ring was cut off and the food thus accumulated led to a hastening of flowering period and raised the number of flowers formed.

In 1927-28, this experiment was repeated on a set of five cage plants. The stem was ringed on 23rd November, 1927, leaving a few branches below the ring. The data obtained (Table No. 163) clearly show the effect of ringing on the success

TABLE No. 163.

Periodical average performance of ringed plants in the cage.

1927-28.

(Average five plants in the field cage.)

Period ending	Average number of flowers per plant per week.	
	Ringed plants.	Unringed plants.
4th December	0.2	0.6
11th December	0.8	0.6
18th December	1.0	1.2
25th December	2.8	2.6
1st January	9.0	4.4
8th January	18.0	9.0
15th January	25.2	12.2
22nd January	17.6	9.4
29th January	13.6	7.4
5th February	5.2	5.4
12th February	3.8	5.6
19th February	0.4	2.4
26th February	0.2	2.8
4th March .. .. .	.....	1.2
11th March .. .. .	.....	1.2
18th March .. .. .	.....	2.0
25th March .. .. .	.....	2.6
6th April .. .. .	.....	0.4
Total flowers	97.8	71.0
Bolls	31.0	37.2

of flower-buds into flowers. Ringing of the main stem intensifies the rate of flowering. Whereas in the ringed plants, the weekly flowers formed in January were nine, eighteen, twenty-five, seventeen and thirteen they were nine, twelve, nine and seven for respective weeks in the control. Further, the ringed plants though they produced a larger number of flowers gave ultimately a less yield and finished their life-cycle earlier owing to a general hastening of plant activity.

Another experiment on cage-plants was carried out this year. Ringing of the main stem was, however, done in this case below all the branches. As no branch was left below the ring, the supply of assimilates to roots was completely cut off. Root activity still continued till all reserved food in the part below the ring was utilized. During this time, there was a certain degree of stimulation to flower-bud development in the part above the ring. This was, however, followed by wilting of leaves and the plants died soon after. These experiments convincingly show that the success of flower-buds into flowers and of flowers into bolls is regulated according to the sufficiency of elaborated food within the plant.

VI. ROOT-PRUNING.

In addition to stem ringing, another series of experiments on cage plants was carried out in 1927-28. Three plants were selected and the roots on one side were pruned on 23rd November, 1927, control of five plants being maintained in their neighbourhood. The average plant performance of these plants is presented below in Table No. 164.

TABLE NO. 164.
Periodical production of flowers in root-pruned and control plants.
(Roots pruned on 23rd November 1927.)

Week ending	Plants subjected to root-pruning.				Plants not subjected to root-pruning.					
	No. 1.	No. 2.	No. 3.	Average.	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.	Average.
4th December	1	0	0	0·3	3	0	0	0	0	0·6
11th December	3	0	0	1·0	1	0	0	2	0	0·6
18th December	12	3	0	5·0	1	1	0	1	3	1·2
25th December	28	9	5	14·0	4	2	0	6	1	2·6
1st January	36	18	8	20·6	5	1	3	5	8	4·4
8th January	29	16	13	19·3	5	7	7	10	16	9·0
15th January	24	19	12	18·3	9	8	10	21	13	12·2
22nd January	13	16	11	13·3	7	7	9	12	12	9·4
29th January	9	10	3	7·3	10	6	4	11	6	7·4
5th February	1	1	6	2·7	4	3	4	10	6	5·4
12th February	2	1	4	2·3	7	2	3	11	5	5·6
19th February	1	0	1	0·7	6	2	0	4	0	2·4
26th February	0	2	0	0·7	6	1	1	7	0	2·8
4th March	0	0	4	1·3	2	0	4	0	0	1·2
11th March	2	2	2	2·0	2	0	4	0	0	1·2
18th March .. .. .	..	..	..	..	2	2	2	2	2	2·0
25th March .. .. .	..	..	..	..	4	4	4	1	0	2·6
1st April .. .. .	..	..	..	..	1	0	1	0	0	0·4
	*161	97	69	109	79	45	56	103	72	71

The data in the above table indicate that owing to root-pruning the period of flowering is shortened while the production of flowers is appreciably raised. These results are similar to those observed under stem-ringing experiments and show that when the flow of assimilates to roots is checked by artificial devices, the supply of plant nutrition is improved with the result that a greater success of buds into flowers is obtained.

D. CHANGE IN THE AERIAL ENVIRONMENT BY DELAYING SOWING.

The effect of climatic factors on the development of the plant and on the shedding of buds and bolls was studied in 1930-31 and 1931-32. Plants were raised by sowing cotton at three different times in the season, namely, the usual time and six and eight weeks after this time. Owing to reduction of soil moisture in the upper layers of the soil when late sowing was done, the seeds found it difficult to germinate and after germination the seedlings also found it equally difficult to get well established. On this account in the first year, germination of seeds in the late sown plots had had to be induced by local watering which was continued for some time until the seedlings got established. During the second year, however, no watering was resorted to and consequently the seedlings in the last-sown plot dried up. No data are, therefore, available for this time of late sowing during the second year. It is necessary to mention that in late-sown plots, there were more gaps than usually occur in areas sown at the proper time. On this account, the performance of the late-sown plants was other than normal. Owing to extra feeding-space caused by the gaps, some plants grew better than others in the late-sown plots.

Growth records on the plants grown at three different times in the season, were maintained both under protected and unprotected conditions. The performance of the protected plants will, however, be here discussed so that the effect of change in the environment on plant growth will be prominently brought to notice. In the following table are presented growth data on these plants for the two years.

TABLE NO. 165.

Average performance of protected plants grown at different times in the season.

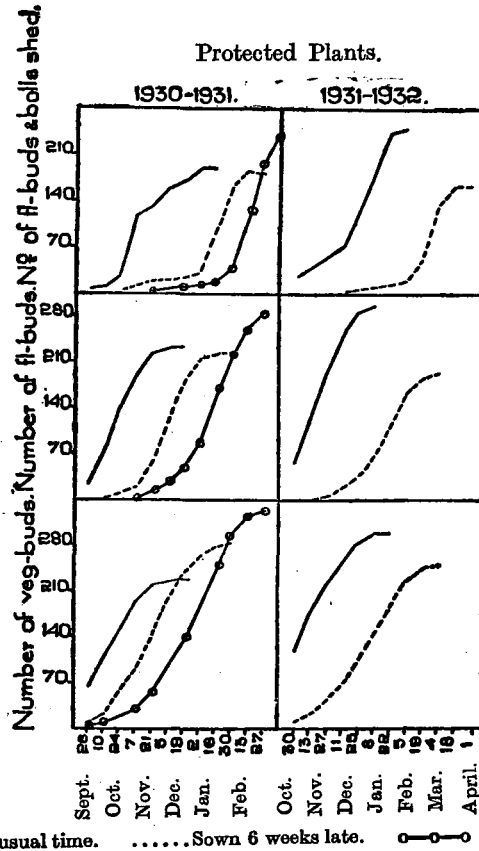
Average of 10 plants.

Sowing time.	1930-31.			1931-32.		
	Sown at the usual time. 3-7-1930	Sown six weeks late. 14-8-1930	Sown eight weeks late. 28-8-1930	Sown at the usual time. 2-7-1931	Sown six weeks late. 16-8-1931	Sown eight weeks late. 31-8-1931
Vegetative buds ..	232.1	284.8	332.4	287.2	251.0	Did not grow.
Flower-buds	254.6	222.4	282.3	288.2	194.0	Do.
Flowers	96.7	131.6	130.8	121.9	90.1	Do.
Bolls	46.3	41.6	41.8	44.9	28.8	Do.
Weight of seed-cotton .. (in grms.)	84.4	92.1	79.95	84.1	52.30	Do.
Weight of seed-cotton per boll. (in grms.)	1.82	2.21	1.91	1.88	1.82	..
Percentage success of :—						
Buds into flowers ..	38.0	58.7	46.0	42.3	46.4	Did not grow.
Flowers into bolls ..	47.9	31.6	32.0	36.8	32.0	Do.
Buds into bolls ..	18.2	18.5	14.8	15.6	14.8	Do.

The figures in the above table indicate that by late sowing the proportion of vegetative buds to flower-buds increases. Similarly, the success of flower-buds into flowers is promoted to a greater extent in the late-sown plots. This greater success of flower-buds into flowers is, however, counter-balanced by a less success of flowers into mature bolls and consequently, the extent of boll retention from the total buds incepted remains almost unaffected. It may be mentioned that during the first year, the number of flowers considerably increased over the usually sown-control plants. This increase in the production of flowers appears to be mainly due to the effects of the unusually heavy shedding of buds caused by a protracted period of cloudy weather terminating in rain towards the end of October. These plants were not able to recoup the loss owing to the presence of growing bolls from the first flush of flower-buds. On the basis of the final yield, the data for the two years are quite consistent in showing that late sowing reduces the number of bolls that mature on the plant.

GRAPH NO. 63.

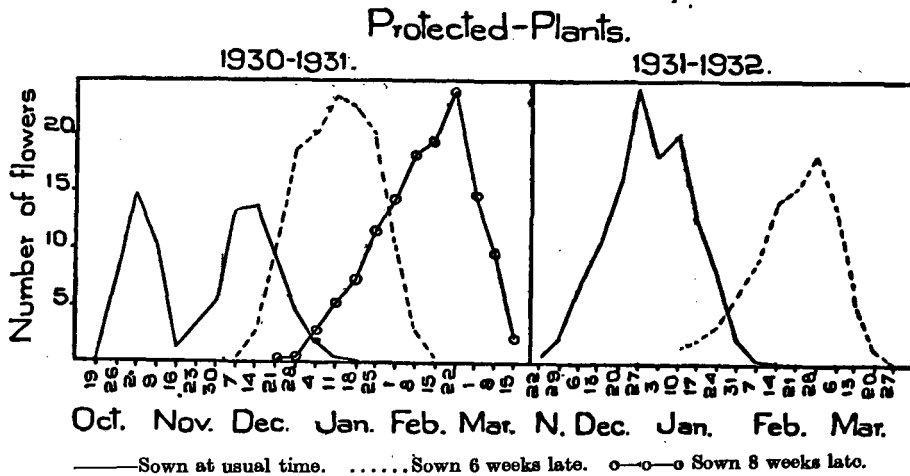
Average progressive production of vegetative buds, flower-buds and the total shedding of the latter on plants grown at different times in the season.



More light on the effect of changing the usual period of development of the cotton plant by late sowing, is thrown by the study of periodical production of different organs and the shedding of reproductive forms. These are given in Table Nos. 320 and 321 in the Appendix and are reproduced above in the Graph No. 63. It will be seen from this graph that the production of buds both vegetative and reproductive, was delayed by a period of about eight weeks although sowing was done only six weeks late. Further, the rate of shedding in the late sown plots was comparatively very low for two and a half months after the advent of flower-buds. This low shedding or in other words, the higher rate of bud success was not due to a lower rate of their formation but appears mainly to be the result of improved climatic conditions conducive to a reproductive type of growth.

GRAPH No. 64.

Periodical flowering in protected plants grown at different times in the season.
(For numerical data see Table Nos. 322 and 323 in the Appendix.)



With regard to flowering, it may be noted that it began eight weeks later in the plot sown six weeks late. Again, in the plot sown eight weeks late, flowering commenced four weeks later although the dates of sowing of the two plots differed only by two weeks. The nature of flowering in all the plots for the two years was, however, the same, the difference arising only in the magnitude of production (Graph No. 64.)

E. MISCELLANEOUS EXPERIMENTS.

It is recognised that wide spacing, ridging and mulching exert a beneficial influence on the growth and development of the plant and lead to a greater production of mature bolls. During the course of the general investigation on the problem of bud and boll shedding, the effects of these treatments on the shedding and the yield performance of the plant were studied. The experiments carried out in this connection and the results obtained, may now be described and discussed.

(1) SPACING.

A systematic study of the effects of variation in spacing on the extent of shedding and the final yield, was made in 1925-26. Plants were grown in rows three feet apart while the distance between plant and plant in these rows was varied from one to six feet. In all, experiments were conducted with five different spacings, the spacing three feet by four feet being omitted. Periodical growth counts were maintained on a set of five plants under each spacing. The average plant performance under each of the five sets, is given below in the Table No. 166.

TABLE No. 166.

Average total production of buds, flowers and bolls and the extent of their success on unprotected plants differently spaced.
1925-27.

Spacing.	Average production of			Percentage success of		
	Buds.	Flowers.	Bolls.	Buds into flowers.	Flowers into bolls.	Buds into bolls.
3'×1'	133.4	31.6	11.6	23.7	36.7	8.7
3'×2'	173.0	47.5	16.75	27.5	35.2	9.1
3'×3'	304.6	83.8	31.60	27.5	37.7	10.4
3'×5'	460.75	153.75	63.50	33.4	41.3	13.8
3'×6'	458.40	153.60	68.20	33.5	44.4	14.9

The figures in the above table indicate that with increased spacing the success of buds into flowers, flowers into bolls and finally of buds into bolls steadily increases. This success has been obtained in spite of the increasing production of buds, flowers and bolls. These observations are again corroborated by the results of 1926-27 and 1927-28 (Table No. 167). Thus, when the spacing is increased, not only the total yield per plant increases but the rate of success of buds into mature bolls is also improved.

TABLE No. 167.

Extent of bud and boll success in unprotected plants differently spaced.

Spacing.	1926-27.			1927-28.			1928-29.		
	Percentage success of			Percentage success of			Percentage success of		
	Buds into flowers.	Flowers into bolls.	Buds into bolls.	Buds into flowers.	Flowers into bolls.	Buds into bolls.	Buds into flowers.	Flowers into bolls.	Buds into bolls.
	Average of five plants			Average of ten plants.			Average of ten plants.		
3'×1' ..	8.1	26.5	2.1	..	..	..	16.1	21.3	3.4
3'×3' ..	24.0	40.4	9.7	26.2	39.1	10.2	22.5	31.8	7.2
3'×6' ..	24.9	41.5	10.3	38.1	38.2	14.6	28.8	34.0	9.8

The salutary effect of wider spacing both on the production and success of fruiting forms is obviously due to the extra feeding-space provided, or in other words to extra nutrition made available to the plants which show consequently a prolonged growth and a prolonged bud-formation. In 1927-28, the nature of food factors in the soil, responsible for a better plant performance was also studied in two plots where plants were spaced three feet by three feet in the one and three feet by six

TABLE NO. 168.

*Total moisture and nitrous and nitric nitrogen together in the soil.
(Average of different layers for 9"—36" layer.)
1927-28.*

Dates.	Total moisture. %		Water supplying power.		Nitrous and nitric nitrogen (together) in m.grms. per 100 grms. of over dry soil.	
	3'×3'.	6'×3'.	3'×3'.	6'×3'.	3'×3'.	6'×3'.
4th October	28.5	26.3	..	..	0.15	0.15
18th October	27.7	25.5	..	..	0.22	0.22
31st October	23.0	26.4	201	227	0.04	0.07
15th November	29.4	30.3	..	209	0.06	0.11
28th November	29.4	30.4	273	257	0.07	0.11
12th December	23.8	24.6	158	252	0.11	0.06
26th December	23.8	25.2	125	204	0.07	0.11
9th January.. .. .	24.0	25.7	116	138	0.08	0.15
23rd January	20.8	23.1	72	115	0.17	0.18
7th February	22.4	23.7	41	67	0.07	0.14
21st February	21.4	22.8	24	51	0.14	0.12
5th March	20.8	22.1	34	55	0.15	0.13
20th March .. .. .	..	..	21	27	..	..

feet in the other. Some of the more important soil determinations are presented above in the Table No. 168. The data for soil moisture show that moisture in the widely-spaced plot was higher than that in the control by about three per cent. throughout the season. The amount of nitrous and nitric nitrogen was also considerably and consistently higher. From these results it will be evident that the greater production of mature bolls and the higher rate of their retention attendant upon wider spacing, was the result of larger quantities of nitrogen and moisture made available to the plants during the season.

(2) *Ridging.*

The system of growing plants on ridges was started by the Bombay Agricultural Department at the Agricultural Farm, Surat, in the year 1922 (Desai and Naik 1925). The object in introducing this system was to overcome the difficulty of establishing the cotton crop on the heavy soils which get water-logged in the early part of the rainy season, necessitating re-sowing. The ridges were fourteen inches high and the distance between the ridges was five feet, the seeds being dibbled at a distance of two feet on the ridge. The records of the Agricultural Farm on this subject (Table No. 169) indicated that by ridging, the water-logging conditions were improved, the seedlings were able to get a better stand pretty early in the season, and as a result the yield of the cotton crop rose up by more than 9 per cent. as the average of seven years.

TABLE No. 169.

Yield of seed-cotton per acre, under ridged and non-ridged conditions.

(Data from the records of the Agricultural Farm, Surat.)

Year.	14" high ridges spaced five feet apart. Plants two feet apart on the ridge.	No ridges. Spacing in sowing the same as in the ridged plots.	Per cent. increase.
	lbs.	lbs.	
1922-23	616	534	15.4
1923-24	542	471	15.1
1924-25	875	800	9.4
1925-26	368	341	7.0
1926-27	397	381	4.2
1927-28	567	532	6.6
1928-29	610	677	9.9
Average	568	534	9.7

These experiments were repeated by us in 1927-28 to see if by reducing the water-logging conditions and thus improving soil-aeration, shedding of buds and bolls could be controlled. Plants were grown on ridges three feet apart while the distance between ridges was six feet. A control with spacing six feet by three feet on a flat plot was maintained. Periodical growth records on plants in the two sets were kept up during the season and the determinations of soil moisture and soil nitrogen were also made from time to time.

TABLE No. 170.
Final performance of ridge and control unprotected plants.
 (Average of 9 plants.)

Treatment.	Flower-buds.	Flowers.	Bolls.	Percentage success of		
				Bud to flower.	Flower to boll.	Bud to boll.
Ridge 6'×3'	439.8	180.1	65.3	40.9	36.3	14.8
Flat 6'×3'	389.3	147.8	56.5	38.1	38.2	14.6

The nature of plant performance in the two cases was almost the same as will be evident from the above Table No. 170. The ridged plants were, however, superior to the control in respect of the production of buds, flowers and bolls. They gave 15 per cent. more flower-buds and 20 per cent. more flowers. Further, the number of mature bolls was also higher by about 15 per cent. in these plants. The usual shedding of buds and bolls, however, remained unaffected.

TABLE No. 171.
Per cent. moisture and nitrous and nitric nitrogen together in milligrammes per 100 grms. of oven-dry soil for the depth of 22.5 to 90 cms.
 1927-28.
 (Average of three equal layers.)

Dates.	Total moisture.		Water supplying power.		Nitrous and nitric nitrogen in m. grms.	
	Ridge.	Control.	Ridge.	Control.	Ridge.	Control.
4th October	27.9	26.3	..	..	0.17	0.15
18th October .. ..	..	25.5	..	..	..	0.22
25th October	26.3	..	..	..	0.30	..
31st October .. ..	..	26.4	77	227	..	0.07
8th November	24.6	..	..	..	0.10	..
15th November .. ..	..	30.3	100	209	..	0.11
22nd November	31.0	..	..	..	0.13	..
28th November .. ..	..	30.4	152	257	..	0.11
6th December	28.1	..	..	..	0.14	..
12th December .. ..	..	24.6	166	252	..	0.06
20th December	27.3	..	..	..	0.08	..
26th December .. ..	..	25.2	96	204	..	0.11
3rd January	24.5	..	..	..	0.09	..
9th January .. ..	..	25.7	83	138	..	0.15
17th January	24.3	..	..	..	0.16	..
23rd January .. ..	..	23.1	62	115	..	0.18
31st January	23.8	..	..	..	0.07	..
7th February .. ..	..	23.7	31	67	..	0.14
14th February	23.0	..	..	..	0.07	..
21st February .. ..	..	22.8	33	51	..	0.12
28th February	22.7	..	..	..	0.11	..
5th March .. ..	..	22.1	31	55	..	0.13
14th March	19.9	..	..	..	0.18	..

The better growth of ridged plants as manifested in a larger production of buds, flowers and bolls has to be attributed to a better physical condition of the soil and its higher nitrogen content (Table No. 171). The figures for soil moisture and water-supplying power of the soil indicate that the moisture content in the ridged plot is at a lower level than in the control. It does not, however, follow that the ridge is in any manner inferior to the control plant. The fact that a larger crop has been raised by ridge cultivation shows that comparatively large quantities of moisture must have been utilized by plants in the ridged plot and hence its low level of moisture.

(3) MULCHING.

With a view to assessing the influence of varying intensities of soil mulch obtained by deeper and repeated inter-tillage on the yield of the cotton plant, experiments were carried out in duplicates in the 1930-31 and in triplicates in 1931-32. Plants were grown at a distance of every three feet on ridges of the usual type while the distance between the ridges themselves was increased from three to four feet to facilitate inter-tillage. The results of these experiments in terms of seed-cotton per plot are given below in the Table No. 172.

TABLE NO. 172.

Yield of seed-cotton in pounds in plots receiving different degrees of inter-tillage.

1930-31.

99 plants per plot excluding a row all round.

	Yield of seed-cotton in pounds per plot of 2.72 cents.		
	No inter-tillage.	Usual inter-tillage.	Intense inter-tillage.
First series	15.25	15.42	17.45
Second series	16.49	17.24	14.56
Average	15.87	16.33	16.00

1931-32.

114 plants per plot of 3.15 cents. excluding a ring all round.

First series	19.95	19.60	18.40
Second series	17.32	18.85	15.87
Third series	17.83	18.85	17.58
Average	18.37	19.10	17.28

The results were inconsistent in the replications for both the years. Out of the five cases it was only in one plot which received intense inter-tillage that the yield was higher. In the remaining four cases, the plots receiving usual inter-tillage gave higher yields than those in which no inter-tillage was done. The increase in the yield, however, was of a small order. These experiments go to show that mulching fails to improve the yield of the cotton crop. It has been already noted (page 18) that mulching as a method of conserving moisture is of little avail in this type of soil and this finding is now confirmed by the yield performance of the plant. Although mulching is not useful in this way, it is nevertheless important in an indirect manner as it prevents the growth of weeds and averts the loss of soil moisture and plant-food which would occur by their presence.

SUMMARY.

Experiments carried out for studying the effects of various treatments on the growth and yield performance of the cotton plant are described and discussed in this chapter. These fall broadly under the following classes: (1) improvement of water supply in the soil, (2) improvement of plant-food supply in the soil, (3) plant manipulations, and (4) miscellaneous. Some of the more important results emerging from these studies are presented below.

(1) Water requirement of the plant during the vegetative phase of growth, is comparatively great. Improvement of soil moisture in the feeding zones by frequent application of water up to two-acre inches per month, fails to reduce bud and boll shedding. It is, therefore, inferred that deficiency of water in the soil is not responsible for shedding. Nevertheless, there is a distinct tendency for the number of bolls to increase though to a small extent with increase of moisture in the soil after the close of the monsoon.

(2) Soils in the Broach cotton tract are poor in nitrogen which, therefore, becomes limiting at all stages of plant growth. Improvement of nitrogen fertility of the soil is advised. Sulphate of ammonia has been found to be most suitable as a quickly acting form of nitrogen in this tract. For the maximum benefit, applications of nitrogenous fertilizer must be made some time in July to get rain water sufficient to make the manure mobile and available to the plant. It is best to use the fertilizer on two sides of the row of plants at a distance of about 15 cms., so that it should be available to the plant during the seedling stage. Nearer applications are more effective than those given two feet away from the plants. In the former case, every pound of added nitrogen is able to increase the yield of seed-cotton by four to five pounds per acre, the rate of increase being maintained up to forty pounds of nitrogen. In case no rain is obtained after the application, the fertilizer remains in the soil and is used by the next crop in rotation, namely jowar. It is calculated that the increase in the yield of this crop is sufficient to meet the cost of the fertilizer.

(3) The way in which added nitrogen is utilized by the plant, depends upon the condition of its growth. Nitrogen given with water during the bud and flowering stages leads to a greater production of flower-buds, flowers and bolls and distinctly improves the rate of buds succeeding into flowers. If it is made available during the period of boll growth, it enhances the number of flowers and bolls and raises the nitrogen percentage of the seeds. In this case, a greater success of bolls from flowers formed and buds incepted, is also obtained. Experiments have conclusively

proved that nitrogen becomes limiting for increased success of buds into flowers and of flowers into bolls. They have also shown that plants do not attain full expanse for want of enough nitrogen in these soils. Nitrogen deficiency for the fullest expression of all growth characters of the plant from stage to stage is clearly indicated.

In spite of the beneficial effect of the late application on the success of fruiting forms, the use of nitrogenous manure in the early stages of growth, has been shown to be of special advantage from economic consideration. With forty pounds of nitrogen to an acre administered early in the season, the plant doubles its yield of seed-cotton, the increase in yield by late applications being only fifty per cent. It is found that a dose of forty pounds gives maximum returns for every pound of nitrogen added though an increase in this direction with larger quantities of nitrogen up to hundred pounds has been obtained. The usual superiority of the protected plants over the unprotected even under conditions of nitrogenous manuring, remains unimpaired. For the same quantity of added nitrogen, the protected plants have been found to respond with larger yield returns.

(4) For improving nitrogen fertility of the soil, the use of green manures is suggested. San, udid and ikad (*Sesbania aculeata*) and wild indigo have been tried. Ikad has been found to be more suitable for this tract as it produces more organic matter within a comparatively short time. Future work on this subject is recommended.

(5) Evidence resulting mainly from plant manipulation experiments is cited to show that the shedding of buds and bolls is caused by an inadequate food supply in the plant. De-foliation induces shedding of the reproductive forms owing to a reduction in the food-manufacturing surface. De-budding prolongs the life period of the plant. It expands plant-scaffolding and leads ultimately to a greater inception of flower-buds. Prolonged de-budding increases flower formation but results in low yield, particularly of seed-cotton, owing to adverse conditions of environment in which bolling is forced to take place. Evidence is adduced to point out that the low efficiency of boll production of the unprotected plants is caused by the constant destruction of growing buds by the spotted boll-worm, damage to shoots being of minor importance. This results in delaying flowering and reducing the number of flowers. The period of boll setting is likewise delayed concurring with the period of commencement of leaf fall. This leads to a reduction in the number of bolls that can mature on the plant. De-floration and de-fruited increase flower-production but fail to enhance the yield of mature bolls. A gradation of nutritional dominance rising from the vegetative organs to flower-buds, flowers and finally to bolls, has been shown. Stem-ringing and root-pruning promote a better condition for flower-bud development but in no case increased yield is obtained.

CHAPTER VII.

PLANT DEVELOPMENT AND ENVIRONMENT.

While describing the development of the cotton plant under usual conditions of crop production it was observed that in no two years had the rate and magnitude of production of the different organs been alike. The consideration of the causes of this variation was reserved for this chapter as, in most cases, the variations introduced are the expression of dynamic growth of the plant acted upon by one or more factors. As such, each variation cannot be properly explained without involving the consideration of previous growth. Having, therefore, acquainted ourselves with the behaviour of the plant under normal and modified conditions of environment and having studied the internal chemical changes as they take place from stage to stage, it would now be easier to understand and to explain the influence of the external and the internal environment on plant growth.

ANNUAL VARIATIONS IN GROWTH.

Plants grown under spotted boll-worm conditions, being constantly disturbed in their normal growth, do not lend themselves for disentangling the various operating factors responsible for growth variations. We have, however, sufficient data on the protected plants where the highly vitiating factor of the spotted boll-worm is completely kept out. These data, therefore, form the right sort of material for the study of growth variations and their causes.

There is a great diversity in plant performance even under conditions of protection. The data reproduced below in Table No. 173 for a period of six years

TABLE No. 173.

Average production of various organs in plants grown protected against the spotted boll-worm.

	1926-27.	1927-28.	1928-29.	1929-30.	1930-31.	1931-32.	Average.
Number of plants under study	10	14	20	20	20	20	..
Vegetative buds ..	257.8	535.5	426.5	287.9	226.8	299.9	335.6
Flower-buds	215.7	525.9	528.4	278.4	231.0	294.9	345.7
Flowers	80.4	169.2	182.6	139.2	85.4	120.9	129.6
Bolls	43.9	48.4	55.5	44.4	42.3	45.9	46.7
Weight of seed-cotton in grms.	69.1	118.0	103.5	91.4	77.9	83.7	90.6
Weight of seed-cotton in grms. per boll.	1.6	2.4	1.9	2.1	1.8	1.8	1.9
Percentage success of :—							
Bud into flower ..	37.3	32.2	34.6	50.0	37.0	41.0	37.5
Flower into boll ..	54.5	28.6	30.4	31.9	49.5	38.0	36.0
Bud into boll ..	20.4	9.2	10.5	16.0	18.3	15.5	13.5

indicate that the magnitude of growth was conspicuously higher in years 1927-28 and 1928-29 than in the remaining four years. Even then, there was no complete agreement between the growth behaviour of the plant for the two years. Thus the production of vegetative buds and the yield of seed-cotton per boll as well as per plant was higher in 1927-28 than in 1928-29. In the latter year, on the other hand, the number of flowers and bolls was greater. The final performance of the plant in the other years, though comparatively poor, exhibited marked differences with regard to the extent of production of the different organs. Again, a larger production of certain organs was not necessarily associated with a larger production of other organs. As an instance of this fact, the years 1929-30 and 1931-32 may be quoted. In the former year, although the number of vegetative buds and flower-buds was less than that in the latter, the number of flowers formed was greater. Similar variations are easily noticeable in the other years also.

As in the case of total production just discussed, so in the case of both the rate and span of production of the different organs considerable variations are observed. This will be evident from Graph No. 65 in which are shown the curves for the average weekly production of vegetative buds, flower-buds and flowers. It is necessary to mention that the curves for vegetative buds and flower-buds for the year 1927-28 are not quite representative from the middle of November as the data for this period have been obtained by halving the fortnightly counts. Nevertheless, they give a fair idea of the nature of growth in general for that year.

Thus, a variety of differences arise every year in the rate, extent and the span of production of different organs. The causes of these variations in growth, in different years, have to be sought both in the internal and the external environment of the plant. Indeed, as Zaitsev (1928) observes that "in the general development of the cotton plant beginning with germination and ending with the opening of bolls, there is a definite rhythm due to internal factors. At the same time this rhythm is subjected to definite changes and is influenced by the external factors such as weather and nutrition." The disentanglement and the apportioning of growth, at any stage, to the internal rhythm and the external factors is complicated owing to "the high relationship of the external factors affecting one or more physiological processes. The effect produced by any one factor is markedly dependent on the intensity of other external factors. This makes much more intricate the study of the effect of meteorological conditions on plant processes such as growth" (Blackman, 1929).

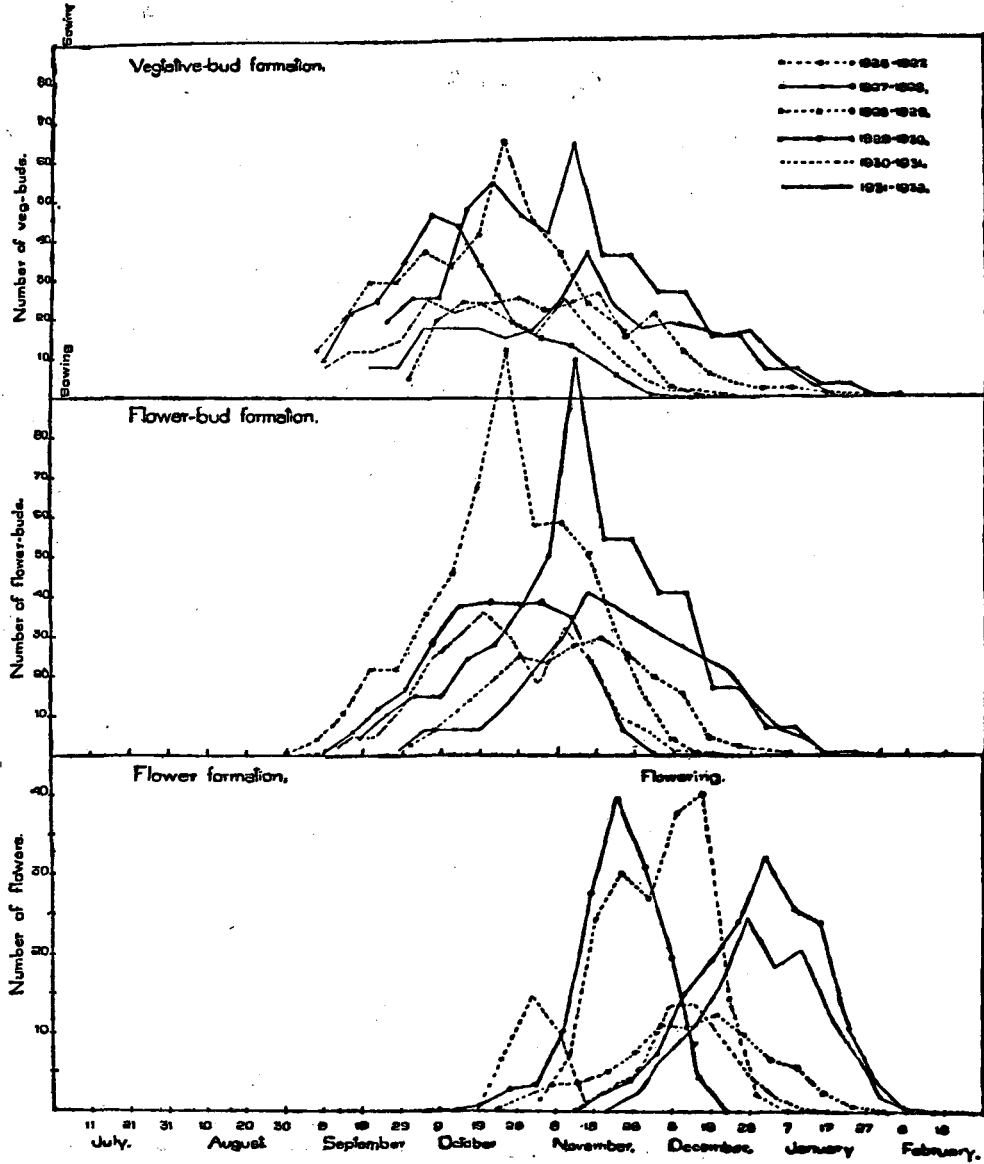
Hence, in the study of the causes of growth variations, we cannot do more than indicate the possible causal factors by pointing out merely certain associations of growth with changes in the environment in which the plant grows. Although the degree of expression of potential capabilities of the plant is governed by the environment, it must not be forgotten that the whole organism follows a certain sequence of growth and creates correlative influences which are also responsible for determining the nature of that growth. Before proceeding, therefore, to the study of the influence of external factors, some of the growth correlations occurring in the cotton plant must needs be considered.

GROWTH CORRELATIONS IN THE COTTON PLANT.

Among the correlative influences of growth, mention may be first made of the relation existing between the production of leaves and flowers. In

GRAPH NO. 65.

Average weekly production of vegetative buds, flower-buds and flowers in protected plants.



Graph No. 66 are shown the curves of the weekly average production of leaves, flower-buds, flowers and the relative success of flowers and bolls. It will be clear from this graph that the commencement of flowering always begins when the rate of leaf production attains a maximum value. Further, as the rate of flower formation increases that of the leaf steadily goes down and this continues until the former reaches a maximum for the season while the latter practically ceases. This means that the flowers, which continue their growth as bolls, exert a retarding influence on the production of leaves or, in other words, on the further expansion of the plant. While dealing with the effects of de-budding on the future performance of the plant (page 237), it has been made abundantly clear that the vegetative expansion of the plant continues unabated provided the flower-buds as they appear on the plant are removed from time to time. If, on the other hand, they are allowed to grow into flowers and bolls, the enlargement of the plant steadily comes to an end.

Another growth relation exactly similar in character is in regard to the elongation of the main stem and the advent of flowers. The data embodied in the Table No. 174 show that the growth of the central axis ceases with the appearance of flowers on the plant. This observation is in accord with that made by Mason (1922) to which we have referred on a previous occasion.

TABLE No. 174.

The time of the cessation of growth of the main stem and the advent of flowers on the plant.

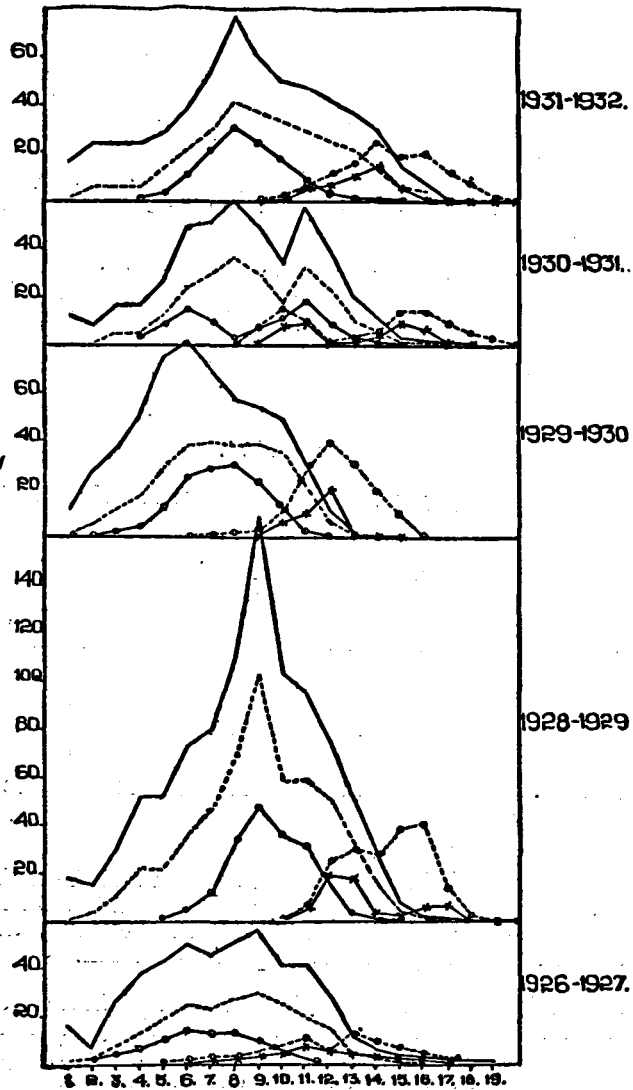
(In the week from sowing.)

Year.	1926-27.	1927-28.	1928-29.	1929-30.	1930-31.	1931-32.
Cessation of growth of stem.	22	22	18	16	20	22
Advent of flowers ..	18	21	18	16	18	22

The third correlation is in respect of root growth and the shedding of reproductive forms. It has been already noted (page 237) that if the flower-buds shed owing to some cause or are directly removed from the plant, the root-system increases in dry matter and penetrates deeper into the soil.

These observations indicate that so far as the growth in terms of plant expansion is concerned, it is largely regulated in its latter half by correlative influences, while in its former half it is governed principally by the environmental complex. Having, thus, dealt with the internal correlative influences to which the plant is subject, we may now turn to the study of the external environment and examine its effect on plant growth. This can best be done by following up the growth of the plant from the seedling to the harvest stage, in relation to its environment.

GRAPH No. 66.
 Average weekly production of leaves, flower-buds, flowers and the relative
 success of flowers and bolls.
 (Protected Plants.)



Number of weeks.
 — Leaves. Flower buds. x-x-x Relative bolls.
 o-o-o Relative flowers. o-o-o Actual flowers.

ENVIRONMENTAL CONDITIONS EXPERIENCED BY THE PLANT.

A general description of the climatic and the soil conditions experienced by the plant has been given, at some length, in the second chapter of this volume. There it has been stated that the environment of the plant does not remain constant but undergoes a continuous change throughout the whole period of nine months during which it happens to occupy the land. This period is divisible into four sub-periods, according to the nature of weather conditions. The first sub-period extends from the date of sowing some time in June or early in July to the end of September. The most prominent features of this period are the saturated condition of the soil and the cloudy condition of the atmosphere. The second sub-period comprises the four weeks of October and is characterised by high temperature and bright sunshine, being the hottest part of the season. The third sub-period commences from the beginning of November and lasts till the middle of February. This period is associated with low temperature and represents the cold period of the year. The fourth sub-period is again conspicuous for its high temperature. We shall now study the progress of the cotton plant through all these periods and see what factors are responsible for causing variations in its growth.

I. FIRST PERIOD OF GROWTH FROM JUNE TO SEPTEMBER.

In this period we shall consider the influence of two factors as modifying the future performance of the plant. Of these the first is the rainfall leading to an over-saturated condition of the soil while the second is the cloudy condition of the atmosphere, as affecting the activity of the leaves.

Rainfall.

In the Broach tract, the cotton crop depends entirely on the natural supply of soil moisture obtained from rains. The rainfall, however, is restricted to the first three to three-and-a-half months after sowing, when not more than ten to fifteen per cent. of the total growth of the plant takes place. In the remaining five and a half to six months of the crop season, no rain is normally obtained although in some years occasional showers may be received in the midst of the growing season. (October to December.) All the water required for the major growth of the plant is, thus, derived from soil moisture. Whatever changes and variations in soil moisture occur, they would naturally depend upon the quantity of water received from rains year after year. It has been already pointed out in Chapter II, that the total moisture at the end of the rainy season, in all layers of the soil, varies between thirty to twenty-eight per cent. and is reduced to about eighteen per cent. at the end of the season. Owing to heavy cracking of the soil under conditions of high temperature, specially in the months of April and May, further losses of moisture particularly in the upper layers of the soil, always occur so that towards the beginning of the crop season, there is not much moisture left in these layers. Unless, therefore, the reduced supply of moisture is augmented every year by rain water, it is not possible to grow any crop whatever. It is no wonder, therefore, that in years of scanty rainfall, the crop completely fails. Such years are, however, not frequent in the Broach tract and appear only once in about twenty.

In the Broach tract, therefore, where the cotton crop has to be raised entirely on the natural supply of moisture in the soil, rainfall naturally occupies the foremost place among the factors which determine the magnitude of plant growth. The development of the plant during the rainy season, is however, very slow owing to the super-saturated condition of the soil. This is well seen in the better condition of growth exhibited, even during the seedling stage, by plants grown on the ridges (page 253). It has been the experience, in this tract, that owing to the saturated condition of the soil and also owing to water-logging, the seedlings generally succumb and resowing has to be resorted to. The Departmental experiments on the Surat Farm (Bulletin No. 123 of 1925), show that if the seeds are sown on ridges where the water-logging conditions are absent, the emerging seedlings do not succumb unless they are actually washed away but are able to get a better stand quite early in the season than on a flat piece of ground. This means that one of the factors responsible for the poor growth of the plant during the rainy season, is the over-saturated condition of the soil.

This observation finds ample evidence in the growth data collected on protected plants for a period of six years. These are given in the Table No. 175. In the next Table No. 176, data on total rainfall and its fortnightly distribution during the

TABLE No. 175.

Average performance of protected plant till the end of September.

Year.	1926.	1927.	1928.	1929.	1930.	1931.
Date of sowing.	4th July	2nd July	7th July	15th July	26th June	2nd July
Date of recording count.	1st Oct.	28th Sept.	28th Sept.	30th Sept.	29th Sept.	28th Sept.
Number of days from sowing.	89	88	83	77	95	88
Height of main stem ..	23.50	45.10*	76.20	56.20	52.80	26.50
Rate per day ..	0.28	0.51	0.92	0.68	0.56	0.30
Vegetative buds ..	23.60	76.53	107.20	102.10	58.55	28.55
Flower-buds ..	3.70	29.53	57.85	34.70	21.55	0.95

Percentage production of the final performance.

	%	%	%	%	%	%
Height of stem ..	27.8	40.7	54.5	54.7	47.2	23.2
Vegetative-buds ..	9.2	14.3	25.2	35.5	25.8	9.5
Flower-buds ..	1.7	5.6	10.9	12.5	9.6	0.3

* Calculated.

six seasons are also presented. These two tables show that in the year 1926 in which there were heavy and incessant rains throughout the period commencing from mid-June and ending with the third week of September, the growth of seedlings had been the poorest. This year is easily marked out as almost a record year of

TABLE No. 176.

Periodical rainfall in inches and the number of rainy days in different years.

	1926.	1927.	1928.	1929.	1930.	1931.
Rainfall in June ..	0.97	9.96	2.91	9.07	16.43	0.35
July, 1st fortnight ..	15.68	5.93	8.59	33.78	10.41	16.67
July, 2nd fortnight ..	13.28	6.41	3.27	0.54	5.54	9.12
August, 1st fortnight ..	11.68	1.50	2.11	1.80	2.19	10.34
August, 2nd fortnight ..	8.09	1.99	1.85	1.45	0.26	4.70
September, 1st fortnight.	6.65	0.99	0.38	..	5.34	0.38
September, 2nd fortnight.	6.60	3.25	5.90	0.45	0.06	3.50
October .. .. .	..	2.15	0.87	0.32	0.95	8.26
After October .. ..	..	2.90	0.33	0.88	0.10	0.06
Total	62.95	35.08	26.21	48.29	41.28	53.38

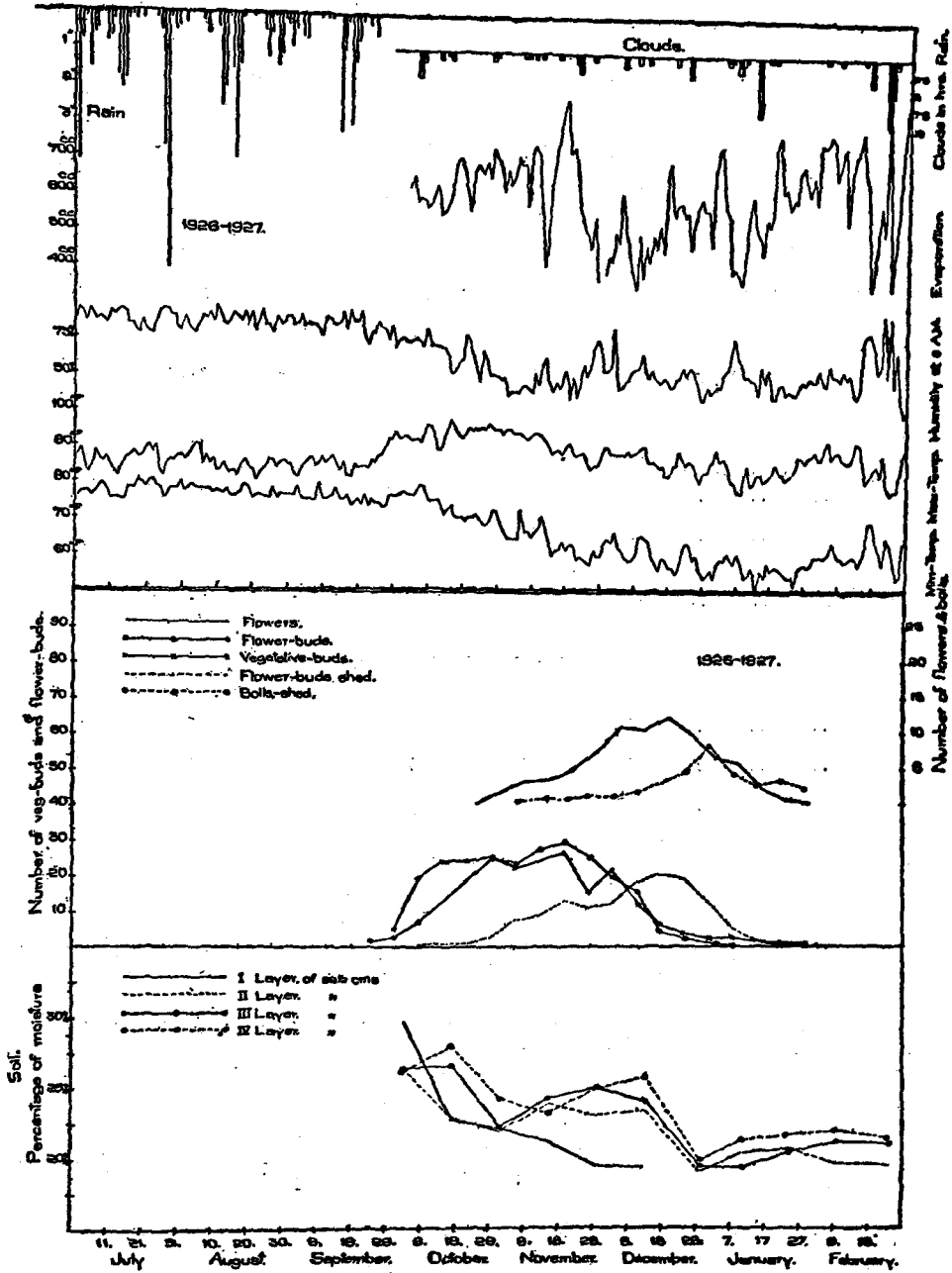
Number of rainy days.

July	26	26	27	19	25	23
August	23	19	16	18	10	27
September	17	18	10	2	8	8

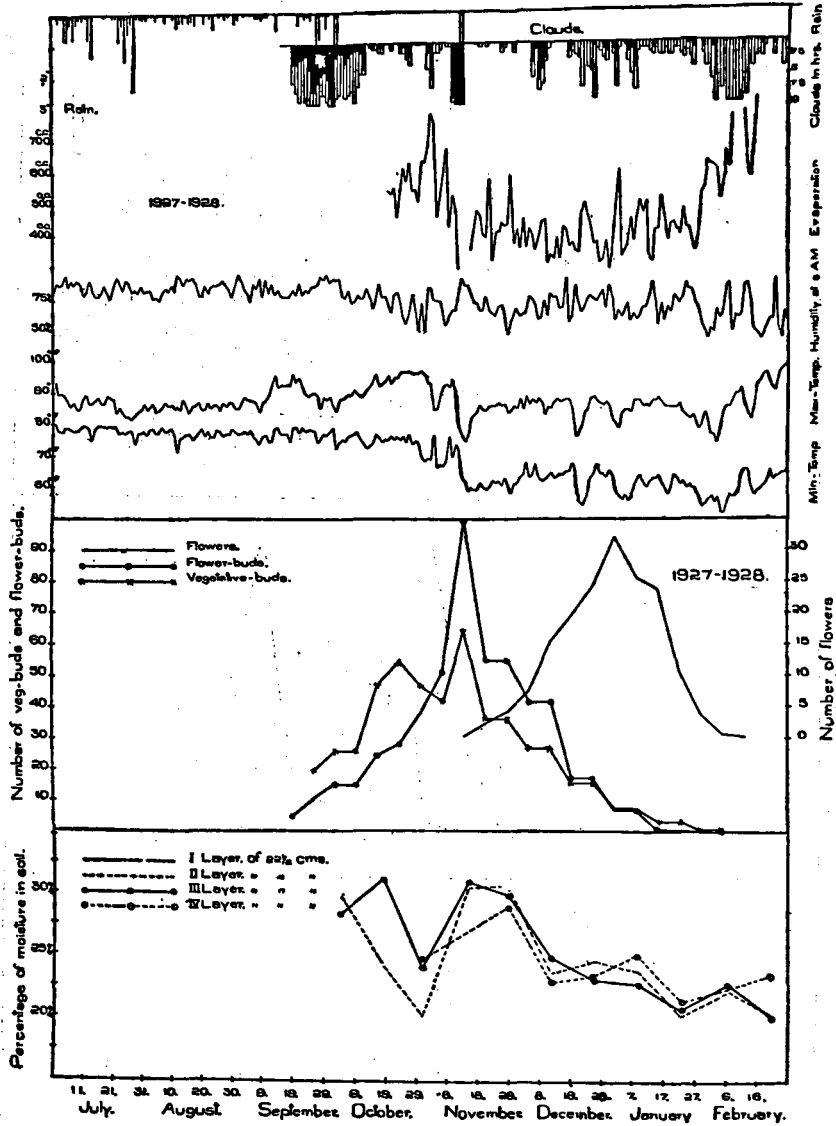
rainfall (Graph No. 67), the total precipitation amounting to 63 inches. Another case of retarded and belated growth is provided in the year 1931. This year, the rains in June, July and August were likewise heavy but the relieving feature of the season was that the rains in September were light with frequent breaks (Graph No. 72). On this account, a slight improvement in the growth of seedlings was noticed.

Going to the extreme, it will be found that of the six years under study, the year 1928 witnessed the earliest and the best growth of the plant. This year was characterised by the least amount of rainfall (26 inches). The distribution of rainfall during this season was an ideal one as after heavy and continued showers in July, very essential for a thorough wetting of the soil, the rains were generally light in character and were interrupted by frequent spells of dry weather (Graph No. 69). The same case is again observed in the year 1929, in spite of the fact that

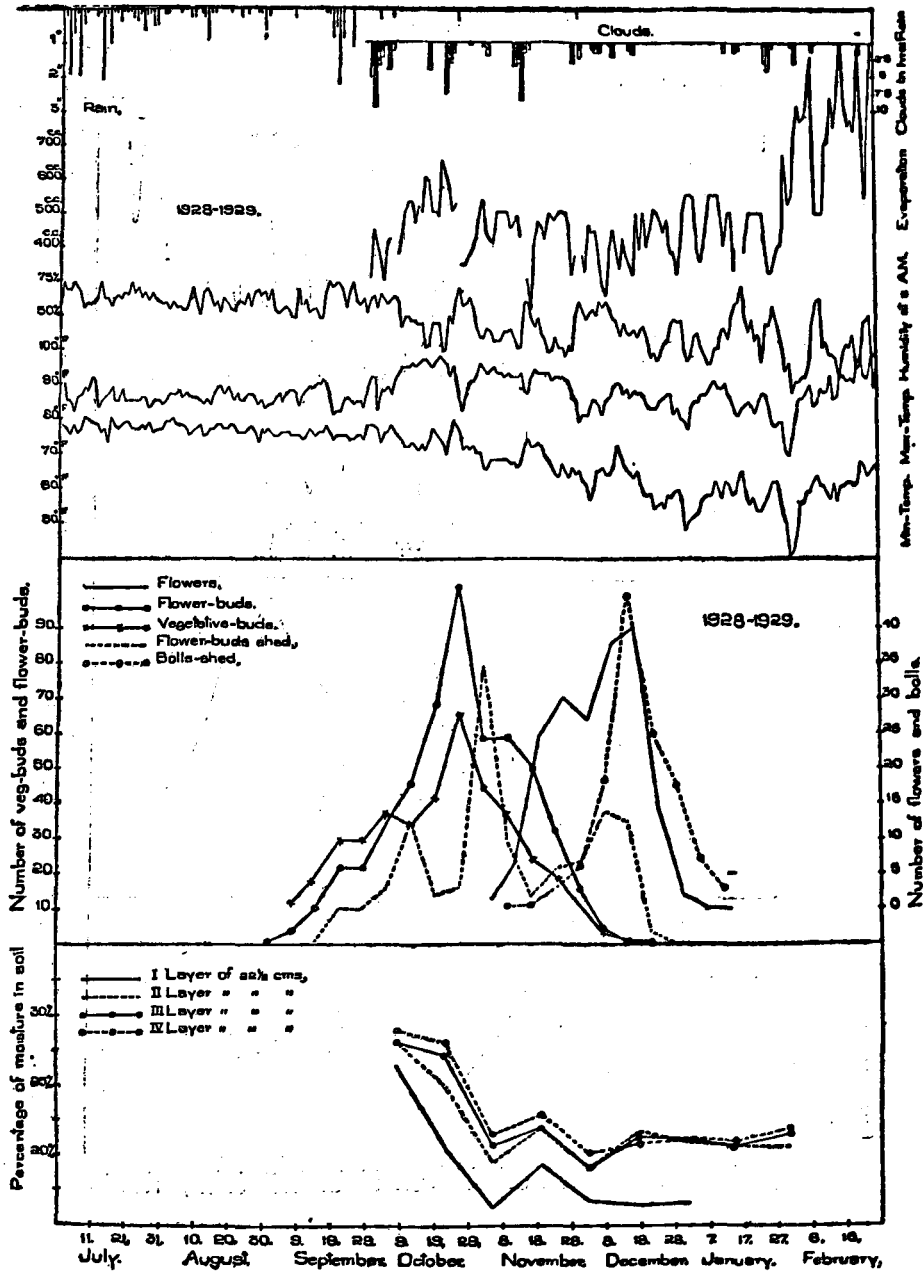
GRAPH No. 67.
 Periodical conditions of the environment and plant performance,
 1926-27.
 (Protected plants.)



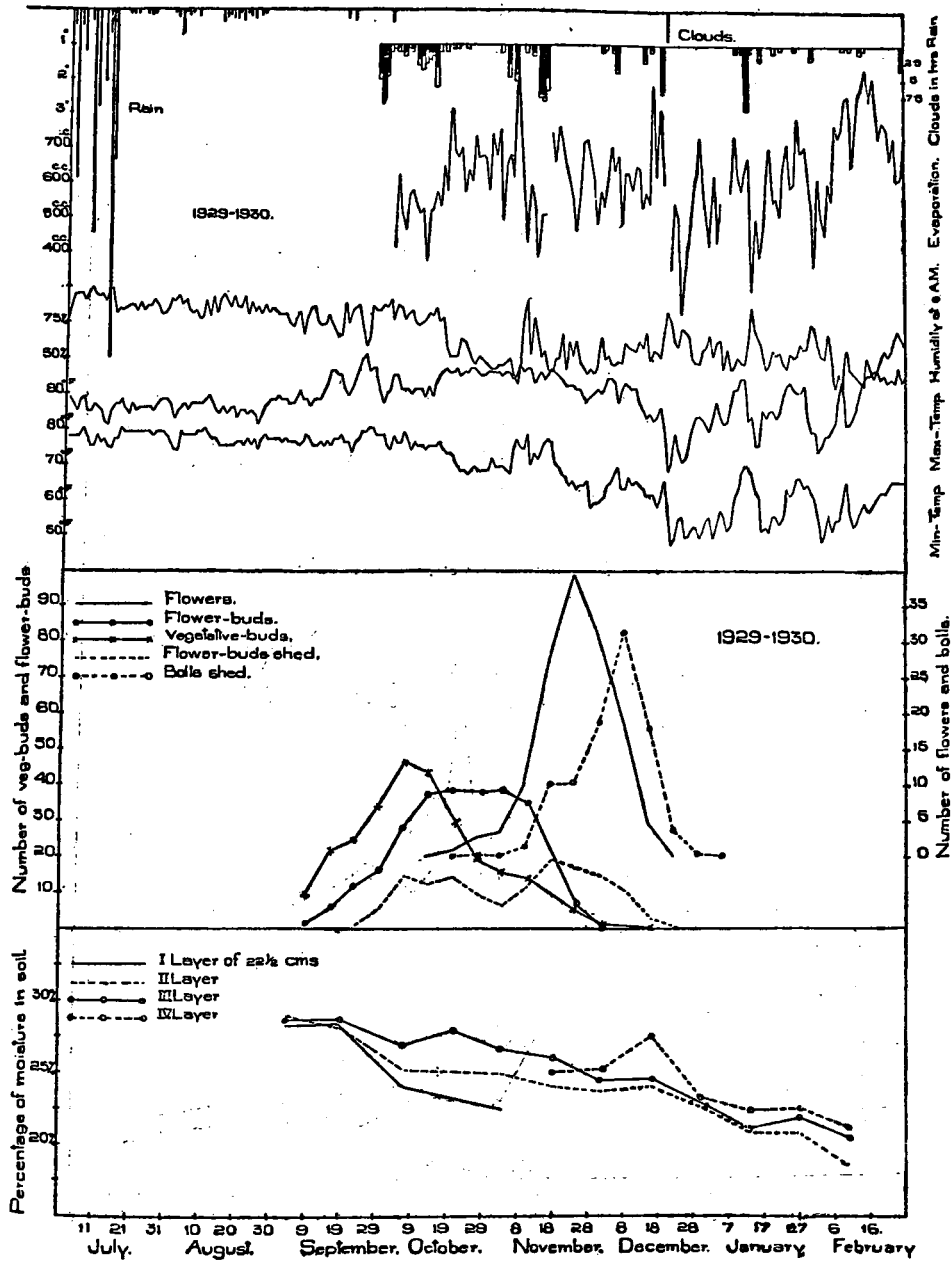
GRAPH No. 68.
Periodical conditions of the environment and plant performance.
 1927-28.
 (Protected plants.)



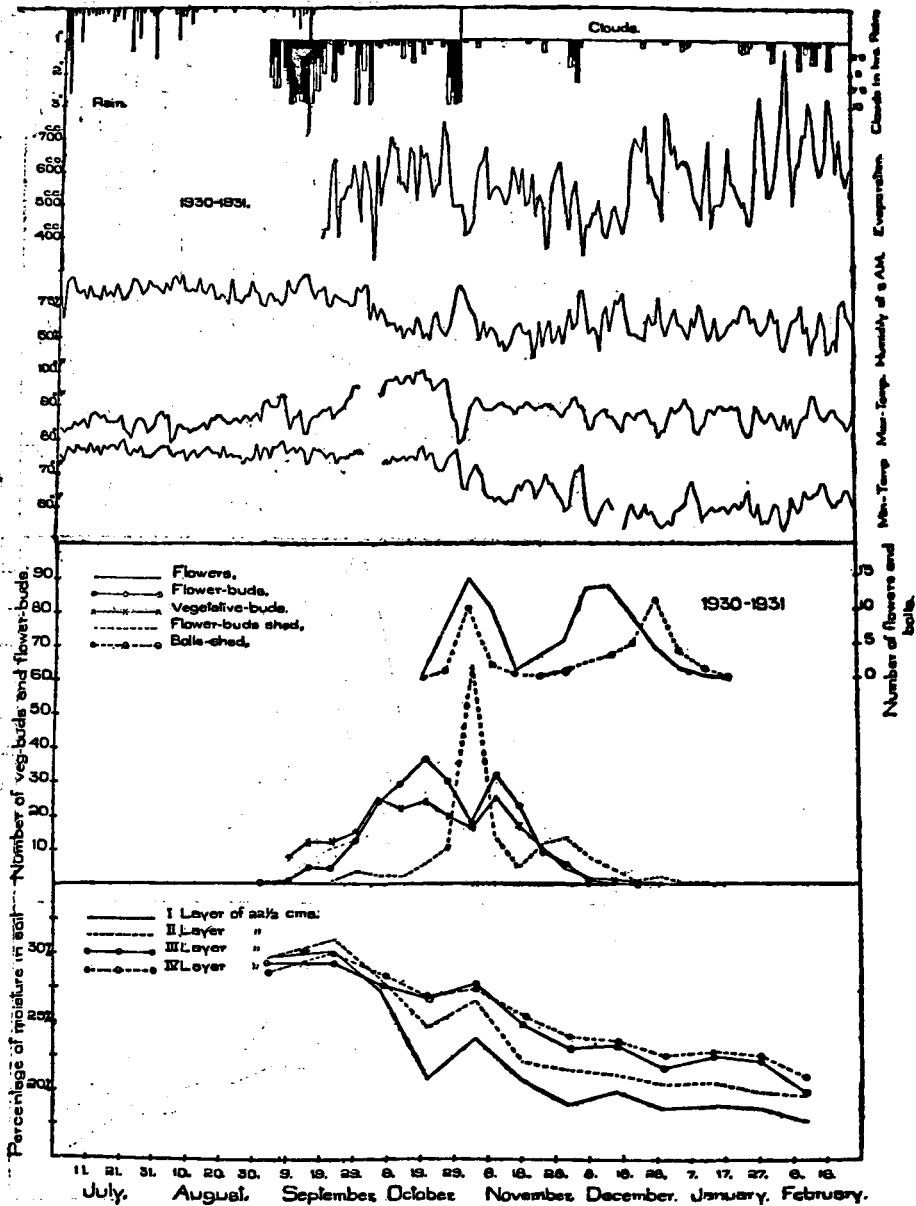
GRAPH No. 69.
 Periodical conditions of the environment and plant performance.
 1928-29.
 (Protected plants.)



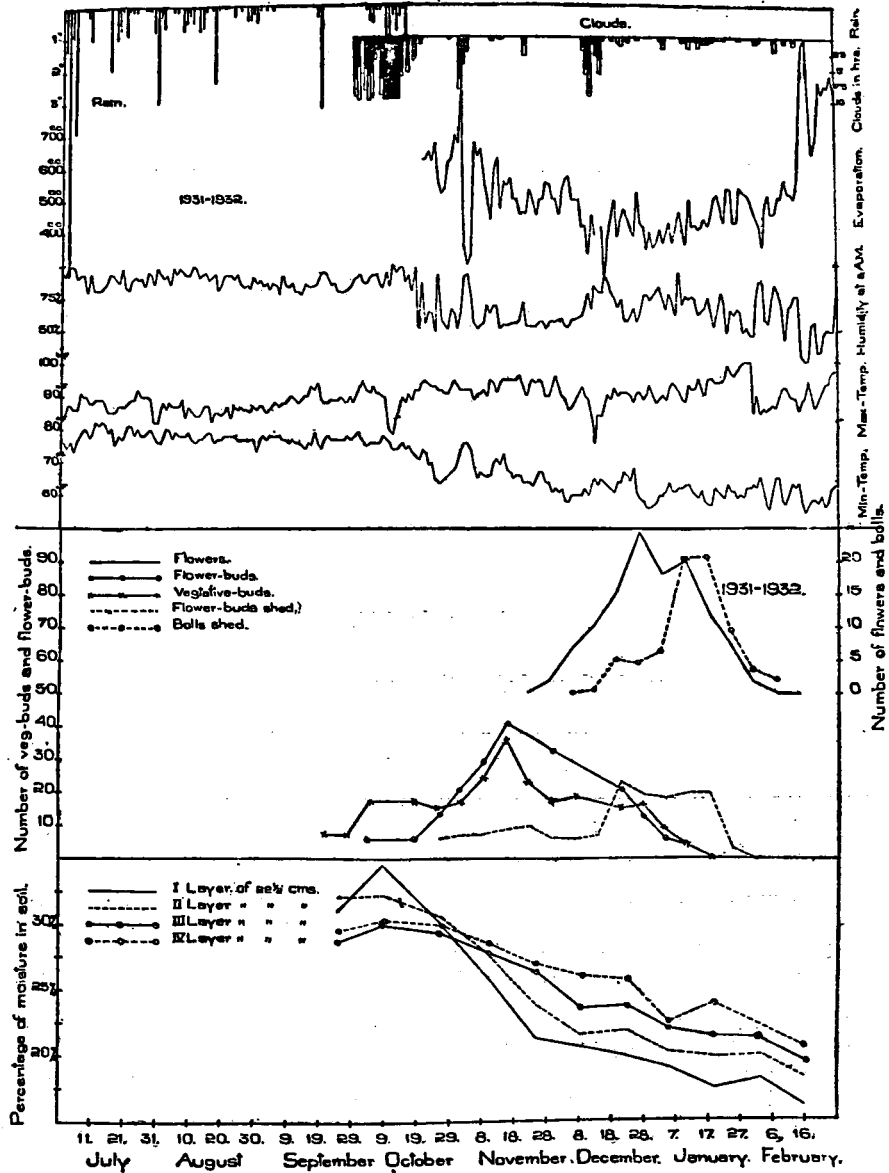
GRAPH No. 70.
 Periodical conditions of the environment and plant performance.
 1929-30.
 (Protected plants.)



GRAPH NO. 71.
 Periodical conditions of the environment and plant performance.
 1930-31.
 (Protected plants.)



GRAPH NO. 72.
 Periodical conditions of the environment and plant performance.
 1931-32.
 (Protected plants.)



the quantity of rain received this year was as high as 48 inches. Out of this, nearly 44 inches of rain was, however, obtainable in the second fortnight of June and the first fortnight of July (Graph No. 70). The undesirable effect of this heavy rainfall concentrated in so short a period as one month, was that it damaged and washed away many a seedling grown even on ridges and necessitated re-sowing. The new seedlings arising from the second sowing received, in small showers, only four inches of rain. The plants, on this account, experienced drier conditions pretty early, grew fast, and produced up to the end of September vegetative buds and flower-buds almost equal to those in 1928, in spite of the late and the second sowing. The growth in the other two years, namely 1927 and 1930, was moderate and intermediate (Graph Nos. 68 and 71).

The unhealthy condition of the soil caused by an excess of rain water is first felt by the roots before its effects are reflected on the development of the plant as a whole. Variations in the growth of the shoot just discussed are, therefore, to be found in the case of the roots as well. The high content of water in the soil retards the downward progress of the roots which, therefore, spread horizontally in the upper layers of the soil (page 43) and descend to lower depths when only better conditions prevail. These facts are well illustrated in the depths reached by the tap-root, in different years, towards the close of the monsoon. The data bearing on this point are reproduced in the Table No. 177 and refer to the unprotected plants as those under protected conditions are not available for most of the six years under study. It may be noted that damage to shoots caused by the spotted boll-worm or the shoot-roller does not affect, in any manner, the development of the roots and hence the figures here reported have been taken to represent the growth of the roots under conditions of protection. (See Table No. 45 in the Appendix.)

TABLE No. 177.

Average depth reached by the tap-root on the 7th October.

	1926.	1927.	1928.	1929.	1930.	1931.
Depth of tap-root in cms.	33	..	81	76	65	52

It will be seen from this table that the depth reached by the tap-root by about the 7th of October is not the same in all the years. It has varied a good deal from 33 to 81 cms, depending upon the extent and the nature of the rainfall. Thus, in the year 1926, a year of heaviest and incessant rainfall, root growth was seriously hampered and consequently the tap-root was not able to descend to a depth below 33 cms. The best growth of the roots is to be found in the year 1928. This year was characterised by light and well-distributed rainfall and as a result the tap-root reached a record depth of 81 cms. by the 7th October. The other years fall in between these two years in respect of the root growth.

The causes of better growth of the plant in years of light and well-distributed rainfall are three-fold. In the first place, the intermittent rains replenish the loss of moisture which usually takes place in the upper layers of the soil, owing to temporary spells of dry weather and the winds which blow heavily during the seedling phase of the plant. Such a replenishment of the lost water is absolutely necessary as the upper layers of the soil in which the plant feeds at this time, dry up quickly before the roots have time to descend to lower depths. Secondly, the intermittent rains are of advantage in that they improve the conditions for soil-aeration, so essential for the respiration of roots. Thirdly, owing to the alternate wetting and drying they induce such conditions of the soil as promote the process of nitrification at a high rate, the products of which become easily available to the plant (Sahasrabudde and Daji, 1925). In years, therefore, when rains alternate with the spells of dry weather the process of nitrification gets accelerated and thus helps the growth of the plant as occurred in 1928 and also in 1929.

It will be evident from the foregoing discussion that the wide variations in the growth of the cotton plant during the seedling stage are caused by the extent and the manner of distribution of rainfall in so far as it affects the activity of the roots.

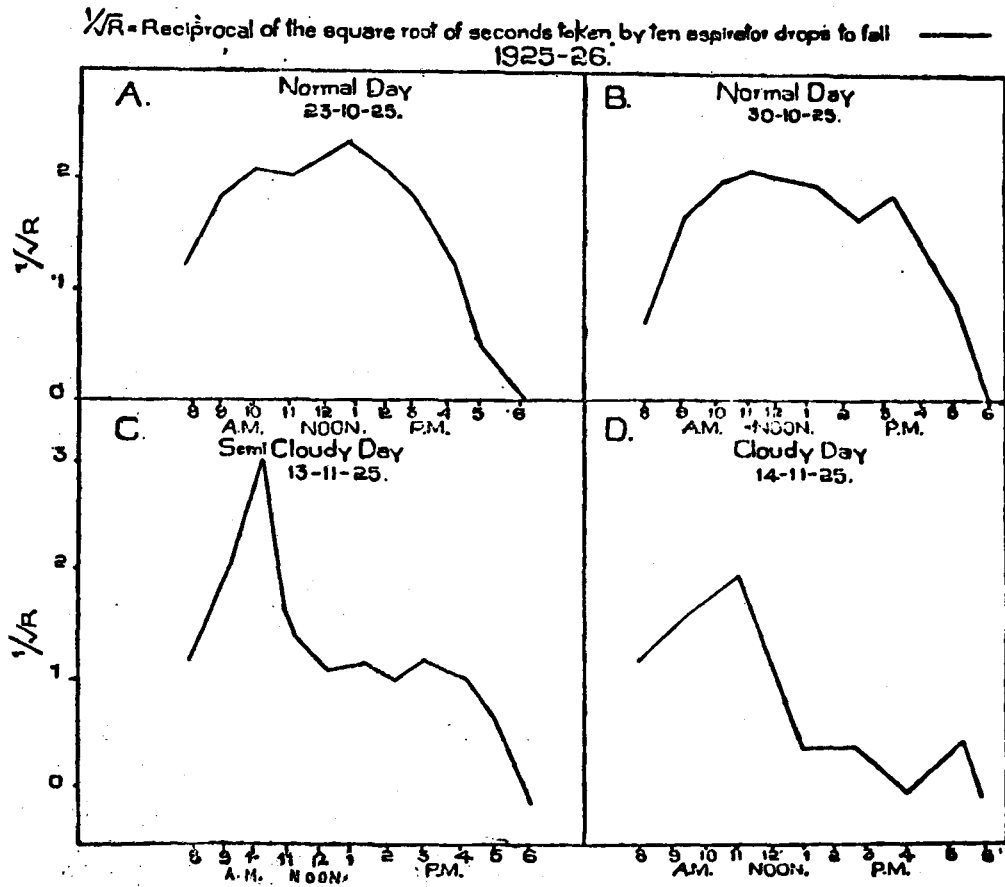
Clouds.

Another factor closely associated with rain and which precedes it, in the constituted order of things, is the general cloudy conditions of the atmosphere. Such conditions exercise no small influence on the growth of cotton seedlings in moulding the future behaviour of the plant. While excessive moisture in the soil affects considerably the activity of the roots, persistent cloudy conditions of the weather impede the progress of normal development of the shoot mainly by regulating the gaseous exchange through stomatal openings of the leaves, and hence the production of assimilates on which depends the further expansion of the plant. This is shown by the results of our experiments in which hourly variations in the width of stomatal opening were studied, during the day, both under cloudy and bright sunshine conditions. These experiments were specially undertaken because of the fact that different plants respond differently to changes in illuminations to which they happen to be exposed. According to Leitgeb as quoted by Pfeffer (1900) (Vol. I, page 194), in certain plants the stomata open more widely in darkness while in many others, they almost close. The results of our studies on this subject are reproduced below in the Graph No. 73. They show that in cotton leaves, the width of stomatal opening narrows or closes according to the degree of illumination or what is the same thing as the extent of cloudy conditions of the atmosphere. Partial or complete closure of stomata, in its turn, affects adversely the physiological process of transpiration. This process is also affected to an appreciable extent by the high relative humidity so characteristic of the rainy period.

The intensity and the duration of cloudy conditions vary considerably every year. Being closely associated with rain, such conditions are particularly restricted to the rainy months though they may appear later in the midst of the growing season, depending upon the nature of the environment. It was not possible to record data on the intensity of clouds during the rainy season for obvious reasons. After the cessation of rains, however, a complete record of all

GRAPH NO. 73.

Activity of stomata in cotton leaves, expressed in terms of the reciprocal of the square-root of seconds required for ten drops to fall from an aspirator.



changes in illumination were maintained with the help of a Campbell's sunshine recorder for all the years. These changes have been reproduced in the climatological Graph Nos. 67 to 72 and will be referred to when occasion arises. Although, therefore, no data are available on the intensity of clouds and its duration for the rainy months, direct observation shows that in 1926 and 1931—years of heavy rainfall

—the sky was overcast with clouds in the months of July, August and September. In 1928, on the other hand, there were intermittent periods of clear sky in August and September. The sky was comparatively more cloudy during this period in the year 1927. In the year 1929, it was free from clouds from the middle of August.

In this way, variations in the intensity of clouds during the rainy season always occur, which either heighten or modify the rate of production of photosynthates. The early disappearance of cloudy conditions accelerates the production of assimilates and leads to an early and a better growth of the plant. If, however, these conditions are prolonged, growth is retarded and delayed. As instances of the disparity in growth introduced by such environment, the years under study may be cited. Thus, in the year 1928, there were intermittent periods of bright and clear sky from the month of August and consequently the growth of the cotton plant commenced pretty early and proceeded also at a high rate. Similarly in 1929, the growth started early owing to the release of better conditions from the middle of August. In 1927, on the other hand, although the distribution of rainfall was more or less similar to that in 1928, the prolonged absence of sunshine checked and delayed the growth of the plant.

From all these considerations, it will be more than evident that the growth and development of the cotton plant during the seedling phase is dominated by the influence of three main factors, namely the moisture in the soil, the relative humidity of the air and the cloudy conditions of the atmosphere.

II. SECOND PERIOD OF GROWTH, THE MONTH OF OCTOBER.

As the rain gradually disappears temperature of the air rises, its humidity falls and the bright sunny conditions typical of October get gradually established. These conditions may sometimes be either delayed or hastened according to the nature and extent of the rainy season. Nevertheless, October still remains the hottest part in the whole of the crop season. It is during the period of transition from the low to the high temperatures of October that the differentiation of the reproductive tissues occurs for the first time in the life of the plant. (Graph Nos. 67 to 72.) Under the influence of bright sunshine, the high temperatures both of the soil and the air and the optimum conditions of soil moisture now prevailing, the plant is stimulated into activity and as a result the production of vegetative buds proceeds faster than ever.

Among the factors which bring about a change in the environment and which direct the growth of the plant in its destined course, temperature exercises by far the greatest influence. This factor comes into play after the cessation of rains. During the first two months from the date of sowing, *i.e.*, July and August, the maximum and the minimum temperatures do not generally show much fluctuation. On this account, the curves for these temperatures run practically parallel to each other at this time, the diurnal difference being of the order of eight degrees F. From September onwards, however, the air maximum shows a tendency to rise although the extent and duration of the rise are largely governed by conditions of rainfall as indicated above. For instance, in 1926 where the rains continued till the third

week of September the air-maximum temperature did not at all rise till that time. In 1928 and 1929 where the rains in September were light and intermittent, the air maximum began to rise from the first of that month and so forth.

A change in the temperature conditions always brings about a change in the growth of the plant. A critical study of the rise in temperature and plant growth brings out in a characteristic manner the close relationship between the two. This will be evident from the Graph No. 74 in which the weekly production of vegetative buds and the weekly mean maximum temperatures are shown. It may be noted that the temperature curve drawn below the curve of vegetative buds does not refer to time as such; it has been shifted forward so as to coincide with the rises or falls in the curve of vegetative buds. The important fact to be noted in this graph is the close parallelism between the curves of the mean maximum temperature and the rate of vegetative bud-production. The period by which the temperature curve has had to be shifted forward is not constant in all the years but varies a good deal from one to four weeks depending upon the intensity of clouds during the period.

Thus, in the year 1926, the effect of the rising maximum temperature was reflected upon the production of vegetative buds within so short a time as one week, there being practically no clouds in the sky at the time. (Graph No. 74.) In 1927 and in 1930, on the other hand, a period of not less than four weeks was required for the manifestation of the temperature effect. This period may be said to be the most cloudy in all the six years under study. Rains were also received in this period, which arrested to some extent the rise of the maximum temperature. In 1928 only three weeks were required. This year the cloudy conditions of the atmosphere were intermediate between those of 1926 on the one hand and of 1927 and 1930 on the other. In 1929, a still shorter period of about two weeks was required, again for the same reason.

From these considerations, it will be obvious that the initiation of vegetative buds in the plant takes place within a period of one to four weeks depending upon the intensity of the maximum air temperature before the actual emergence of these organs. Thus, the production of vegetative buds seems to be determined by temperature conditions two to three weeks earlier. The intensity of maximum temperature which determines beforehand the rise or fall in the production of vegetative buds differs widely in different years, the extent of production being conditioned by the previous tone of the plant. This will be seen from Graph No. 74.

Another correlation existing between the air temperature and plant growth is with respect to the production of flower-buds. In all the years, the divergence of the air maximum and the air minimum is associated with the commencement of the accelerated growth of the main stem and the production of vegetative buds. But the more noteworthy feature of the time when the difference between the two temperatures begins to widen is the sprouting of the first fruiting branch or in other words, the initiation of the reproductive phase of the plant. This will be seen from Table No. 178 where the difference between the weekly mean maximum and minimum air temperatures and the dates of the first arrival of flower-buds have been given.

GRAPH No. 74.

The mean maximum temperature and the rate of vegetative bud production in different years.

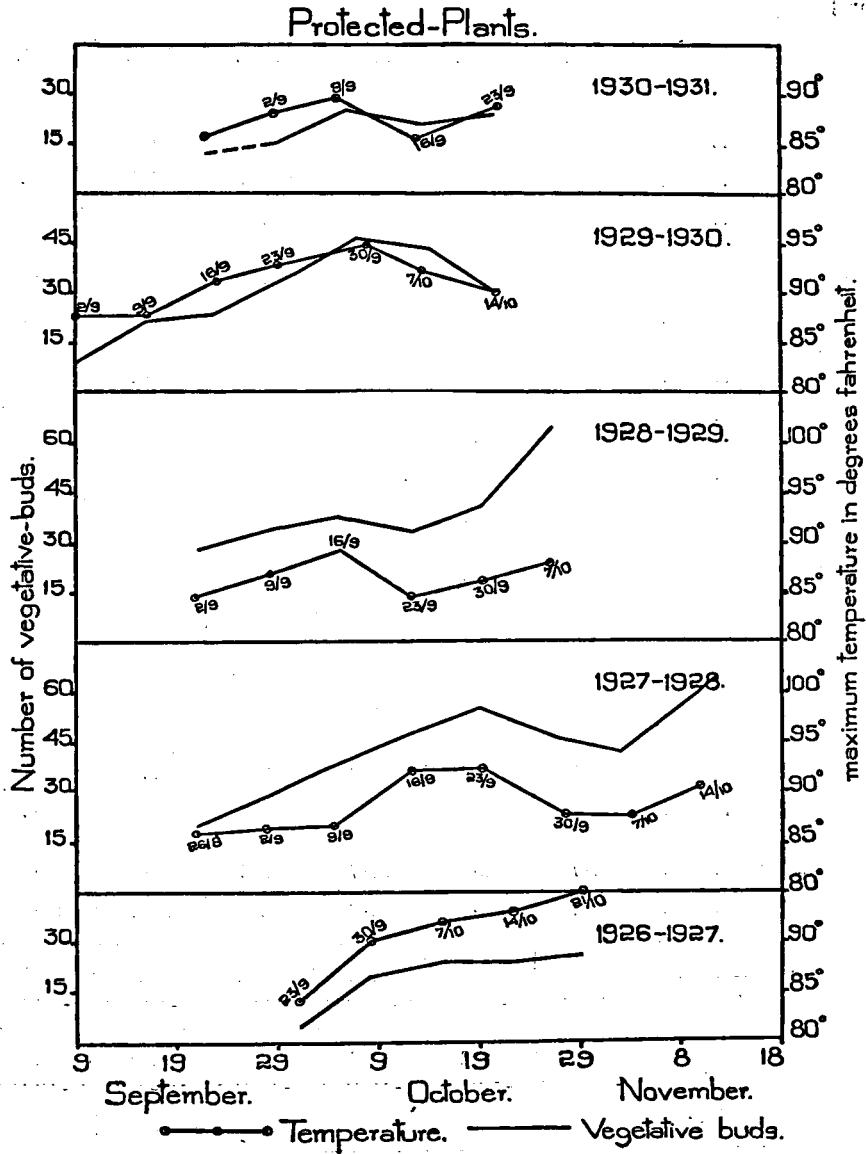


TABLE No. 178.

The difference between the weekly mean maximum and minimum air temperatures and the dates of the first appearance of flower-bud in different years.

Week ending	1926.	1927.	1928.	1929.	1930.	1931.
8th July	9.1	10.3	9.0	9.0	7.2	11.0
15th July	8.1	8.5	10.0	8.7	9.3	8.3
22nd July	8.8	7.9	7.7	7.1	6.7	8.0
29th July	7.8	6.4	7.7	7.7	7.8	10.8
5th August	9.5	7.7	7.8	9.2	7.7	7.7
12th August	7.5	9.2	9.1	9.0	7.2	8.1
19th August	6.4	9.2	10.1	9.3	9.0	7.7
26th August	7.4	8.9	9.1	8.1	10.4	8.0
2nd September ..	7.6	9.0	8.9	10.7	12.1	9.7
9th September ..	9.7	10.7	11.2	11.4	12.0	9.4
16th September ..	9.0	15.5	13.5	15.5	9.4	13.6
23rd September ..	9.5	15.0	9.2	16.8	12.4	13.8
30th September ..	14.9	11.8	10.7	16.5	17.2	11.7
7th October	15.1	12.4	11.8	15.6	..	15.5
14th October	18.0	16.2	22.3	15.5	23.8	9.7
21st October	23.7	18.4	22.7	22.6	23.4	17.3
28th October	25.5	21.3	15.7	28.0	21.3	25.8
Flower-bud arrived in week ending.	24th September.	14th September.	7th September.	9th September.	8th September.	28th September.
Commencement of widening between the max. and min. temperatures after week ending.	23rd September.	2nd September.	2nd September.	2nd September.	26th August.	9th September.

There is a fairly close agreement between the time of the arrival of the flower-bud on the plant and the commencement of divergence of the maximum and the minimum air temperatures. This means that one of the important factors for the initiation of reproductive phase in the cotton plant is the rise in the temperature difference between day and night.

III. THE THIRD PERIOD OF GROWTH FROM 1ST NOVEMBER TO 15TH FEBRUARY.

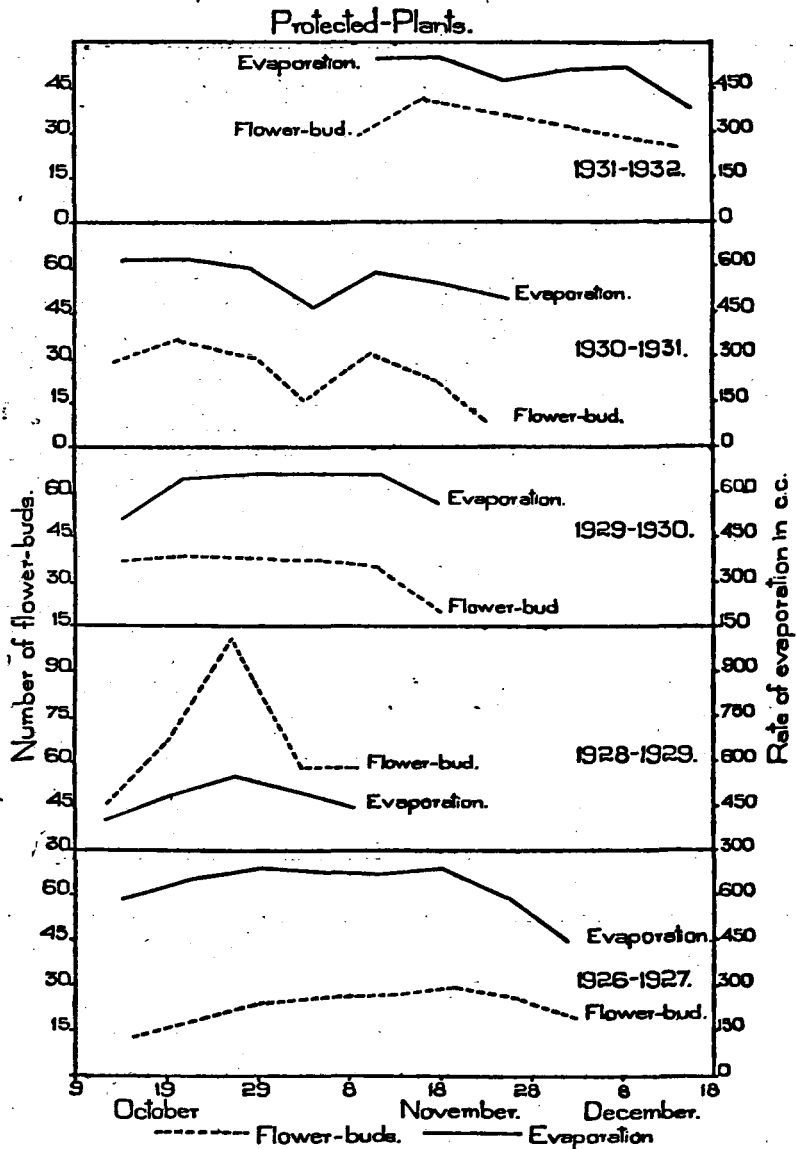
We may now pass on to the consideration of the environment which prevails in the third period. This period is characterised, as stated before, by cold weather which sets in after the end of October and continues for over three and a half months till about the middle of February. The high temperatures both of the soil and the aerial environment which dominate the growth of the cotton plant during the whole of October begin to descend in November and reach the lowest values in the season some time in the latter part of December or early in January. Just as a rise in temperature in the preceding period stimulates the production of vegetative buds and flower-buds, so a progressive fall in temperature leads to a general reduction in the activity of the plant as a whole. Although as a result of previous impetus to growth, the production of buds both vegetative and reproductive continues almost at the same rate for about a fortnight after the commencement of the decline in temperature, new production perceptibly declines from this time onwards until it practically ceases by the middle of December (Graph Nos. 67 to 72). Hereafter, the plant utilizes all its energies and resources towards the growth and development of the reproductive organs already produced. Thus, in the third period also it is again the temperature that governs all activities of the plant.

Occasionally after the close of the monsoon, clouds of great intensity precipitating in rains may appear in the midst of the crop season and seriously disturb the growth of the plant. Their effect may be manifested either immediately or after some time, depending upon the nature of the previous weather. Thus, in 1930, they appeared towards the end of October and caused a heavy shedding of flower-buds. This year their effect was immediate owing to the persistent cloudy conditions in the preceding week (Graph No. 71) and their termination in rain. In 1928, clouds precipitating in rains occurred twice; once, in the first week of October and again in the fourth week of the same month. In both these cases, their effect on bud-shedding, instead of being immediate as in 1930 was manifested after some time (Graph No. 69). This was due to the excellent weather conditions obtained in the previous weeks. Clouds, less intense and transitory in character also affect the growth of the plant but their effect is not manifested unless they are of a sufficiently long duration.

Thus, the plant undergoes a continuous change in response to changes in the environment in which it develops and follows up at the same time a certain sequence of growth. That it is in equilibrium with its surroundings will be more evident from the close parallelism existing between the curves for the production of flower-buds and for the rate of evaporation of water from an open pan, which represents at any time the total effect of the climatic complex (Graph No. 75). Indeed, it is not possible to isolate one single factor and study its influence on growth. For, the different factors involved undergo a continual change and even if they remain constant, the relationship of growth to temperature or to any other factor cannot be precisely determined as the activity of the plant and the power of its responsa

GRAPH No. 75.

The evaporation of water from an open vessel and the rate of flower-bud production in protected plants in different years.



In the year 1928-1929 the evaporation curve is shifted by one week.

are governed, in no small measure, by internal correlative influences referred to in the earlier pages of this chapter. It may, however, be pointed out that among the external agents which cause variations in growth and determine its magnitude, the importance of rainfall and the manner of its distribution cannot too strongly be emphasised. Whatever the influence exerted by any subsequent factor, it is the vigour of growth determined by rainfall, during the seedling stage, that endures and moulds the future character of the plant.

SUMMARY.

In this chapter the influence of environment on the development of the cotton plant has been discussed and the causes of annual variations in growth shown. Among the external agencies, the effect of rainfall, clouds, soil and air temperatures has been emphasised. It is pointed out that the extent of rainfall and the manner of its distribution exert by far the greatest influence during the seedling stage and determine the future development of the plant.

CHAPTER VIII.

BUD AND BOLL SHEDDING AND ITS SIGNIFICANCE IN CROP PRODUCTION.

Although a good deal of evidence regarding the nature and the causes of bud and boll shedding has been adduced in the preceding chapters according to exigencies of the occasion, their consistent and coherent account has not yet been presented. It is, therefore, necessary to put together all the results recorded on this subject and to see how far they are luminiferous in understanding the problem of shedding as a whole.

1. CAUSES OF BUD AND BOLL SHEDDING.

It will be remembered that the shedding of buds and bolls is continuous throughout the period of their formation and a little over (Chapters III and IV). Further, the buds incepted early and late in the season always shed at one time or another while only some belonging to the intermediate period grow at all and reach the stage of young bolls. Boll shedding takes place after the manner of bud-shedding but differs from the latter in the fact that it is very low in the beginning and increases in magnitude as the season advances.

It may further be recollected that the shedding of buds and bolls which thus takes place under crop conditions amounts to 90 per cent. and that out of the total shed forms as many as 33 per cent. are found attacked by the spotted boll-worm while the remaining bear no sign of any external injury. The conclusion was, therefore, drawn that if the plants were grown free from the pest, a material improvement in the yield of mature bolls would naturally result. It was surprising to find, however, that although a decided improvement over the normal yield was obtained when protection was offered, the increase in the number of mature bolls failed to rise in direct proportion to the number of forms rescued from the pest and that shedding continued to take place almost as heavily as under normal conditions—86 versus 90 per cent (page 134). This indicated in no uncertain manner that the spotted boll-worm was only a secondary or additive factor in shedding and that the real causes responsible for such a huge loss of reproductive forms were internal in origin and pertained to the life processes of the plant.

More light on this problem was thrown by the results of such experiments as the stem ringing, complete or partial de-foliation, the early removal either of flower-buds or flowers, the effect of augmenting food supply in the soil, the effect of increased spacing, etc. These experiments have been already described and discussed at some length in the foregoing chapter and hence their repetition here has been avoided. Suffice it to say, however, that they all indicate and even place above doubt the fact that the causes of bud and boll-shedding in cotton, at least in this tract, are nutritional in character and that shedding occurs as a direct consequence of the insufficiency of food in the plant.

This deficiency of food operates primarily in two ways: in the first place, the quality of the nutritive fluid or the "finished sap" does not become conducive

to the growth of buds and bolls, and secondly when it becomes conducive, it falls too short of their current demands. We shall first explain how the quality of the sap affects the growth of the reproductive forms and then take up its quantitative aspect.

QUALITY OF THE SAP AFFECTING SHEDDING.

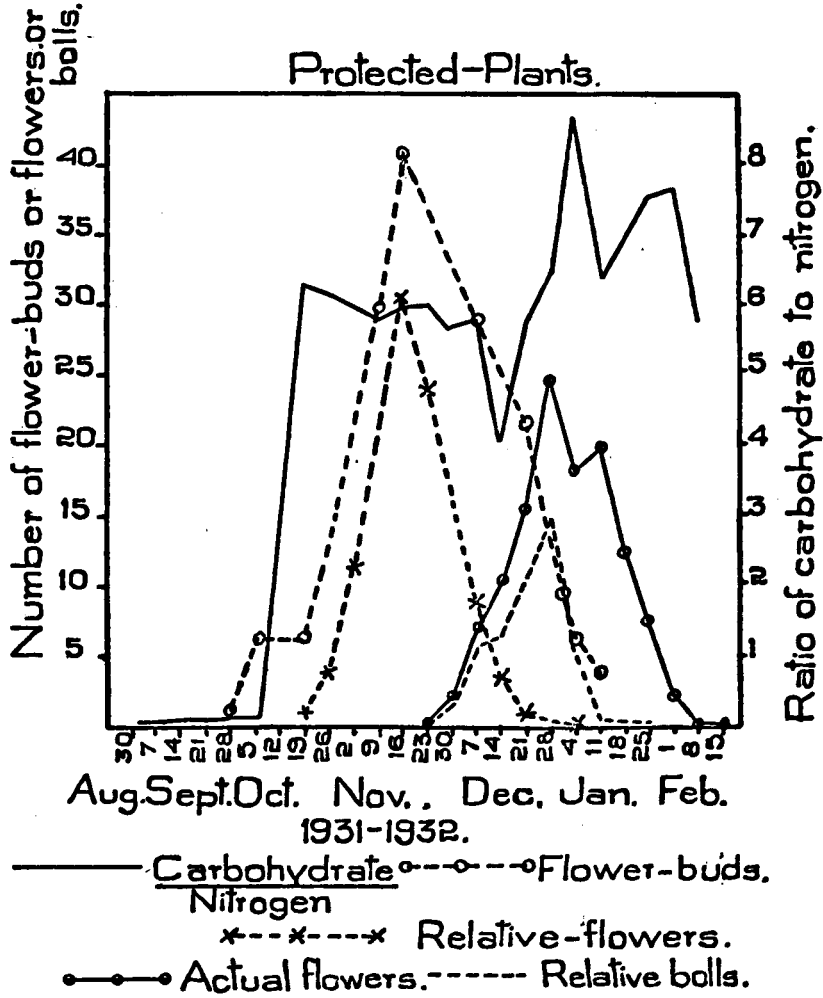
The quality of the sap depends principally upon the relative proportions of its constituents and is governed entirely by the soil and the aerial environment of the plant. Among the substances present in the sap which exercise a directive influence on the subsequent growth of the plant, the relative amounts of carbohydrates and nitrogenous compounds have been found to be of the greatest consequence. We have pointed out on a previous occasion that during the purely vegetative phase of the plant the ratio of the carbohydrates to nitrogen present in the leaf sap is at a very low level. With the improvement of external conditions, the relative concentration of carbohydrates steadily rises and the reproductive phase happens to be ushered on the plant. This rise in the relative concentration of the active forms of carbohydrates may take place in the month of September when opportunities for photosynthetic activity of the leaves become more frequent owing to intermittent spells of dry weather and bright sunshine. Such conditions of weather do not, however, persist for a long time and fluctuate a good deal between those of the rainy season on the one hand and those of October on the other.

Under these circumstances, the flower-buds which appear quite early in the season owing to local rise in the ratio of carbohydrates to nitrogen, begin shedding as a result of subsequent disturbances in the ratio and this process continues until the ratio remains fairly constant at a much higher level. A permanent change of this type in the quality of the sap generally occurs in the month of October and is accompanied by a greater rate of production as also a greater rate of success of the reproductive forms. These interpretations of the internal changes and their effect upon external plant performance will be evident from Graph No. 76 in which the weekly production of flower-buds and their relative success into flowers have been plotted against the ratio curve. The same graph also shows the periodical formation of flowers and their relative success into mature bolls. It will be seen from this graph that so long as the concentration of carbohydrates relative to nitrogen in the leaf sap remains at a very low level, those flower-buds which appear early in the season under temporary conditions favourable to their growth, do not remain long on the plant and shed entirely at one time or another. When, however, the external environment alters and the ratio rapidly increases, both the production and the success of these forms begin and continue at a very high rate.

Any subsequent change in the environment which is calculated to bring about a lowering in the ratio leads invariably to the shedding of flower-buds. Thus, the presence of cloudy conditions terminating in rain appears to have a depressing effect upon the ratio because owing to a partial or complete absence of sunshine, the assimilatory activity of the leaves diminishes leading ultimately to a relatively low concentration of the carbohydrate material. As a consequence of this change in the nutritive quality of the sap, a heavy shedding of flower-buds occurs as happened towards the end of October in 1930 and on two occasions in the same month in the year 1928.

GRAPH NO. 76.

Weekly production of flower-buds and flowers the relative success of buds into flowers and of flowers into mature bolls and the ratio of carbohydrates to nitrogen in the leaf sap.



Another evidence of the view that a highly nitrogenous sap is not conducive to the growth and development of the reproductive forms is available from an independent source. It has been stated under manurial experiments (page 210) that whereas in the control plants, flowers from the first flush of flowering in 1930-31 grew into mature bolls, none succeeded from this flush in the plants which received a dose of ammonium sulphate along with water during that time. These results conclusively show that the failure of flowers from the first flush of flowering in the treated plants was the result of nitrogen and water which for some time after application, lowered the proportion of carbohydrates to nitrogen in the plant sap and thus made it quite unsuited for the development of young bolls.

In this way, the quality of the sap or the elaborated food-stuff inhibits the success of flower-buds which appear during the initial stages of the reproductive phase and leads ultimately to their separation from the parent plant. Having thus dealt with the nature of plant sap and its relation to the failure of reproductive forms, we may now turn to its quantitative aspect and see how it comes in the way of the successful development of all buds and bolls.

INADEQUACY OF THE SAP LEADING TO SHEDDING.

Although the quality of the sap becomes conducive to the initiation of the reproductive phase, the magnitude of production and the subsequent development of flower-buds are largely governed by the quantity of food available. According to Kraus and Kraybill and according to our results also, the relatively high concentration of carbohydrates which obtains during the months of October and November is congenial both to the vegetative and the reproductive growth. Owing to a high rate of production of the daily output of elaborated food under the most favourable conditions of environment, a certain quantity of this food over and above the current requirements of the vegetative growth begins to be available and on the surplus food thus left, further growth of flower-buds continues. As the quantity of the surplus food steadily increases, the number of the forms on the plant gradually rises. Thus, the vegetative and the reproductive growths of the plant proceed simultaneously for some time, the daily output of elaborated food being divided between the two types of growth. In this process, only those flower-buds which have established their food-gradient continue to grow and reach the flower stage while the rest shed at one time or another. It has been already shown that flower-buds are most susceptible to shedding while they are young but once this stage is passed, they remain practically undisturbed in their growth unless subjected to drastic conditions of environment.

As the number of flower-buds that have established their food-gradient steadily increase, they exert a greater pull on the daily production of assimilates with the result that the vegetative growth of the plant slowly declines. This is well seen from the reduction in the size of leaves incepted in November (Table No. 25.) The internodes of sympodial branches also begin to be shorter from this time onwards and the general expansion of the plant as such shows a great tendency towards decline. We have already referred to the retarding influence of growing flower-buds on plant growth while discussing the effects of de-budding for various periods (pages 230-237). With the formation of flowers and the setting of bolls, practically all the food synthesised by the leaves is monopolised by these organs owing to their higher nutritional gradients and very little is left for further expansion of the plant. The result of this deflection of nutritive fluid towards the growth and

development of reproductive forms is that the rate of production of new leaves gradually declines and ceases later on with the maximum setting of bolls. The leaves incepted during this period never develop to the full stature of those in October and, as stated before, their size goes on rapidly dwindling in the chronological order in which they are produced. Owing to the desiccated conditions both of the soil and aerial environment and owing also to the increasing shortage of food now felt by the vegetative parts, leaf-fall happens to be soon initiated and thus a progressive curtailment in the manufacturing units of the plant occurs.

While this process continues on one side, some interesting events take place in the growth of the reproductive organs. Those flower-buds which are the first to establish their food-gradients turn into young bolls and begin to drag larger quantities of nutrients for further growth. On this account as these young bolls increase in number, the flower-buds which appear later in the season considerably suffer so much so that those incepted during the closing weeks of the period of bud formation completely shed. As in the case of buds, so in the case of bolls it is always the young ones that stand the greatest chance of shedding (pages 123 and 123); but, once they get over the critical time, they generally have a smooth sailing towards maturity. Thus, while on the one hand the quantity of food daily manufactured by the leaves gets steadily reduced owing to the commencement of leaf fall, the demand for food on the part of growing bolls rapidly increases on the other. This state of affairs does not continue very long. As the leaf-surface gets steadily reduced, the food synthesised undergoes naturally a corresponding reduction with this consequence that the shedding of bolls which was very low in the beginning increases until all the bolls formed during the closing weeks of the flowering period never develop to maturity and shed at one time or another.

During all this time, the plant practises the greatest economy of nitrogen. It has already been stated that the plant withdraws nitrogen in preference to carbohydrates from leaves prior to their shedding and even from flower-buds and bolls which fail to establish their food-gradient and shed in consequence. The quantity of nitrogen thus saved from these organs and utilized again for the growth of surviving buds and bolls is indeed very great and is equivalent to about 15 mature bolls per plant. In the absence of this quantity, the wholesale shedding of bolls which takes place late in the season would have started earlier and led to a serious reduction in the yield of mature bolls. Thus, although the plant exercises a very great economy, the quantity of the food daily synthesised is always below the current needs of the reproductive forms. On this account, a continuous shedding of both the buds and bolls occurs, the rate of shedding varying according to the amount of food available at the time.

The phenomenon of shedding, then, is merely an outward expression of the internal shortage of elaborated food so essential for the growth and development of reproductive forms. It is indeed a case of starvation of a large number of buds and bolls which shed owing to the activity of cambium at the basis of pedicels. According to this evidence, shedding is a simple case of the non-development of emerged organs on the plant. Such a failure of the growth of emerged organs—whether reproductive or vegetative—is, however, by no means restricted to the cotton plant alone. The failure of a large number of tillers of late origin to develop to maturity has been established in rice by Joshi (1923) and in wheat by Doughty, Engledow and Sansom (1928). It is a phenomenon of wide occurrence in plant life. Baily (1908) asserts that probably less than a fifth of the buds upon any tree ever make any branches and less than a fifth of the branches ever persist.

2. SIGNIFICANCE OF SHEDDING IN CROP PRODUCTION.

It will be clear from the preceding discussion that the natural shedding of buds and bolls which occurs to balance the growth of the plant as a whole in accordance with the internal conditions of food supply at all stages of development, is not a matter to be viewed with concern. It ensures the completion of the life-cycle of the plant and secures under the changing conditions of environment (1) a maximum possible plant expanse and (2) a maximum formation of mature bolls. As such, shedding does not lower the yield; for, what is shed is not from what the plant could have retained and grown to maturity. It is not a disease which leads to a curtailment of yield-producing organs of the plant. Had it been so, yield would have gone down proportional to the loss of these forms. It may be remembered that buds lost by shedding are constantly recouped by new production and therefore there is never a dearth of these organs if the plant has had the capacity to nourish them to maturity. The number of buds on the plant, at any stage of plant growth, is always in excess of its capacity to maintain them. The same holds true in the case of flowers and bolls as well.

If, however, buds and bolls already set growing on the plant are caused to shed by any extraneous agency, it may lead to a lowering of the efficiency of the plant for boll production. The degree to which this efficiency would be lowered is governed by the nature and extent of augmented shedding. If shedding is augmented on a single occasion in the midst of the season as occurs under the influence of cloudy conditions terminating in rains, it does not lower the efficiency of boll-production as has been shown on page 243. If on the other hand, shedding is augmented continuously as happens under the damage of the spotted boll-worm, it lowers the efficiency of the plant to sustain bolls more or less proportional to the loss of the successfully growing organs. It has been shown that under the spotted boll-worm conditions, the yield is lowered by 30 to 50 per cent. depending upon the virulence and duration of attack on buds and bolls (page 135).

The chief reason for this reduction, as shown by the results of the wholesale and partially augmented bud-pruning experiments (pages 240-243), and the studies on the distribution and absorption of nitrogen in the plant, is that the retention of successfully growing buds in partial numbers has a retarding influence on the capacity of the plant for recuperating the lost buds. This results in reducing the number of buds that grow successfully into flowers. Flowering gets also delayed and protracted with this consequence that the time of boll-setting instead of commencing before the start of leaf-fall is shifted forward and made to synchronise with it. It is unnecessary to mention that the nourishing power of the plant at the commencement of leaf-fall is seriously reduced and hence the low efficiency for boll retention.

This loss of efficiency of boll production under conditions of constant damage to the successfully set buds in partial number, is permanently stamped on the plant and is not remediable even by augmenting the supply of nitrogen which has been found to be one of the important limiting factors of food for a greater retention of buds and bolls. The results of our experiments on the application of nitrogenous fertilizers have conclusively shown that with the same addition of nitrogen the highly efficient protected plants give a larger return in the form of mature bolls than the less efficient unprotected plants (page 203).

3. IMPROVEMENT IN YIELD.

We have already referred to the shortage of nutrition in the plant as the primary cause of the failure of a large number of buds and bolls to grow. This shortage can be remedied either by (1) supplementing plant-food in the soil or by (2) *evolving a more efficient type of plant or by (3) a combination of both. The efforts made in these directions have yielded results of practical importance.

The yield in cotton is determined by the number of mature bolls on the plant and the yield of seed cotton per boll. The mature boll is the final stage of the flower-bud. The number of bolls on the plant would, therefore, have been equal to the number of flower-buds produced if all of them had grown. But as we have seen, this does not at all happen and many flower-buds shed either as buds or as young bolls owing mainly to nutritional deficiency. Hence, the number of bolls on the plant is determined by the percentage of flower-buds that grow successfully into flowers and of flowers that develop into mature bolls. Thus, the yield in cotton depends upon the following factors:

- (1) Number of flower-buds on the plant.
- (2) Percentage of flower-buds growing into flowers.
- (3) Percentage of flowers retained and grown into mature bolls.
- (4) Yield of seed cotton per boll.

The same yield can, therefore, be attained by a number of permutations and combinations of these factors and similarly an increase in the same can be effected by increasing simultaneously the magnitude of each of these factors or by increasing substantially the magnitude of one or more of these factors.

It has been shown that for the fullest expression of each of these four attributes of yield, nitrogen becomes deficient. Application of nitrogen during the vegetative phase leads to an increase in the expanse of the plant and thereby in the number of flower-buds (pages 198-217). If the supply of additional nitrogen is continued during the phase of flower-bud development, it results in increasing the proportion of this increased flower-bud production to grow successfully into flowers; if, again, the supply is continued still further to the stage of boll development, it goes to help the setting of more flowers and mature bolls. Making nitrogen available during the phase of boll development increases the yield of seed-cotton. By maintaining a steady supply of nitrogen at all stages of development the yield of the plant has risen from four to five times (page 208). If, however, the supply is maintained for any shorter period the plant responds by giving proportionately increased yields. Comparatively larger yields are obtained by making additional nitrogen available during the first half of plant growth (page 205).

The problem of increasing the yield of cotton, in the Broach tract, is therefore the problem of increasing the nitrogen fertility of the soil so as to make more nitrogen available at all stages of the plant.

Under conditions of crop production, it is not possible to administer nitrogen during periods of bud and boll development. It has got to be applied in one dose

* The work done on the evolution of a more efficient type of cotton has been omitted from this monograph.

during the seedling stage to get the fullest benefit of rain-water required for dissolving and making it available to the plant. It has been found that the nitrogenous fertilizer should be applied close to the row of plants so that the young seedlings begin to be benefited without much loss of time. Our experiments have shown that application of sulphate of ammonia in increasing quantities from hundred to two hundred pounds per acre, leads to proportionately increased yields from twenty to forty per cent. This increase is enough to meet the cost of the fertilizer and incidental charges. For making nitrogenous manuring profitable, either the prices of seed-cotton must go high or nitrogen must be made available at a much cheaper rate. For this purpose, cheaper resources of nitrogen such as green-manure compost, poudrette and other organic matters, that are at present neglected must be critically tapped. The use of organic manures has the extra advantage of steadily building up the fertility of the soil by their cumulative effects.

The importance of these findings from the practical point of view cannot be over-rated. The finding that soil-moisture in the Broach cotton tract is not deficient for the present crop and that it is even enough for a larger crop (fifty to hundred per cent. larger) is of no small importance. For, if the moisture had been limited, it would not have been possible to supply it in the absence of any irrigation facilities in this tract. Nitrogen alone is deficient in these soils for increased yields and it should be practicable to augment its supply within the economics of cotton farming.

SUMMARY.

This chapter contains a brief survey of the results obtained on the nature and causes of bud and boll shedding. It discusses also the significance of natural and augmented shedding in crop production, and describes finally the different yield attributes and the ways and means of increasing the load of mature bolls on the plant. It is pointed out that the shedding of buds which appears quite early in the season is due to uncongenial quality of the sap and that the rest of the shedding of both buds and bolls which occurs incessantly throughout the period of their formation is the result of food shortage in the plant. On this account, it is emphasised that the shedding of reproductive organs which takes place in the natural course of growth adjustments need not be viewed with concern.

APPENDIX I.

TABLES FOR CHAPTER II.

TABLE No. 1A.
Monthly rainfall in inches at Surat.

Year.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1877	3'74	3'00	3'97	2'48	5'38	..	..	18'57
1878	0'06	..	13'78	24'44	14'90	30'48	0'95	..	..	84'61
1879	0'11	8'95	5'26	12'51	5'04	3'30	..	..	35'17
1880	7'70	9'67	6'77	5'15	3'21	..	..	32'50
1881	0'63	15'07	7'05	5'71	1'28	0'13	..	29'87
1882	8'84	22'08	1'18	10'84	..	..	..	42'94
1883	..	0'66	..	..	0'17	17'76	14'43	2'33	10'52	4'30	..	..	50'17
1884	4'35	15'69	2'62	16'24	1'13	..	0'13	40'16
1885	1'96	0'57	14'08	17'59	1'46	2'83	0'05	..	38'54
1886	0'04	15'08	19'86	9'73	1'93	2'77	..	..	49'41
1887	0'50	8'08	22'16	5'48	1'36	..	1'85	0'16	39'59
1888	6'97	15'87	6'05	0'24	0'16	0'20	..	29'49
1889	..	0'12	..	..	0'17	2'38	25'73	3'43	6'30	3'47	..	..	41'60
1890	29'98	13'93	5'23	12'38	0'87	0'04	..	62'43
1891	0'04	..	..	0'50	41'88	12'87	4'94	0'18	..	..	60'41
1892	0'12	12'95	21'64	7'78	12'61	0'05	..	..	55'15
1893	0'10	0'17	..	23'41	10'75	6'69	3'86	..	0'47	..	45'45
1894	..	0'30	..	..	..	7'62	28'75	4'65	6'87	16'89	..	..	65'08
1895	5'30	13'25	5'27	3'83	1'42	..	..	29'07
1896	6'48	28'74	5'60	1'22	..	0'79	..	42'83
1897	1'63	12'48	16'04	7'54	1'33	..	..	39'02
1898	1'68	..	..	12'39	12'08	1'76	4'47	..	0'13	0'03	32'54
1899	0'02	16'32	0'87	0'74	0'54	..	..	..	18'49
1900	0'10	0'10	13'38	17'84	2'77	..	..	..	34'19
1901	..	0'38	..	0'01	1'26	0'08	0'21	12'27	3'45	0'35	0'44	..	18'45
1902	..	0'50	..	..	..	1'59	25'39	12'15	14'39	0'23	..	0'84	55'08
1903	0'06	1'95	19'57	10'02	8'45	0'12	..	..	40'19
1904	0'50	0'31	..	..	2'12	4'75	1'74	3'91	0'88	0'08	14'29
1905	0'24	0'15	..	..	1'51	15'44	1'72	1'18	0'02	..	26'26
1906	0'17	..	..	..	9'15	10'51	6'95	2'96	..	..	29'86
1907	0'08	..	0'05	..	4'83	18'44	15'28	0'20	..	..	38'88
1908	0'32	..	..	..	2'83	33'85	6'48	3'96	0'01	..	47'45
Average of 32 years	0'07	0'08	0'02	0'05	0'10	7'49	17'04	7'37	6'07	1'61	0'11	0'04	40'05

(From 1877 to 1908 the data are from the Civil Hospital, Surat, and from 1909 to 1931 they are from the Agricultural Station, Surat.)

TABLE NO. 1B.

Monthly rainfall in inches at the Agricultural Station, Surat.

Year.	Jan.	Feb.	March.	April.	May.	June.	July.	August.	Sept.	Oct.	Nov.	Dec.	Total.
1909	..	0'05	..	0'03	..	11'13	27'03	7'61	6'57	0'38	..	0'53	53'33
1910	0'03	..	..	..	..	15'07	7'36	7'14	1'05	1'31	0'27	..	32'23
1911	0'04	..	0'15	..	..	5'20	2'08	7'31	2'71	..	..	..	17'49
1912	..	..	..	..	..	5'92	32'67	5'49	2'10	1'00	3'60	..	51'68
1913	..	..	..	..	..	18'43	8'43	3'68	2'71	0'01	..	..	33'26
1914	..	0'10	..	..	..	22'18	18'64	2'02	16'54	..	1'33	..	60'81
1915	..	..	0'12	..	..	9'67	6'31	3'16	4'17	3'60	..	..	27'03
1916	..	..	..	..	0'41	5'26	18'97	16'84	11'67	4'01	..	..	57'16
1917	..	..	..	..	4'15	11'88	12'72	8'95	5'93	16'76	..	..	60'39
1918	..	..	..	..	0'95	1'14	12'25	3'04	0'24	..	..	..	17'62
1919	0'03	..	..	..	..	3'30	15'60	11'73	4'54	2'73	0'04	..	37'97
1920	3'93	..	..	..	..	7'76	10'51	4'51	2'13	..	..	..	28'84
1921	..	..	..	..	..	0'81	27'42	8'18	11'71	..	..	..	48'12
1922	..	..	..	..	..	14'70	13'49	2'07	11'17	..	0'15	..	41'48
1923	..	0'54	..	..	..	0'05	14'62	6'54	2'96	..	..	..	24'71
1924	..	0'03	..	..	..	7'36	13'74	13'12	6'10	0'51	..	..	41'16
1925	..	..	..	..	1'75	17'33	2'86	4'15	1'04	..	0'06	..	27'19
1926	1'37	..	..	..	..	0'97	28'96	19'77	13'25	..	..	..	64'32
1927	..	..	..	..	..	9'96	12'34	3'49	4'24	2'15	2'88	0'02	35'03
1928	..	..	..	..	..	2'91	11'86	3'96	6'28	0'87	0'29	0'04	26'21
1929	..	..	..	0'03	..	9'04	34'32	3'25	0'45	0'32	..	0'88	48'29
1930	..	..	..	..	..	16'43	15'95	2'45	5'40	0'95	..	0'10	41'28
1931	..	..	..	..	..	0'35	25'79	15'04	3'88	8'26	0'06	..	53'38
Average of 23 years	0'23	0'03	0'01	..	0'32	8'56	10'26	7'11	5'51	1'92	0'37	0'07	40'39
Average of 55 years	0'14	0'06	0'01	0'03	0'19	7'94	16'71	7'26	5'84	1'74	0'22	0'05	40'20

TABLE No. 2.

Weekly rainfall in inches at the Agricultural Station, Surat.

(Average of 23 years from 1909 to 1931.)

Week ending	Average of 23 years.
From 1st January to 27th May	0.40
3rd June	0.31
10th June	0.70
17th June	1.72
24th June	2.29
1st July	4.30
8th July	4.26
15th July	3.71
22nd July	3.00
29th July	3.91
5th August	2.79
12th August	1.25
19th August	1.41
26th August	1.13
2nd September	1.47
9th September	1.34
16th September	1.29
23rd September	1.97
30th September	0.79
7th October	0.87
14th October	0.64
21st October	0.15
28th October	0.21
From 29th October to 31st December	0.48
Total	40.39

TABLE No. 3.

Mean monthly Maximum and Minimum temperatures, Relative humidity, Vapour tension and Wind velocity, recorded by the Indian Meteorological Department at Surat.

Month.	Temperature °F		Differences between Max. and Min. °F.	Relative Humidity % at 8 a.m.	Vapour tension at 8 a.m.	Wind velocity in M.P.H.
	Max.	Min.				
January	86.5	57.6	28.9	62.1	0.373	2.6
February	89.2	59.6	29.6	60.2	0.403	3.1
March	96.0	66.8	29.2	60.0	0.537	3.3
April	99.5	73.6	25.9	62.3	0.706	4.1
May	97.4	73.8	18.6	66.3	0.831	6.6
June	93.1	79.8	13.3	76.9	0.916	7.4
July	87.3	77.7	9.6	85.5	0.919	7.3
August	86.4	76.8	9.6	85.3	0.885	5.7
September	88.6	75.8	12.8	82.5	0.862	3.7
October	93.5	71.8	21.7	70.0	0.714	2.4
November	91.5	64.5	27.0	59.3	0.490	2.7
December	87.5	59.0	28.5	60.4	0.395	2.6

TABLE No. 4.

Amount of water held unfree out of 10 c.c. of added water, in several layers of the soil, in the flat area for the year 1926-27.

Date of sampling.	SOIL LAYERS.				
	5 to 22½ cms.	22½ to 45 cms.	45 to 67½ cms.	67½ to 90 cms.	Average for 22½ to 90 cms.
18th October	5.90	5.35	3.20	3.85	4.1
1st November	6.60	5.45	4.45	5.60	5.2
15th November	3.95	3.45	4.30	6.70	3.9
29th November	4.20	4.60	4.40	5.90	5.0
13th December	5.00	5.10	5.60	3.20	4.6
29th December	4.10	5.50	6.15	5.85	5.8
10th January	4.30	5.00	4.50	6.10	5.2
24th January	5.20	3.90	5.80	5.95	5.2
7th February	3.00	6.05	4.90	4.90	5.3
22nd February	5.70	5.50	5.20	4.20	5.0
7th March	5.00	4.90	5.40	5.50	5.2

TABLE No. 5.

Amount of water held unfree out of 10 c.c. of added water, in several layers of the soil, in the flat area for the year 1927-28.

Date of sampling.	SOIL LAYERS.			
	22½ to 45 cms.	45 to 67½ cms.	67½ to 90 cms.	Average for 22½ to 90 cms.
5th October	5.00	4.40	4.05	4.50
31st October	5.20	4.50	4.10	4.60
15th November	6.10	5.90	6.35	6.10
28th November	5.75	6.20	6.50	6.20
12th December	6.00	4.50	4.85	5.10
26th December	4.20	5.40	6.20	5.30
9th January	6.20	5.70	5.70	5.90
23rd January	5.80	6.00	6.20	6.00
7th February	5.50	5.50	5.70	5.60
22nd February	(Determined on a mixed sample).			5.20
5th March	5.40	4.70	4.20	4.80

TABLE NO. 6.

Percentage of total moisture in several layers of the soil, expressed on oven-dry basis.

1927-28.

Period ending	UNCROPPED LAND.				CROPPED LAND.			
	5—22½ cms.	22½—45 cms.	45—67½ cms.	67½—90 cms.	5—22½ cms.	22½—45 cms.	45—67½ cms.	67½—90 cms.
14th September	27.40	26.10	24.37	25.00	..	..	..	..
4th October	33.33	29.70	28.37	27.87	..	29.70	28.20	27.71
18th October	31.40	30.20	28.73	27.55	..	24.22	31.07	..
31st October	29.70	30.21	28.53	26.42	..	20.19	24.07	24.68
15th November*	34.77	31.75	30.55	29.70	..	30.38	30.89	26.90
28th November	32.10	30.04	28.45	29.87	..	30.55	29.87	27.88
12th December	29.87	30.04	27.87	29.03	..	23.61	24.84	22.92
26th December	28.20	30.04	27.39	28.53	..	24.68	23.15	23.46
9th January, 1928	27.87	27.87	26.24	25.78	..	23.85	22.85	25.12
23rd January	25.42	27.46	25.25	25.00	..	20.25	20.77	21.33
7th February	25.39	28.73	28.24	28.71	..	22.20	22.74	22.37
21st February	23.45	26.75	26.32	28.73	..	20.35	20.19	23.59
5th March	22.20	23.53	22.92	25.63	..	20.87	20.73	20.92
20th March .. .. .	..	..	..	..	..	19.72	19.80	20.60
4th April .. .. .	..	..	..	..	..	20.45	18.64	20.82
17th April .. .. .	..	..	..	..	..	16.93	17.01	19.39
1st May .. .. .	..	..	..	..	..	17.60	18.48	19.28
15th May .. .. .	..	..	..	..	..	17.78	18.34	18.51

* Rain equal to 2.90 inches on 11th and 12th November.

TABLE NO. 7.
Percentage of total moisture in several layers of the soil, expressed on oven-dry basis.
 1930-31.

Period ending	UNCROPPED LAND.				CROPPED LAND.			
	5—22½ cms.	22½—45 cms.	45—67½ cms.	67½—90 cms.	5—22½ cms.	22½—45 cms.	45—67½ cms.	67½—90 cms.
21st August, 1930	27·23	28·20	..	..	28·04	29·53	..	..
3rd September	29·70	29·37	29·03	29·37	29·70	31·92	29·37	28·86
23rd September R	32·80	31·23	28·70	29·70	29·20	30·38	30·21	30·55
7th October	29·70	30·89	29·20	29·20	28·37	28·37	28·20	28·37
21st October	28·70	27·39	26·90	27·39	22·70	24·68	26·74	26·58
4th November R	29·87	29·03	27·71	27·71	24·22	26·10	27·39	27·88
18th November	30·04	28·70	28·53	28·70	21·80	22·70	25·31	25·78
2nd December	26·42	26·26	27·06	26·90	19·90	20·19	21·80	23·15
16th December	25·46	27·39	29·37	29·20	19·76	22·40	22·70	23·61
30th December	24·37	26·58	27·23	27·06	18·76	20·19	20·77	21·95
13th January, 1931	25·46	25·78	28·04	27·88	18·76	20·19	20·77	22·25
27th January	25·31	25·94	26·42	27·88	19·19	20·05	21·21	21·80
10th February	22·25	23·30	24·37	27·55	17·23	18·76	19·62	20·48
24th February	22·40	23·91	25·62	25·78	17·92	19·33	19·90	20·63

R = Rain.

TABLE NO. 8.

Percentage of total moisture in several layers of the soil, expressed on oven-dry basis.

1931-32.

Period ending	UNCROPPED LAND.				CROPPED LAND.			
	5—22½ cms.	22½—45 cms.	45—67½ cms.	67½—90 cms.	5—22½ cms.	22½—45 cms.	45—67½ cms.	67½—90 cms.
25th September (1931)	30.89	29.20	30.27	30.21	30.04	31.58	29.37	29.87
9th October	31.93	31.06	31.06	30.72	31.93	32.45	30.21	30.21
27th October	31.93	30.55	31.58	30.89	31.58	30.72	29.70	30.38
10th November	32.45	32.28	30.89	30.21	27.55	29.37	28.86	29.87
24th November	29.70	28.86	29.37	30.38	23.61	26.42	28.86	29.03
9th December	28.53	28.04	29.20	29.20	23.00	25.78	27.06	28.20
22nd December	26.26	28.04	29.20	29.53	21.36	24.22	25.78	26.42
5th January (1932)	26.42	27.55	..	29.37	20.63	22.25	23.61	24.53
19th January	26.42	27.71	28.20	29.03	19.47	21.51	22.55	25.16
2nd February	25.16	27.23	28.04	29.03	19.62	19.90	21.07	22.85
16th February	23.46	25.94	25.46	26.90	17.51	18.06	19.33	21.07
1st March	20.63	23.91	24.07	25.94	15.61	18.62	18.48	19.91

TABLE No. 9.

Percentage of total moisture in several layers of the soil, expressed on oven-dry basis.

(Crop under boll-worm condition.)

1926-27.

Date of sampling.	5—22½ cms.	22½—45 cms.	45—67½ cms.	67½—90 cms.	Average of 22½—90 cms.
4th October	29.53	26.26	26.26	26.00	26.20
18th October	22.69	22.73	26.58	27.84	26.70
1st November	22.04	21.85	22.19	24.15	23.70
15th November	21.15	23.85	24.16	23.21	23.80
29th November	19.39	23.06	24.97	24.94	24.30
13th December	19.33	23.33	24.10	25.69	24.40
29th December	14.49	19.02	19.33	19.82	19.40
10th January	14.23	20.30	19.33	21.24	20.60
24th January	11.14	20.71	20.42	21.68	20.90
7th February	11.36	19.62	21.18	21.95	20.90
22nd February	18.12	19.56	21.12	21.49	20.70
7th March	13.57	18.12	20.38	20.77	19.90
21st March	10.30	14.05	17.15	17.69	16.30

TABLE No. 10.

Percentage of total moisture in several layers of the soil, expressed on oven-dry basis.

(Crop under boll-worm condition.)

1927-28.

Date of sampling.	5—22½ cms.	22½—45 cms.	45—67½ cms.	67½—90 cms.	Average of 22½—90 cms.
4th October	29.70	28.20	27.71	28.50
18th October	24.22	31.07	..	27.70
31st October	20.19	24.07	24.68	23.00
15th November	30.38	30.89	26.90	29.40
28th November	30.55	29.87	27.88	29.40
12th December	23.61	24.84	22.92	23.80
26th December	24.68	23.15	23.46	23.80
9th January	23.85	22.85	25.12	24.00
23rd January	20.25	20.77	21.33	20.80
7th February	22.20	22.74	23.37	22.40
21st February	20.35	20.19	23.59	21.40
5th March	20.87	20.73	20.92	20.80
20th March	19.72	19.80	20.60	20.10
3rd April	20.45	18.64	20.82	20.00
17th April	16.93	17.01	19.39	17.80
1st May	17.60	18.48	19.28	18.50
15th May	17.78	18.34	18.51	18.20

TABLE No. 11.

Percentage of total moisture in several layers of the soil, expressed on oven-dry basis.
(Crop under boll-worm condition.)
1928-29.

Date of sampling.	5—22½ cms.	22½—45 cms.	45—67½ cms.	67½—90 cms.	Average of 22½—90 cms.
2nd October	25.78	27.32	27.66	26.66	27.2
16th October	19.85	24.39	26.57	27.31	26.1
30th October	19.33	22.29	23.30	24.50	23.4
13th November	18.48	20.18	21.17	23.99	21.8
27th November	18.65	20.21	20.22	21.11	20.5
11th December	16.16	19.42	20.06	20.95	20.1
25th December	16.69	19.46	19.65	20.03	19.7
8th January	15.37	19.27	19.37	20.48	19.7
22nd January	15.07	19.14	19.74	20.48	19.8
5th February	14.68	19.16	19.69	20.23	19.7
19th February	13.63	18.55	18.81	20.39	19.3
6th March	..	19.82	20.08	21.77	20.6
20th March	..	18.55	18.90	20.32	19.3
11th April	..	17.14	17.36	19.80	18.1

TABLE No. 12.

Percentage of total moisture in several layers of the soil, expressed on oven-dry basis.
(Crop under boll-worm condition.)
1929-30.

Date of sampling.	5—22½ cms.	22½—45 cms.	45—67½ cms.	67½—90 cms.	Average of 22½—67½ cms.
5th September	28.21	27.15	20.36	..	28.26
19th September	27.55	28.12	28.87	..	28.50
5th October	27.71	27.79	26.42	..	27.11
14th October	25.00	27.71	29.20	..	28.46
28th October	24.22	26.74	27.71	..	27.23
					Average of 22½—90 cms.
11th November	Not deter- mined.	25.47	26.82	28.87	27.05
25th November	..	23.92	27.71	28.70	26.78
9th December	..	21.65	22.85	24.07	22.86
23rd December	..	22.55	23.92	24.07	23.51
6th January	..	23.69	24.07	24.07	23.94
20th January	..	23.00	23.76	23.76	23.51
3rd February	..	21.36	21.95	22.70	22.00
17th February	..	20.85	21.80	22.25	21.63

TABLE NO. 13.

Percentage of total moisture in the several layers of the soil, expressed on oven-dry basis.

(Crop under boll-worm condition.)

1930-31.

Date of sampling.	5—22½ cms.	22½—45 cms.	45—67½ cms.	67½—90 cms.	Average of 22½—90 cms.
21st August	28.04	29.53	..	..	..
3rd September	29.70	31.92	29.37	28.86	30.05
23rd September R.. .. .	29.20	30.38	30.21	30.55	30.38
7th October	28.37	28.37	28.20	28.37	28.31
21st October	22.70	24.68	26.74	26.58	26.00
4th November R... .. .	24.22	26.10	27.39	27.88	27.12
18th November	21.80	22.70	25.31	25.78	24.59
2nd December	19.90	20.19	21.80	23.15	21.71
16th December	19.76	22.40	22.70	23.61	22.90
30th December	18.76	20.19	20.77	21.95	20.97
13th January	18.76	20.19	20.77	22.25	21.07
27th January	19.19	20.05	21.21	21.80	21.02
16th February	17.23	18.76	19.62	20.48	19.62
24th February	17.92	19.33	19.90	20.63	19.95

R=Rains between 3rd September and 23rd September, 5.32 inches; on 14th September, 3.92 inches, on 30th October, 0.95 inch.

TABLE NO. 14.

Percentage of total moisture in several layers of the soil, expressed on oven-dry basis.

(Crop under boll-worm condition.)

1931-32.

Date of sampling.	5—22½ cms.	22½—45 cms.	45—67½ cms.	67½—90 cms.	Average of 22½—90 cms.
25th September	30.04	31.58	29.37	29.87	30.27
9th October	31.93	32.45	30.21	30.21	30.96
27th October	31.58	30.72	29.70	30.38	30.27
10th November	27.55	29.37	28.86	29.87	29.37
24th November	23.61	26.42	28.86	29.03	28.10
9th December	23.00	25.78	27.06	28.20	27.01
23rd December	21.36	24.22	25.78	26.42	25.47
5th January	20.63	22.25	23.61	24.53	23.46
19th January	19.47	21.51	22.55	25.16	23.07
2nd February	19.62	19.90	21.07	22.85	21.27
16th February	17.51	18.06	19.33	21.07	19.49
1st March	15.61	18.62	18.48	19.91	19.00

TABLE NO. 15.

Percentage of total moisture in several layers of the soil, expressed on oven-dry basis, in the uncropped area receiving normal interculture.

1930-31.

Date of sampling.	5—22½ cms.	22½—45 cms.	45—67½ cms.	Average of 22½—67½ cms.
2nd September	26.58	28.37	26.90	27.63
24th September R .. .	31.23	29.20	28.86	29.03
8th October .. .	27.06	27.88	28.20	28.04
22nd October .. .	27.39	26.74	27.71	27.22
5th November R .. .	29.37	27.71	26.58	27.14
19th November .. .	27.39	31.60	30.04	30.82
3rd December .. .	25.00	26.58	26.26	26.42
17th December .. .	25.31	27.39	25.62	26.50
31st December .. .	25.78	26.26	26.42	26.34
14th January .. .	25.78	26.74	27.39	27.56
28th January .. .	25.46	26.74	26.90	26.57
11th February .. .	24.84	25.62	26.10	25.86
25th February .. .	22.70	25.78	26.58	26.18
11th March .. .	20.77	23.30	24.53	23.91

R=Rains between 2nd to 24th September, 5.32 inches.

14th September, 3.92 inches.

30th October, 0.95 inch.

TABLE NO. 16.

Percentage of total moisture in several layers of the soil, expressed on oven-dry basis, in the uncropped area receiving no interculture.

1930-31.

Date of sampling.	5—22½ cms.	22½—45 cms.	45—67½ cms.	Average of 22½—67½ cms.
2nd September	26.58	27.71	29.87	28.79
24th September R. .. .	30.21	29.37	29.87	29.62
8th October .. .	27.06	27.23	27.88	27.56
22nd October .. .	29.87	29.87	31.06	30.47
5th November R .. .	27.39	26.26	27.71	26.99
19th November .. .	28.53	28.86	29.37	29.12
3rd December .. .	23.15	26.58	27.71	27.15
17th December .. .	23.46	26.26	27.39	26.82
31st December .. .	23.46	25.94	28.37	27.15
14th January .. .	24.53	27.06	28.53	27.80
28th January .. .	24.68	26.26	29.03	27.65
11th February .. .	24.22	25.94	27.71	26.82
25th February .. .	24.22	26.42	27.71	27.06
11th March .. .	19.47	23.61	25.31	24.46

R=Rains between 2nd to 24th September, 5.32 inches.

14th September, 3.92 inches.

30th October, 0.95 inch.

TABLE NO. 17.

Percentage of total moisture in several layers of the soil, expressed on oven-dry basis, in the uncropped area receiving intense interculture.

1930-31.

Date of sampling.	5—22½ cms.	22½—45 cms.	45—67½ cms.	Average of 22½—67½ cms.
2nd September	23.91	27.71	26.90	27.30
24th September R	29.53	31.58	28.66	30.22
8th October	28.53	27.88	27.55	27.71
22nd October	27.88	27.23	27.71	27.47
5th November R	28.70	27.39	27.88	27.63
19th November	29.87	28.70	27.23	27.96
3rd December	26.26	26.42	26.42	26.42
17th December	27.06	26.90	26.90	26.90
31st December	26.90	26.10	27.55	26.82
14th January	26.90	27.71	27.39	27.55
28th January	24.34	28.04	27.88	27.96
11th February	26.10	27.23	27.06	27.15
25th February	24.53	26.42	27.88	27.15
11th March	19.47	22.70	24.68	23.69

R—Rains between 2nd and 24th September, 5.32 inches.
14th September, 3.92 inches.
30th October, 0.95 inch.

TABLE NO. 18.

Percentage of total moisture in several layers of the soil, expressed on oven-dry basis in the uncropped area receiving normal interculture.

1931-32.

Date of sampling.	5—22½ cms.	22½—45 cms.	45—67½ cms.	Average of 22½—67½ cms.
28th October	30.38	31.23	30.72	30.97
11th November	29.87	29.87	29.87	29.87
25th November	25.16	28.20	28.04	28.12
10th December	27.06	27.39	28.70	28.04
23rd December	25.62	29.20	29.87	29.53
6th January, 1932	24.22	25.31	29.87	27.59
20th January	25.16	27.71	27.88	27.80
3rd February	23.46	25.00	26.74	25.87
17th February	22.25	23.91	24.68	24.30
2nd March	20.63	23.15	25.16	24.16

TABLE NO. 19.
Percentage of total moisture in several layers of the soil, expressed on oven-dry basis, in the uncropped area receiving no interculture.
 1931-32.

Date of sampling.	5—22½ cms.	22½—45 cms.	45—67½ cms.	Average of 22½—67½ cms.
28th October	30·38	31·58	30·04	30·81
11th November .. .. .	..	29·20	29·37	29·28
25th November	24·53	27·55	27·39	27·46
10th December	26·26	27·55	28·70	28·12
23rd December	28·20	28·53	29·03	28·78
6th January	24·22	28·20	28·53	28·36
20th January	24·07	27·88	28·37	28·12
3rd February	22·55	26·74	26·74	26·74
17th February	21·51	25·31	26·58	25·95
2nd March	21·07	24·37	25·62	25·00

TABLE NO. 20.
Percentage of total moisture in several layers of the soil, expressed on oven-dry basis, in the uncropped area receiving intense interculture.
 1931-32.

Date of sampling.	5—22½ cms.	22½—45 cms.	45—67½ cms.	Average of 22½—67½ cms.
28th October	32·28	35·13	33·69	34·41
11th November .. .. .	..	30·55	31·23	30·89
25th November	29·37	31·58	29·20	30·39
10th December	27·55	31·06	29·87	30·47
23rd December	28·37	29·53	30·04	29·78
6th January, 1932	26·10	28·70	29·03	28·86
20th January	27·23	29·37	29·03	29·20
3rd February	24·07	26·26	28·53	27·40
17th February	24·22	26·90	28·04	27·47
2nd March	24·22	25·00	25·16	25·08

TABLE NO. 21.

Percentage of total moisture in several layers of the soil, expressed on oven-dry basis, in the cropped area receiving normal interculture.

1928-29.

Date of sampling.	5—22½ cms.	22½—45 cms.	45—67½ cms.	67½—90 cms.	Average of 22½—90 cms.
9th October	25.6	26.8	27.5	27.7	27.3
23rd October	21.7	25.6	26.5	27.7	26.6
6th November	14.7	18.3	20.7	21.6	20.2
20th November	19.3	20.6	22.8	22.9	22.1
4th December	17.0	19.4	19.2	19.8	19.4
19th December	16.8	19.4	20.8	21.7	20.6
2nd January	15.5	20.3	20.9	21.0	20.7
15th January	14.9	19.8	21.1	21.1	20.6
31st January	14.2	20.1	19.9	21.3	20.4
12th February	13.4	18.0	19.3	19.6	19.0
26th February .. .. .	..	18.1	18.9	19.3	18.8

TABLE NO. 22.

Percentage of total moisture in several layers of the soil, expressed on oven-dry basis, in the cropped area receiving no interculture.

1928-29.

Date of sampling.	5—22½ cms.	22½—45 cms.	45—67½ cms.	67½—90 cms.	Average of 22½—90 cms.
9th October	24.9	29.5	29.4	29.8	29.6
23rd October	18.8	24.4	26.7	28.3	26.4
6th November	14.9	17.6	19.0	20.8	19.1
20th November	17.7	18.6	21.3	23.6	21.0
4th December	14.5	19.4	20.6	21.3	20.4
19th December	14.1	19.7	20.6	21.4	20.8
2nd January	14.1	20.5	20.7	21.8	21.0
15th January	13.6	20.2	20.1	20.7	20.3
31st January	13.4	19.9	20.8	20.8	20.5
12th February	12.2	18.0	18.9	19.3	18.7
26th February .. .. .	..	17.8	19.0	19.6	18.8

TABLE No. 23.

Percentage of total moisture in several layers of the soil, expressed on oven-dry basis, in the cropped area receiving intense interculture.

1928-29.

Date of sampling.	5—22½ cms.	22½—45 cms.	45—67½ cms.	67½—90 cms.	Average of 22½—90 cms.
9th October	23.8	26.8	27.7	27.6	27.4
23rd October	20.0	24.4	26.9	27.7	26.3
3rd November	15.2	19.7	21.3	21.3	20.8
20th November	18.1	19.9	22.8	23.0	21.9
4th December	16.7	19.3	18.8	21.1	19.7
19th December	15.3	19.4	20.5	21.3	20.4
2nd January	15.2	19.9	20.7	21.9	20.8
15th January	14.3	20.4	20.8	21.1	20.8
2nd February	11.6	20.4	20.2	21.8	20.8
12th February	11.9	17.7	18.0	18.4	18.0
26th February .. .. .	..	18.0	18.5	18.9	18.5

TABLE No. 24.

Water delivering power of several layers of the soil, expressed in milligrammes.
(Control plot : plants spaced 3' × 3'.)

1926-27.

Date of sampling.	At surface	At 22½ cms. depth.	At 45 cms. depth.	At 67½ cms. depth.	Average for 22½—67½ cms.
12th October .. .. .	..	551.0	255.0	..	269.0
26th October	16.0	238.5	523.5	240.0	334.0
9th November	7.9	135.6	342.8	126.0	201.0
23rd November	11.6	29.3	132.7	153.7	105.0
7th December	3.5	41.1	45.3	75.0	54.0
21st December	4.2	27.1	40.3	51.7	40.0
4th January	2.0	30.5	36.6	40.0	36.0
18th January .. .. .	..	27.8	40.3	42.0	37.0
1st February .. .. .	..	36.3	39.7	43.0	40.0
15th February .. .. .	..	36.0	40.0	40.5	39.0
1st March .. .. .	..	22.5	28.2	36.5	29.0
15th March .. .. .	..	19.0	24.5	23.0	22.0
29th March .. .. .	..	19.0	20.5	27.5	22.0

TABLE NO. 25.

Water delivering power of several layers of the soil, expressed in milligrammes.

(Control plot : plants spaced 3' x 3'.)

1927-28.

Date of sampling.	At surface.	At 22½ cms. depth.	At 45 cms. depth.	At 67½ cms. depth.	Average for 22½—67½ cms.
29th October	45.0	130.0	272.0	..	201.0
12th November	Rains.	Rains.	Rains.	Rains.	Rains.
26th November	95.0	361.0	230.2	228.0	273.0
12th December	16.0	201.5	172.0	100.5	158.0
24th December	..	148.0	114.1	112.1	125.0
7th January	..	98.1	121.4	127.4	116.0
21st January	..	51.7	71.1	93.7	72.0
4th February	..	29.1	44.0	48.3	41.0
17th February	..	21.5	22.2	27.1	24.0
5th March	..	26.5	36.0	39.0	34.0
16th March	..	13.0	29.5	20.0	21.0

TABLE NO. 26.

Water delivering power of several layers of the soil, expressed in milligrammes.

(Control plot : plants spaced 3' x 3'.)

1928-29.

Date of sampling.	At surface.	At 22½ cms. depth.	At 45 cms. depth.	At 67½ cms. depth.	Average for 22½—67½ cms.
25th October	19	98	200	309	202
9th November	2	61	78	129.5	89
24th November	..	39	67	100	68
8th December	..	38	72	114	75
21st December	..	36	60	86	61
5th January	..	23	35	57	38
17th January	..	18	26	39	28
31st January	..	15	22	31	23
16th February	..	17	20	19	19

TABLE No. 27.
Concentration of the soil solution in milligrammes per 100 c.c.
 (Cropped area.)
 1926-27.

Date of sampling.	22½—45 cms.	45—67½ cms.	67½—90 cms.	Average of 22½—90 cms.
15th November	155.9	109.6	..	132.8
29th November	150.3	208.8	218.1	192.4
13th December	142.5	239.5	206.1	196.0
10th January	257.5	348.3	353.3	319.7
24th January	241.1	309.5	285.1	278.6
7th February	331.2	345.8	295.7	324.2
22nd February	272.6	361.8	458.6	364.3
7th March	584.8	293.9	476.1	451.6
21st March	500.7	302.7	269.0	357.5

TABLE No. 28.
*Total nitrogen in several layers of the soil, in milligrammes per 100 grammes of
 oven-dry soil.*
 (Cropped area : plants spaced 3' × 3'.)
 1926-27.

Date of sampling.	22½—45 cms.	45—67½ cms.	67½—90 cms.	Average of 22½—90 cms.
29th November	36.53	36.89	34.39	35.94
13th December	34.27	29.76	40.93	34.99
29th December	31.88	32.52	37.62	34.01
10th January	30.47	32.81	32.64	31.97
24th January	33.61	33.87	31.54	33.01
7th February	33.29	33.83	32.12	33.08
22nd February	34.05	29.24	33.00	32.10
7th March	25.55	25.95	31.77	27.76
21st March	21.17	26.39	21.40	22.99

TABLE No. 29.

Total nitrogen in several layers of the soil, in milligrammes, per 100 grammes of oven-dry soil.

(Cropped area : plants spaced 3' × 3'.)

1928-29.

Date of sampling.	5—22½ cms.	22½—45 cms.	45—67½ cms.	67½—90 cms.	Average for 22½—90 cms.
2nd October	41.47	49.19	37.83	38.08	41.70
16th October	58.22	38.30	51.51	38.32	42.71
30th October	43.47	39.38	38.01	35.73	37.71
13th November	33.94	32.53	33.71	35.62	33.95
27th November	38.11	40.21	35.04	42.38	39.21
11th December	43.93	43.35	44.80	42.38	43.51
25th December	42.35	44.38	45.15	41.11	43.55
8th January	42.89	40.91	46.06	49.93	45.63
22nd January	37.41	40.55	40.16	39.48	40.06
5th February	39.76	35.89	37.81	41.36	38.35
19th February	37.42	36.75	34.79	36.07	35.87

TABLE No. 30.

Organic nitrogen in several layers of the soil, in milligrammes, per 100 grammes of oven-dry soil.

(Cropped area : plants spaced 3' × 3'.)

Date of sampling.	22½—45 cms.	45—67½ cms.	67½—90 cms.	Average for 22½—90 cms.
29th November	34.70	34.80	34.30	34.60
13th December	31.30	26.80	38.00	32.00
29th December	30.30	30.90	29.30	30.20
10th January	24.50	27.50	26.60	26.90
24th January	30.50	30.80	28.50	29.60
7th February	28.80	30.90	28.50	29.40
22nd February	30.96	27.80	31.60	30.10
7th March	24.80	25.20	28.10	26.00
21st March	21.10	25.40	21.40	22.60

TABLE No. 31.

Organic nitrogen in several layers of the soil, in milligrammes, per 100 grammes of oven-dry soil.

(Cropped area : plants spaced 3' × 3'.)

1928-29.

Date of sampling.	5—22½ cms.	22½—45 cms.	45—67½ cms.	67½—90 cms.	Average for 22½—90 cms.
2nd October	38.9	45.9	36.7	36.2	39.6
16th October	56.4	36.5	50.1	36.9	41.2
30th October	42.1	37.6	35.8	33.5	35.6
13th November	36.4	29.8	32.4	34.1	32.1
27th November	37.2	39.3	33.2	40.6	37.7
11th December	42.0	42.5	43.2	39.4	41.7
25th December	40.6	41.8	42.0	39.4	41.1
8th January	39.3	38.1	42.5	45.2	41.9
22nd January	36.7	39.4	37.2	38.3	38.3
5th February	38.5	33.9	36.5	40.1	36.9
19th February	36.3	35.5	33.9	35.0	34.8

TABLE No. 32.

Ammoniacal nitrogen in several layers of the soil, in milligrammes, per 100 grammes of oven-dry soil.

(Cropped land : plants spaced 3' × 3'.)

1926-27.

Date of sampling.	22½—45 cms.	45—67½ cms.	67½—90 cms.	Average for 22½—90 cms.
15th November	1.10	3.34	..	1.48
29th November	1.69	2.00	..	1.23
13th December	2.86	2.90	2.86	2.87
29th December	1.55	1.60	3.30	3.82
10th January	5.92	5.15	5.97	5.68
24th January	2.97	2.94	2.97	2.96
7th February	4.42	2.86	3.55	3.61
22nd February	2.94	1.35	1.33	1.87
7th March	0.68	0.68	3.60	1.65
21st March .. .. .	..	0.97	..	0.32

TABLE No. 33.

Ammoniacal nitrogen in several layers of the soil, in milligrammes, per 100 grammes of oven-dry soil.

(Cropped area : plants spaced 3' x 3'.)

1928-29.

Date of sampling.	5—22½ cms.	22½—45 cms.	45—67½ cms.	67½—90 cms.	Average for 22½—90 cms.
2nd October	2.32	3.06	0.84	1.60	1.83
16th October	1.58	1.56	1.19	1.19	1.31
30th October	1.17	1.54	1.91	1.92	1.79
13th November	2.36	2.72	1.21	1.21	1.71
27th November	0.83	0.90	1.60	1.59	1.36
11th December	1.60	0.84	1.60	2.75	1.73
25th December	1.58	2.35	3.08	1.58	2.34
8th January	3.56	2.79	3.54	4.71	3.68
22nd January	0.59	1.06	2.81	1.06	1.31
5th February	1.04	1.79	1.04	1.05	1.29
19th February	1.03	0.89	0.89	1.07	0.95

TABLE No. 34.

Nitrous and nitric nitrogen in several layers of soil, in milligrammes, per 100 grammes of oven-dry soil.

(Cropped area : plants spaced 3' x 3'.)

1926-27.

Date of sampling.	22½—45 cms.	45—67½ cms.	67½—90 cms.	Average for 22½—90 cms.
15th November	0.135	0.198	..	0.11
29th November	0.140	0.093	0.087	0.11
13th December	0.112	0.066	0.065	0.08
29th December	0.027	0.015	0.024	0.02
10th January	0.054	0.160	0.066	0.09
24th January	0.139	0.126	0.073	0.11
7th February	0.072	0.073	0.070	0.07
22nd February	0.113	0.094	0.065	0.09
7th March	0.074	0.074	0.069	0.07
21st March	0.074	0.017	0.001	0.03

TABLE NO. 35.

Nitrous and nitric nitrogen in several layers of the soil, in milligrammes, per 100 grammes of oven-dry soil.

(Cropped area : plants spaced 3' × 3'.)

1928-29.

Date of sampling.	5—22½ cms.	22½—45 cms.	45—67½ cms.	67½—90 cms.	Average for 22½—90 cms.
2nd October	0.253	0.227	0.290	0.282	0.266
16th October	0.241	0.237	0.222	0.233	0.231
30th October	0.198	0.242	0.300	0.313	0.285
13th November	0.176	0.007	0.095	0.306	0.136
27th November	0.080	0.005	0.235	0.185	0.142
11th December	0.326	0.007	0.002	0.226	0.078
25th December	0.174	0.226	0.070	0.128	0.141
8th January	0.032	0.015	0.022	0.016	0.018
22nd January	0.123	0.088	0.153	0.124	0.122
5th February	0.220	0.195	0.272	0.206	0.224
19th February	0.096	0.361	..	0.002	0.121

TABLE NO. 36.

Nitrous nitrogen in several layers of the soil, in milligrammes, per 100 grammes of oven-dry soil.

(Cropped area : plants spaced 3' × 3'.)

1926-27.

Date of sampling.	22½—45 cms.	45—67½ cms.	67½—90 cms.	Average for 22½—90 cms.
15th November	0.015	0.018	..	0.011
29th November	0.183	0.031	0.056	0.035
13th December	0.021	0.036	0.034	0.030
29th December	0.015	0.015	0.012	0.014
10th January	0.024	0.040	0.036	0.021
24th January	0.018	0.021	0.019	0.019
7th February	0.031	0.021	0.018	0.023
22nd February	0.032	0.039	0.022	0.031
7th March	0.021	0.021	0.042	0.023
21st March	0.021	0.006	0.001	0.009

TABLE NO. 37.

Nitrous nitrogen in several layers of the soil, in milligrammes, per 100 grammes of oven-dry soil.

(Cropped area : spaced 3' x 3'.)

1928-29.

Date of sampling.	5—22½ cms.	22½—45 cms.	45—67½ cms.	67½—90 cms.	Average for 22½—90 cms.
2nd October	0.078	0.052	0.083	0.074	0.070
16th October	0.094	0.092	0.062	0.073	0.076
30th October	0.056	0.071	0.071	0.082	0.075
13th November	0.013	0.007	0.007	0.011	0.008
27th November	0.0073	0.005	0.027	0.007	0.013
11th December	0.058	0.007	0.002	0.032	0.138
25th December	0.027	0.019	0.011	0.011	0.014
8th January	0.032	0.015	0.022	0.016	0.018
22nd January	0.005	..	0.006	0.006	0.004
5th February	0.003	0.007	0.011	0.002	0.007
19th February	0.010	0.072	..	0.002	0.025

TABLE NO. 38.

Nitric nitrogen in several layers of the soil, in milligrammes, per 100 grammes of oven-dry soil.

(Cropped area : plants spaced 3' x 3'.)

1926-27.

Date of sampling.	22½—45 cms.	45—67½ cms.	67½—90 cms.	Average for 22½—90 cms.
15th November	0.120	0.180	..	0.100
29th November	0.122	0.062	0.031	0.072
13th December	0.091	0.030	0.031	0.051
29th December	0.012	0.000	0.012	0.008
10th January	0.030	0.120	0.030	0.024
24th January	0.121	0.105	0.054	0.257
7th February	0.041	0.052	0.052	0.048
22nd February	0.081	0.055	0.043	0.060
7th March	0.053	0.530	0.027	0.044
21st March	0.053	0.011	..	0.018

TABLE No. 39.

Nitric nitrogen in several layers of the soil, in milligrammes, per 100 grammes of oven-dry soil.

(Cropped area : plants spaced 3' x 3'.)

1928-29.

Date of sampling.	5—22½ cms.	22½—45 cms.	45—67½ cms.	67½—90 cms.	Average for 22½—90 cms.
2nd October	0·175	0·175	0·207	0·208	0·197
16th October	0·147	0·145	0·160	0·160	0·155
30th October	0·142	0·171	0·229	0·231	0·210
13th November	0·163	..	0·088	0·295	0·128
27th November	0·073	..	0·208	0·178	0·129
11th December	0·268	..	..	0·194	0·065
25th December	0·147	0·207	0·059	0·117	0·128
8th January .. .. .	..	..	..	..	..
22nd January	0·118	0·088	0·147	0·118	0·118
5th February	0·217	0·188	0·261	0·204	0·218
19th February	0·086	0·289	..	..	0·096

TABLE No. 40.
Weekly average temperature at Surat from the Indian Daily Weather Report.

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Week ending	MAXIMUM TEMPERATURE (°F.)							MINIMUM TEMPERATURE (°F.)						
	1926.	1927.	1928.	1929.	1930.	1931.	1932.	1926.	1927.	1928.	1929.	1930.	1931.	1932.
8th July	86.3	88.5	86.3	86.9	83.6	87.1	..	77.2	78.2	77.3	77.9	76.4	76.1	..
15th July	84.5	86.6	87.4	84.7	86.3	88.6	..	76.4	76.1	77.4	76.0	77.0	80.3	..
22nd July	88.0	87.0	86.0	86.0	84.6	86.3	..	79.2	79.1	78.3	78.9	77.9	78.3	..
29th July	85.9	82.9	85.0	86.6	83.7	89.9	..	78.1	76.5	77.3	78.9	75.9	79.1	..
5th August	88.4	84.9	86.1	85.9	84.6	85.5	..	78.9	77.2	78.3	76.7	76.9	77.8	..
12th August	85.1	85.5	85.7	87.4	83.1	86.0	..	77.6	76.3	76.6	78.4	75.9	77.9	..
19th August	89.8	85.4	87.1	84.7	85.4	85.0	..	77.4	76.2	77.0	75.4	76.4	77.3	..
26th August	83.9	85.3	86.1	84.0	85.7	85.6	..	76.5	76.4	77.0	75.9	75.3	77.6	..
2nd September	84.4	86.0	84.6	87.7	88.1	86.3	..	76.8	77.0	75.7	77.0	76.0	76.6	..
9th September	85.8	86.4	86.6	87.7	89.6	87.0	..	76.1	75.7	75.4	76.3	77.6	77.6	..
16th September	85.2	91.8	89.1	91.1	85.7	89.3	..	76.2	76.3	75.6	75.6	76.3	75.7	..
23rd September	84.4	92.2	84.6	92.9	88.1	90.4	..	74.9	77.2	75.4	76.1	75.7	76.6	..
30th September	89.9	87.9	86.1	95.4	93.1	89.0	..	75.0	76.1	75.4	78.9	75.9	77.3	..
7th October	92.3	87.3	88.1	92.0	..	92.1	..	77.2	74.9	76.3	76.4	..	76.6	..
14th October	93.0	90.3	95.0	90.4	98.0	85.4	..	75.0	74.1	72.7	74.9	74.2	75.7	..
21st October	95.0	93.3	96.6	95.7	99.0	90.9	..	71.3	74.9	73.9	73.1	75.6	73.6	..
28th October	95.6	96.8	90.0	96.0	94.7	92.9	..	70.1	74.5	74.3	68.0	73.4	67.1	..
4th November	94.8	91.7	93.1	95.7	86.3	92.6	..	66.4	69.9	68.9	68.9	70.6	71.0	..
11th November	93.6	89.0	92.9	96.1	90.0	91.4	..	67.8	70.0	67.7	73.4	64.9	67.6	..
18th November	89.7	80.4	91.3	95.0	89.7	94.1	..	62.2	59.8	70.9	73.9	63.4	68.9	..
25th November	88.0	85.1	92.3	92.4	90.3	93.7	..	59.4	60.1	67.0	65.4	66.9	64.6	..
2nd December	87.8	84.8	84.7	89.7	89.0	93.0	..	62.5	60.8	63.7	60.9	63.3	63.7	..
9th December	88.5	86.2	83.9	92.0	88.4	89.3	..	60.6	63.5	62.7	65.3	65.7	59.7	..
16th December	86.9	86.1	88.3	86.1	87.8	85.6	..	60.3	63.2	66.7	62.7	59.6	63.1	..
23rd December	85.2	81.1	84.7	77.0	86.5	90.6	..	58.1	59.5	58.4	55.7	58.0	63.9	..
31st December	84.2	85.9	83.5	78.3	85.1	90.3	..	56.5	63.8	55.9	51.6	57.1	59.9	..
7th January .. ..	..	83.7	82.7	84.6	83.0	89.3	90.7	..	58.7	56.7	54.0	53.3	59.4	60.7
14th January .. ..	..	81.5	86.3	88.9	86.9	85.9	91.4	..	53.9	61.4	59.7	65.3	61.3	61.4
21st January .. ..	..	82.5	85.6	83.0	83.0	89.3	93.3	..	55.5	60.6	58.7	54.0	59.6	59.4
28th January .. ..	..	85.5	81.9	82.7	91.0	85.6	97.6	..	54.8	59.1	58.0	62.3	60.4	60.3
4th February .. ..	..	83.9	77.9	78.0	78.0	85.6	89.9	..	59.8	54.3	49.0	56.4	57.1	61.9
11th February .. ..	..	83.3	87.0	87.4	84.1	85.0	88.9	..	59.3	56.6	60.7	56.1	59.3	60.0
18th February .. ..	..	84.4	88.0	90.6	93.1	88.9	89.1	..	63.3	60.6	60.1	57.7	64.4	59.1
25th February .. ..	..	81.9	94.6	95.4	94.1	86.3	91.9	..	58.8	63.1	65.0	63.9	62.4	58.6
4th March .. ..	..	92.0	94.0	97.6	95.3	89.4	97.7	..	61.7	63.4	66.9	65.7	62.4	65.5
11th March .. ..	..	91.5	89.4	100.1	96.6	91.8	99.6	..	62.7	61.7	70.7	65.1	61.7	68.0
18th March .. ..	..	94.7	99.8	103.6	94.7	..	97.6	..	68.0	68.2	70.4	65.0	..	64.7
25th March .. ..	..	98.0	96.6	103.9	101.0	102.6	95.9	..	67.7	70.7	71.7	70.9	69.0	70.6
1st April .. ..	..	93.7	102.0	101.0	98.6	98.7	99.4	..	66.9	71.7	71.9	70.5	72.9	70.2

TABLE No. 40A.

Weekly mean temperature of the soil at the depths of 30 and 60 cms.

Week ending	MAXIMUM TEMPERATURE (°F.)										MINIMUM TEMPERATURE (°F.)										
	At 30 cms.					At 60 cms.					At 30 cms.					At 60 cms.					
	1928.	1929.	1930.	1931.	1932.	1928.	1929.	1930.	1931.	1932.	1928.	1929.	1930.	1931.	1932.	1928.	1929.	1930.	1931.	1932.	
3rd June
10th June
17th June
24th June
1st July
8th July
15th July
22nd July
29th July
5th August
12th August
19th August
26th August
2nd September
9th September
16th September
23rd September
30th September
7th October
14th October
21st October
28th October
4th November
11th November
18th November
25th November

TABLE NO. 40A—contd.

Weekly mean temperature of the soil at the depths of 30 and 60 cms.—contd.

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Week ending	MAXIMUM TEMPERATURE (°F.)										MINIMUM TEMPERATURE (°F.)										
	At 30 cms.					At 60 cms.					At 30 cms.					At 60 cms.					
	1928.	1929.	1930.	1931.	1932.	1928.	1929.	1930.	1931.	1932.	1928.	1929.	1930.	1931.	1932.	1928.	1929.	1930.	1931.	1932.	
2nd December	80.0	81.4	78.1	..	81.7	84.9	82.9	80.7	..	78.1	79.4	80.7	77.7	..	81.1	83.7	81.9	80.2	..
9th December	..	78.7	79.7	80.4	76.1	..	80.3	83.1	81.9	79.7	..	78.6	79.6	79.6	75.6	..	80.0	82.3	81.1	78.7	..
16th December	..	79.0	78.9	78.0	74.9	..	80.0	82.4	80.0	78.2	..	78.0	78.3	77.8	74.4	..	80.0	82.0	79.9	78.0	..
23rd December	..	77.4	76.3	76.9	76.4	..	79.3	81.3	79.4	78.5	..	76.7	75.7	76.1	76.0	..	78.4	80.7	78.6	78.1	..
31st December	..	75.8	70.5	75.6	75.2	..	78.0	77.0	78.2	78.3	..	74.9	70.4	75.1	74.8	..	77.1	76.9	77.4	77.6	..
7th January	74.0	70.7	74.9	74.1	..	76.3	76.0	77.0	77.1	..	79.3	70.3	74.4	78.6	..	75.9	75.6	76.3	76.0
14th January	74.6	73.9	76.4	74.9	..	75.9	77.1	78.0	77.2	..	74.5	73.6	75.9	74.4	..	75.9	76.6	77.4	76.4
21st January	75.0	73.0	75.9	74.1	..	75.6	77.7	77.7	76.6	..	74.8	72.3	75.3	73.7	..	75.4	76.6	76.9	75.9
28th January	74.0	74.3	75.6	74.1	..	75.3	77.4	77.1	76.3	..	74.0	74.3	75.4	73.6	..	74.7	76.6	76.4	75.9
4th February	70.6	75.0	75.4	74.5	..	73.4	78.0	76.9	76.1	..	70.6	74.9	75.0	73.9	..	73.1	77.1	76.1	75.9
11th February	73.6	75.2	74.9	..	73.4	77.1	76.2	76.4	..	..	73.0	74.9	74.1	..	73.3	76.1	76.0	76.0
18th February	74.6	77.5	75.0	..	74.0	77.9	77.5	76.4	..	..	74.4	77.1	74.2	..	74.0	76.4	76.9	76.0
25th February	76.4	77.0	78.6	75.1	..	75.3	78.4	78.8	76.0	..	75.7	76.4	78.2	74.1	..	74.9	78.9	73.0	75.7
4th March	78.0	79.7	79.3	79.1	..	76.3	80.6	79.4	77.9	..	77.6	79.7	78.9	78.2	..	75.4	79.9	78.7	77.4
11th March	79.9	80.7	79.9	82.4	..	77.3	81.3	79.9	80.1	..	79.2	80.4	79.4	81.2	..	76.4	80.3	79.4	79.5
18th March	81.6	82.0	81.3	82.3	..	79.3	82.3	80.5	80.3	..	80.4	81.6	80.9	81.1	..	78.0	81.6	80.1	80.0
25th March	82.8	82.9	83.5	85.0	..	80.3	82.9	82.3	81.9	..	81.8	82.5	83.1	83.9	..	79.6	82.0	81.5	81.4
1st April	84.3	85.6	85.9	..	80.8	84.0	84.5	83.6	..	..	..	85.2	84.6	..	79.8	83.0	83.9	82.6
8th April	86.3	86.6	86.2	..	..	85.6	85.3	83.7	..	..	86.1	86.4	85.4	..	..	85.1	84.7	82.7
15th April	84.7	88.1	88.9	..	..	85.3	86.1	85.0	..	..	84.4	87.7	87.7	..	..	84.7	86.5	84.6
22nd April	86.3	88.6	..	..	..	85.8	86.5	..	..	..	85.8	88.1	..	..	..	85.4	86.1	..
29th April	87.7	88.5	..	..	..	86.4	86.1	..	..	..	86.9	87.9	..	..	..	85.9	85.5	..
6th May	90.0	89.3	..	..	..	89.3	87.1	..	..	..	89.7	88.7	..	..	..	88.0	86.9	..
13th May	90.7	90.1	..	..	..	90.9	87.6	..	..	..	90.1	89.1	..	..	..	89.7	87.8	..
20th May	88.3	89.8	..	..	..	88.3	87.4	..	..	..	87.6	88.4	..	..	..	88.1	87.1	..
27th May	89.6	92.1	..	..	..	88.7	88.2	..	..	..	88.7	90.6	..	..	..	88.1	87.9	..

TABLE No. 41.
Weekly mean temperature (°F.) of the soil at the depth of 15 cms.

Week ending	At 9 A.M.				At 11 A.M.				At 2-30 P.M.				At 5-30 P.M.			
	1929.	1930.	1931.	1932.	1929.	1930.	1931.	1932.	1929.	1930.	1931.	1932.	1929.	1930.	1931.	1932.
8rd June	..	92.3	92.3	..	..	93.4	92.4	..	..	94.5	93.1	..	..	95.8	93.7	..
10th June	94.5	..	..	..	94.4	..	..	..	95.2	..	..	..	95.8	..
17th June	91.5	..	..	..	91.9	..	..	..	92.4	..	..	..	92.8	..
24th June
1st July
8th July
15th July	..	83.0	..	..	..	83.0	..	..	..	83.5	..	..	..	83.7	..	..
22nd July	..	82.4	..	..	..	82.6	..	..	..	82.5	..	..	..	82.6	..	..
29th July	..	81.2	85.3	..	..	81.0	85.4	..	..	81.1	85.6	..	..	81.3	85.6	..
5th August	..	82.5	83.2	..	..	82.4	83.1	..	..	82.5	83.3	..	..	82.8	83.5	..
12th August	..	80.5	83.0	..	..	80.5	82.8	..	..	80.9	83.0	..	..	81.1	83.0	..
19th August
26th August	..	82.4	82.2	..	..	82.3	82.2	..	..	82.4	82.2	..	..	82.8	82.5	..
2nd September	..	85.4	82.4	..	..	85.6	82.5	..	..	86.1	82.9	..	..	86.6	83.3	..
9th September	..	86.4	82.8	..	..	86.6	82.9	..	..	86.8	83.3	..	..	86.6	83.5	..
16th September	..	83.5	84.0	..	..	84.2	84.5	..	..	84.3	84.9	..	..	84.3	85.8	..
23rd September	..	84.8	84.4	..	..	85.0	84.6	..	..	85.0	85.0	..	..	85.1	85.0	..
30th September	..	89.1	86.5	85.6	..	89.2	86.6	85.5	..	89.5	86.9	85.8	..	89.7	87.1	86.3
7th October	..	88.4	87.7	86.1	..	88.4	88.0	86.1	..	88.9	88.1	86.5	..	89.4	88.3	86.9
14th October	..	86.2	87.5	82.4	..	88.3	87.9	82.5	..	88.7	88.2	82.7	..	89.4	88.1	82.8
21st October	..	88.5	83.9	82.4	..	88.6	89.2	82.5	..	89.0	89.3	83.1	..	89.8	89.1	83.8
28th October	..	85.6	85.9	81.6	..	85.8	89.0	81.7	..	86.4	88.9	82.8	..	87.5	88.8	84.2
4th November	..	84.2	84.1	80.8	..	84.3	84.7	81.2	..	84.9	84.7	81.7	..	85.9	84.6	82.3
11th November	..	84.8	82.9	80.4	..	84.7	83.4	80.8	..	85.6	83.3	81.3	..	86.0	83.1	81.9
18th November	..	85.2	80.7	80.6	..	85.3	81.3	80.8	..	85.9	81.3	81.5	..	86.3	81.0	82.2
25th November	..	81.9	81.5	77.9	..	81.8	82.0	78.1	..	82.7	82.2	79.2	..	83.5	81.9	80.1

TABLE NO. 41—(contd.)
Weekly mean temperature (°F.) of the soil at the depth of 15 cms.

Week ending	At 8 A.M.				At 11 A.M.				At 2-30 P.M.				At 5-30 P.M.			
	1929.	1930.	1931.	1932.	1929.	1930.	1931.	1932.	1929.	1930.	1931.	1932.	1929.	1930.	1931.	1932.
2nd December	77.7	80.4	76.7	..	78.0	80.9	76.8	..	78.5	80.8	78.4	..	79.5	80.6	79.5	..
9th December	79.1	79.7	74.4	..	79.8	79.8	74.2	..	79.8	80.0	75.8	..	80.5	79.8	73.8	..
16th December	77.9	76.9	73.8	..	78.2	77.8	73.7	..	78.6	77.8	75.1	..	79.5	77.1	76.3	..
23rd December	73.9	75.8	75.1	..	74.7	76.2	75.1	..	74.1	76.2	76.9	..	75.8	75.8	78.4	..
31st December	68.6	74.8	73.1	..	68.7	75.3	73.1	..	69.3	75.3	75.0	..	69.9	74.9	76.3	..
7th January	69.8	74.9	72.1	..	69.7	75.1	72.4	..	70.4	75.2	74.5	..	71.3	75.0	76.8
14th January	74.4	76.0	73.2	..	74.4	76.4	73.8	..	75.6	76.4	75.6	..	76.1	76.1	77.0
21st January	71.4	75.3	72.3	..	71.5	75.6	72.5	..	72.1	75.6	74.6	..	73.5	75.5	76.5
28th January	74.6	75.8	72.4	..	74.4	76.1	72.8	..	75.5	76.1	74.9	..	76.7	76.0	76.8
4th February	74.1	75.8	72.7	..	74.4	76.1	73.0	..	74.7	76.1	75.6	..	76.7	76.0	77.3
11th February	73.8	75.5	72.8	..	72.8	75.8	72.8	..	73.8	75.8	75.3	..	75.7	75.8	77.4
18th February	74.3	78.3	73.2	..	74.3	78.5	73.1	..	75.6	78.7	75.8	..	77.8	78.7	77.8
25th February	78.1	78.9	73.2	..	78.0	79.3	73.5	..	79.6	79.3	76.7	..	82.0	79.3	75.7
4th March	80.1	79.8	78.2	..	79.9	80.0	78.4	..	81.8	80.0	81.6	..	84.1	80.1	83.8
11th March	81.1	80.6	81.4	..	81.2	80.8	81.6	..	83.3	80.7	84.8	..	86.1	80.8	87.6
18th March	82.6	82.2	80.9	..	82.5	82.3	81.4	..	84.5	82.4	85.7	..	87.0	82.5	88.5
25th March	84.2	85.0	84.5	..	83.8	85.2	84.6	..	86.9	85.0	88.7	..	89.2	85.5	91.2
1st April	86.0	87.1	85.5	..	86.0	87.3	85.8	..	86.9	87.5	90.1	..	90.7	87.7	92.7
8th April	88.1	88.1	86.5	..	88.2	88.4	87.0	..	90.6	88.5	91.2	..	92.5	88.9	93.6
15th April	85.6	90.1	88.5	..	86.4	90.2	89.6	..	89.0	90.9	92.8	..	90.0	91.0	94.5
22nd April	88.7	91.2	..	..	88.9	91.5	..	..	91.1	92.2	..	..	92.3	92.5	..
29th April	90.0	92.0	..	..	90.4	92.1	..	..	92.1	92.3	..	..	93.7	92.7	..
6th May	92.5	93.1	..	..	92.9	92.2	..	..	94.4	92.7	..	..	95.6	93.2	..
13th May	93.2	91.0	..	..	93.7	91.3	..	..	94.7	92.1	..	..	95.4	92.5	..
20th May	89.9	89.9	..	..	90.3	90.0	..	..	91.8	90.4	..	..	92.7	91.0	..
27th May	92.5	91.9	..	..	92.6	91.8	..	..	94.1	92.3	..	..	95.0	93.0	..

TABLES FOR CHAPTER III.

Explanation of some of the difficult columns in the root-register (Chart No. I).

Roots of different orders.

The roots which directly arise on the tap-root have been designated as the roots of the first order. Those that immediately arise on the roots of the first order are called "roots of the second order" and so on. In this way roots of various orders have been classified.

Soil layer.

This shows the depth reached by the tap-root from the soil-surface.

Total rootlets.

This is the sum of all the rootlets, developed (large), and undeveloped (small). The large rootlets have appreciable lengths which can be easily measured and hence these rootlets are later on called "measured rootlets." The small rootlets are very small and their length could not be easily measured. Hence, these are called "unmeasured rootlets."

Total length.

This is the total length of the individual root.

Total depth.

This is the depth reached by the individual root from the soil-surface.

Originating at.

This shows the length of the roots of one order from the point at which another rootlet belonging to the next order arises.

The rest of the columns are self-explanatory.

TABLE No. 42.

Chart No. I.

Specimen page from the field register of root measurements.

(Measurements in centimeters.)

Dates.	Plant number	Tap-root.			Roots of 1st order.				
		Diameter of tap-root.	Length of tap-root.	Depth of tap-root.	Depth of soil layer.	Total root-lets.	Total length.	Total depth.	Directions.
1	2	3	4	5	6	7	8	9	10
25th January, 1931	100	90	5	..	8	7	S
	8	..	9	10	W
	7	..	8	12	E
	15	..	12	32	N
	17	..	35	18	S
	20	..	91	34	S
	24	..	44	35	W
	21	..	127	57	E

	13	..	146	88	S

	28	..	138	84	W

	25	..	10	30	E
	27	..	105	85	W
	30	..	13	38	S
	33	..	97	40	N
	20	..	39	51	W
	23	..	126	69	E

	36	..	75	94	S

	40	..	70	109	N
	37	..	11	54	E
	62	..	14	78	W
	20	42	1,178	..	..

TABLE No. 42—contd.

Chart No. I—contd.

Specimen page from the field register of root measurements—contd.

(Measurements in centimeters.)

Roots of 2nd order.					Roots of 3rd order.					Roots of 4th order.				
Originating at (length).	Total rootlets.	Total length.	Total depth.	Directions.	Originating at (length).	Total rootlets.	Total length.	Total depth.	Directions.	Originating at (length).	Total rootlets.	Total length.	Total depth.	Directions.
11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
6	1	14	24	W	..	3	..	..	..	..	..	..	..	..
6	1	34	21	E	..	12	..	..	..	..	..	..	..	..
8	4	16	19	N	..	4	..	..	..	..	..	..	..	..
12	8	21	27	S	..	7	..	..	..	..	..	..	..	..
10	6	18	16	E	..	1	..	..	..	..	..	..	..	..
..	14	..	..	..	..	..	..	..	..	..	..	..	..	..
..	6	..	..	..	..	..	..	..	..	..	..	..	..	..
24	30	23	26	N	..	1	..	..	..	..	..	..	..	..
27	..	15	30	S	..	4	..	..	..	..	..	..	..	..
12	60	83	15	E	..	4	..	..	..	..	..	..	..	..
14	..	119	55	N	35	24	13	48	S	..	2	..	..	..
18	..	9	20	W	44	..	25	56	W	..	4	..	..	..
18	..	7	24	W	..	4	..	..	..	..	..	..	..	..
19	..	43	22	S	..	..	..	..	..	..	..	..	..	..
26	87	20	40	E	..	4	..	..	..	..	..	..	..	..
30	..	35	41	N	35	3	8	40	S	..	2	..	..	..
33	..	30	36	W	39	7	11	42	W	..	1	..	..	..
15	..	8	35	S	..	1	..	..	..	..	..	..	..	..
29	34	47	64	S	..	4	..	..	..	..	..	..	..	..
31	1	70	53	N	..	5	..	..	..	..	..	..	..	..
30	10	105	51	E	..	4	..	..	..	..	..	..	..	..
28	4	79	33	S	..	6	..	..	..	..	..	..	..	..
31	..	58	43	S	..	4	..	..	..	..	..	..	..	..
24	24	51	36	W	30	3	18	36	E	..	2	..	..	..
27	..	25	30	W	..	2	..	..	..	..	..	..	..	..
43	..	18	64	E	..	1	..	..	..	..	..	..	..	..
55	..	22	65	W	..	2	..	..	..	..	..	..	..	..
45	..	48	71	N	..	3	..	..	..	..	..	..	..	..
44	..	14	54	E	..	1	..	..	..	..	..	..	..	..
56	..	15	58	W	..	1	..	..	..	..	..	..	..	..
61	..	29	77	S	..	4	..	..	..	..	..	..	..	..
62	..	9	75	S	..	1	..	..	..	..	..	..	..	..
75	..	28	81	N	..	2	..	..	..	..	..	..	..	..
40	14	23	62	N/E	..	2	..	..	..	..	..	..	..	..
40	..	13	53	W	..	2	..	..	..	..	..	..	..	..
41	..	19	42	E	42	1	68	40	W	..	2	..	..	..
46	..	75	87	W	49	4	30	71	N/E	..	2	..	..	..
54	..	89	72	S	68	16	34	89	S	..	8	..	..	..
..	..	..	..	..	70	..	25	90	W	..	2	..	..	..
36	..	1,276	..	..	59	147	31	92	S	..	1	..	..	..
..	11	..	..	..	10	..	263	..	..	..	26	..	..	..
..	1	..	..	..	..	..	..	..	..	..	..	..	..	..
..	2	..	..	..	..	..	..	..	..	..	..	..	..	..
267	..	..	..	..	..	..	..	..	..	..	..	..	..	..

EXPLANATION.—In column 6, the 10th figure is 13. This shows that a sub-root arose on the tap-root at a distance of 13 cms. from the soil-surface. This has a length of 146 cms. (column 8) and reaches the depth of 88 cms. (column 9) and has proceeded in the southern direction (column 10). On this sub-root, one rootlet at a distance of 12 cms. (column 11) from the point of its origin arises. This rootlet gives rise to 60 rootlets (column 12) out of which one attains the length of 35 cms. (column 13) and penetrates to the depth of 15 cms. (column 14). This has gone in the eastern direction (column 15). This rootlet gives rise in its turn to 4 rootlets (column 17) which are very small. In this way, all the columns can be read.

TABLE No. 43.

Chart No. II.

The method of classifying the data obtained in Chart No. I.

Tap-root.		Roots of 1st order.				Roots of 2nd order.			Roots of 3rd order.				Roots of 4th order.			Roots of the whole plant.						
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Length.	Depth.	Measured rootlets (large).	Unmeasured rootlets (small).	Total rootlets.	Total length of all large roots.	Measured rootlets (large).	Unmeasured rootlets (small).	Total rootlets.	Total length of all large rootlets.	Measured rootlets (large).	Unmeasured rootlets (small).	Total rootlets.	Total length of all large rootlets.	Measured rootlets (large).	Unmeasured rootlets (small).	Total rootlets.	Total length of all large rootlets.	Measured rootlets (large).	Unmeasured rootlets (small).	Total rootlets.	Total length of all large rootlets.	Feeding zone.
100	90	20	22	42	1,178	36	231	267	1,276	10	137	147	263	..	26	26	..	66	416	482	2,317	..

Introduction to the classification of data of root measurements obtained from the original field register.

Chart No. II.

Columns 1 and 2—These offer no difficulty.

Column 3—The figure 20 is obtained by noting the number of figures in column 6 of Chart No. I.

„ 4—The figure 22 is obtained by subtracting 20 from 42 (column 7, Chart No. I).

„ 6—This is the total length of the individual rootlets in column 8 of Chart No. I.

„ 7—This is the number of figures in column No. 11, Chart No. I.

„ 8—This is the difference between the total rootlets, 267 (column No. 12, Chart No. I) and 36.

The other columns have been similarly filled.

TABLE No. 44.

Periodical diameter of the tap-root in cms. at the surface of the soil. Plants grown exposed to the usual damage by the spotted boll-worm.

(Average of 4 to 5 plants.)

Period ending	1926-27.	1928-29.	1929-30.
27th August .. .. .	..	0.50	0.24
2nd September .. .. .	..	..	..
9th September .. .. .	..	0.56	..
16th September .. .. .	..	..	..
23rd September .. .. .	..	1.15	..
30th September .. .. .	..	..	0.83
7th October	0.63	1.25	..
14th October .. .. .	..	..	0.93
21st October	0.68	1.40	..
28th October .. .. .	..	..	1.01
4th November	0.76	1.75	..
11th November .. .. .	..	..	1.20
18th November	0.95	1.72	..
25th November .. .. .	..	..	1.10
2nd December	1.17	1.70	..
9th December .. .. .	..	..	1.22
16th December	1.35	1.70	..
23rd December .. .. .	..	..	1.20
30th December	1.53	1.83	..
6th January .. .. .	..	..	1.20
13th January	1.50	1.73	..
20th January .. .. .	..	..	1.20
27th January	1.55	1.80	..
3rd February .. .. .	..	..	1.37
10th February	1.45	1.70	..
17th February .. .. .	..	..	1.20
24th February	1.53	1.53	..
3rd March .. .. .	..	..	1.20

TABLE NO. 45.

Periodical depth in cms. reached by the tap-root. Plants grown exposed to the usual damage by the spotted boll-worm.
(Average of 4 to 5 plants.)

Period ending	1926-27.	1928-29.	1929-30.	1930-31.	1931-32.
27th August .. .. .	..	77·55	..	..	..
2nd September .. .. .	..	..	51·90	45·6	..
9th September .. .. .	..	80·35	..	Rain.	..
16th September .. .. .	..	..	49·83	..	49·83
23rd September .. .. .	..	90·35	..	70·6	47·21
30th September .. .. .	..	..	64·17	60·1	..
7th October	33·04	81·13	..	..	52·25
14th October .. .. .	..	..	90·67	84·4	..
21st October	35·83	93·88	..	..	..
28th October .. .. .	..	..	96·33	83·9	53·83
4th November .. .. .	..	92·67	..	..	..
11th November .. .. .	..	..	103·88	97·7	60·91
18th November	58·50	90·33	..	..	..
25th November .. .. .	..	..	119·50	112·1	65·20
2nd December	120·00	93·63	..	..	..
9th December .. .. .	..	..	99·00	123·3	85·20
16th December	113·25	103·75	..	..	..
23rd December .. .. .	..	..	118·25	148·5	95·00
30th December	130·00	120·00	..	..	..
6th January .. .. .	..	..	138·00	110·2	98·70
13th January	157·88	127·75	..	..	..
21st January .. .. .	..	..	151·87	132·0	100·25
27th January	106·50	117·00	..	..	..
3rd February .. .. .	..	..	115·25	108·7	109·25
10th February	160·50	125·00	..	..	..
17th February .. .. .	..	..	112·48	119·5	125·00
24th February	187·00	109·33	..	..	..
3rd March .. .. .	..	..	116·75	111·2	140·00

TABLE No. 46.

Length of tap-root in cms. for different years. Plants grown exposed to the usual damage by the spotted boll-worm.

(Average of 4 to 5 plants.)

Period ending	1926-27.	1928-29.	1929-30.	1930-31.	1931-32.
27th August .. .. .	..	77·55	..	..	..
2nd September .. .. .	..	..	55·20	50·2	..
9th September .. .. .	..	81·67	..	rain.	..
16th September .. .. .	..	..	57·75	..	53·16
23rd September .. .. .	..	101·00	..	77·7	53·21
30th September .. .. .	..	..	73·17	72·6	..
7th October	28·50	91·35	..	..	54·95
14th October .. .. .	..	..	102·50	108·9	..
21st October	37·50	104·50	..	..	..
28th October .. .. .	..	..	109·33	92·7	66·50
4th November	55·00	89·75	..	..	..
11th November .. .. .	..	..	120·60	122·1	75·33
18th November	63·00	108·00	..	..	..
25th November .. .. .	..	..	139·40	138·3	96·80
2nd December	151·50	109·13	..	..	..
9th December .. .. .	..	..	118·00	130·7	129·20
16th December	122·00	112·25	..	..	..
23rd December .. .. .	..	..	136·25	174·0	118·25
30th December	168·50	138·00	..	..	..
6th January .. .. .	..	..	162·50	124·0	113·50
13th January	161·50	125·67	..	..	..
21st January .. .. .	..	..	181·87	143·0	117·50
27th January	165·50	109·67	..	..	..
3rd February .. .. .	..	..	127·50	123·5	115·25
10th February	161·00	153·25	..	..	..
17th February .. .. .	..	..	138·00	146·7	152·25
24th February	192·50	135·67	..	..	..
3rd March .. .. .	..	..	136·87	149·7	164·00
10th March	172·50	..	..	125·5	..

TABLE NO. 47.

Number of developed and undeveloped roots of the first order. Plants grown exposed to the usual damage by the spotted boll-worm.
(Average of 4 to 5 plants.)

Date of sowing.				7-7-1928.			1-7-1929.			26-6-1930.			2-7-1931.		
				1928-29.			1929-30.			1930-31.			1931-32.		
Period ending				Dev.	Undev.	Total.	Dev.	Undev.	Total.	Dev.	Undev.	Total.	Dev.	Undev.	Total.
				27th August	13.0	29.0	42.0
2nd September	..	..	..	..	11.0	39.0	50.0	7.2	25.6	32.8	8.8	33.4	42.2	..	..
9th September	..	..	..	..	11.00	55.5	66.50	9.67	20.83	30.5	10.0	34.0	44.0	6.33	35.5
16th September	..	..	..	..	..	..	..	13.0	24.5	37.5	11.2	24.2	35.4	5.60	37.06
23rd September	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
30th September	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
7th October	..	..	..	..	14.0	29.0	43.0	11.17	41.83	53.0	15.4	34.0	49.4	12.0	38.0
14th October	..	..	..	..	14.0	42.5	56.5	..	..	..	..	..	..	..	..
21st October	..	..	..	..	..	..	..	15.16	42.17	57.33	23.0	33.2	56.2	13.33	29.5
28th October	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
4th November	..	..	..	..	13.75	24.75	38.5	16.40	41.6	58.0	20.0	31.2	51.2	16.83	29.34
11th November	..	..	..	..	21.33	25.67	47.0	15.6	45.4	61.0	24.8	34.6	59.6	21.4	30.2
18th November	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
25th November	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
2nd December	..	..	..	..	19.50	27.5	47.0	17.2	29.4	46.6	24.4	33.4	57.8	23.4	30.4
9th December	..	..	..	..	18.25	29.5	47.75	16.0	37.75	53.75	21.0	56.0	77.0	22.5	26.25
16th December	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
23rd December	..	..	..	..	17.66	30.66	48.33	..	..	..	..	..	..	..	..
30th December	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
6th January	..	..	..	..	16.67	25.67	42.33	20.75	55.75	76.5	21.5	27.75	49.25	28.2	33.0
13th January	..	..	..	..	..	..	..	20.75	74.25	95.0	21.5	34.75	56.25	23.5	33.75
20th January	..	..	..	..	15.67	18.0	23.67	..	..	..	..	..	..	..	..
27th January	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
3rd February	..	..	..	..	12.5	31.5	44.0	26.5	56.0	82.5	20.75	36.5	57.25	20.0	32.25
10th February	..	..	..	..	..	..	..	24.75	47.5	72.25	20.75	36.5	57.25	24.5	36.25
17th February	..	..	..	..	20.33	22.67	43.0	..	..	..	..	..	..	..	..
24th February	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
3rd March	..	..	..	..	..	..	..	19.0	44.75	63.75	18.75	34.75	53.5	25.0	33.0

TABLE NO. 48.

Length of roots in cms. of the 1st order for different years. Plants exposed to the usual damage by the spotted boll-worm.

(Average of 4 to 5 plants.)

Date of sowing—Period ending	1928-29.	1929-30.	1930-31.	1931-32.
27th August	150·95	..	..	..
2nd September .. .. .	..	182·30	192·5	..
9th September	215·60	..	..	190·33
16th September .. .. .	..	237·25	..	..
23rd September	446·75	..	266·0	193·43
30th September .. .. .	..	491·42	359·6	..
7th October	607·9	..	..	357·37
14th October .. .. .	..	607·6	658·3	..
21st October	752·97	..	..	..
28th October .. .. .	..	840·5	1106·7	501·91
4th November	797·32	..	..	..
11th November .. .. .	..	972·6	1161·9	698·5
18th November	1102·26	..	..	..
25th November .. .. .	..	1016·0	1625·7	1195·0
2nd December	1185·0	..	..	..
9th December .. .. .	..	1074·2	1686·2	1227·0
16th December	1100·37	..	..	..
23rd December .. .. .	..	1070·5	1608·5	1325·75
30th December	1324·20	..	..	..
6th January .. .. .	..	1549·62	1457·6	1648·20
13th January	1081·17	..	..	..
20th January .. .. .	..	1236·37	1553·3	1461·0
27th January	999·17	..	..	..
3rd February .. .. .	..	1355·62	1671·0	1173·75
10th February	869·25	..	..	..
17th February .. .. .	..	1240·10	1394·9	1800·5
25th February	1217·0	..	..	..
3rd March .. .. .	..	976·75	1241·0	1594·66

TABLE NO. 49.

*Number of developed and undeveloped roots of the 2nd order:
Plants grown exposed to the usual damage by the spotted boll-worm.*

(Average of 4 to 5 plants.)

Date of sowing.	7-7-1928.			15-7-1929.			26-6-1930.			2-7-1931.		
	1928-29.			1929-30.			1930-31.			1931-32.		
	Dev.	Undev.	Total.	Dev.	Undev.	Total.	Dev.	Undev.	Total.	Dev.	Undev.	Total.
27th August	2.0	35.5	37.5	..	..	..	..	..	..	..	..	..
2nd September .. .. .	..	..	..	1.4	88.4	89.8	1.6	129.0	130.6	..	..	..
9th September	5.5	133.0	138.5	..	..	..	..	..	..	2.33	107.67	110.0
16th September	10.0	176.0	186.0	1.5	107.33	108.83	..	..	..	1.83	86.08	86.91
23rd September .. .. .	..	..	..	1.83	202.17	204.0	5.6	107.2	112.8	..	..	..
30th September .. .. .	..	..	..	..	..	..	6.6	93.6	99.6	..	..	..
7th October	9.25	244.0	253.25	4.17	231.5	235.67	14.6	161.4	176.0	2.75	110.0	112.75
14th October .. .. .	..	..	..	..	..	..	..	..	..	..	..	..
21st October	9.0	296.75	305.75	4.33	242.67	247.0	14.2	256.2	270.4	7.33	102.84	110.17
28th October .. .. .	..	..	..	..	..	..	..	..	..	..	..	..
4th November	14.75	264.0	278.7	5.2	258.2	263.4	16.6	187.8	204.4	16.5	218.83	235.33
11th November .. .. .	..	..	..	5.4	221.8	227.2	25.8	287.2	313.0	23.6	237.2	260.8
18th November	11.33	356.33	367.66	..	..	..	..	..	..	..	..	..
25th November .. .. .	..	..	..	7.0	263.2	270.2	35.4	266.8	302.2	30.2	273.6	303.8
2nd December	16.0	315.75	331.75	11.0	281.75	292.75	31.75	315.75	347.5	29.0	241.5	270.5
9th December	10.75	281.5	292.25	..	..	..	..	..	..	..	..	..
16th December	16.0	365.0	381.0	6.0	468.5	474.5	29.5	252.0	281.5	34.0	316.0	350.0
23rd December .. .. .	..	..	..	8.25	386.25	394.5	32.75	310.25	343.0	30.25	286.25	317.5
30th December .. .. .	..	..	..	..	..	..	..	..	..	..	..	..
6th January	14.0	210.33	224.67	5.5	489.75	495.25	28.5	322.5	351.0	25.25	213.25	238.5
13th January	9.33	232.66	242.0	6.75	324.75	331.5	20.0	257.25	277.25	23.75	345.5	369.25
20th January .. .. .	..	..	..	..	..	..	..	..	..	..	..	..
27th January .. .. .	..	..	..	..	..	..	..	..	..	..	..	..
3rd February	11.5	197.0	208.5	7.25	236.25	243.5	16.0	161.25	177.25	23.66	301.67	325.33
10th February
17th February	9.0	284.33	293.33
24th February
3rd March

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TABLE No. 50.

Length in cms. of roots of the 2nd order for different years. Plants grown exposed to the usual damage by the spotted boll-worm.

Period ending	1928-29.	1929-30.	1930-31.	1931-32.
27th August	16.10			
2nd September	..	15.8	19.6	..
9th September	95.0	..	..	..
16th September	..	41.67	..	83.83
23rd September	170.60	..	113.0	34.17
30th September	..	57.92	163.6	..
7th October	202.5	..	..	73.25
14th October	..	193.5	553.7	..
21st October	354.17	..	..	..
28th October	..	132.08	505.9	229.0
4th November	595.40	..	..	..
11th November	..	221.4	618.4	555.5
18th November	458.33	..	..	..
25th November	..	237.3	941.3	648.0
2nd December	641.60	..	..	..
9th December	..	314.0	1578.0	1005.2
16th December	509.75	..	..	..
23rd December	..	556.75	1540.5	930.25
30th December	890.56	..	..	..
6th January	..	263.63	1603.1	1054.0
13th January	586.17	..	..	..
20th January	..	339.0	1459.5	1134.0
27th January	424.17	..	..	..
3rd February	..	220.37	1359.4	1107.75
10th February	681.25	..	..	..
17th February	..	309.10	873.8	1203.5
24th February	415.00	..	..	..
4th March	..	267.0	710.5	818.66
11th March	..	..	687.3	..
18th March	..	..	..	1029.25

TABLE No. 51.

*Number of developed and undeveloped roots of the 3rd order.
Plants grown exposed to the usual damage by the spotted boll-worm.*

(Average of 4 to 5 plants.)

Date of sowing.	7-7-1928.			15-7-1929.			26-6-1930.			2-7-1931.		
	1928-29.			1929-30.			1930-31.			1931-32.		
	Dev.	Undev.	Total.	Dev.	Undev.	Total.	Dev.	Undev.	Total.	Dev.	Undev.	Total.
27th August .. .. .	..	2.5	2.5	..	..	..	..	..	..	..	..	..
2nd September	0.25	60.0	60.25	..	6.4	6.4	..	11.4	11.4	..	..	..
9th September .. .. .	..	..	..	..	15.0	15.0	..	..	..	..	14.83	14.83
16th September	3.5	83.5	87.0	..	..	..	0.2	31.0	31.2	0.16	12.67	12.83
23rd September .. .. .	..	..	..	..	24.83	24.83	1.0	32.2	33.2	..	..	..
30th September .. .. .	..	..	..	..	..	..	..	..	..	..	..	..
7th October	0.75	87.60	88.25	..	..	..	..	..	..	..	25.0	25.0
14th October .. .. .	..	..	..	0.16	67.17	67.33	2.8	136.2	139.0	..	..	..
21st October	1.25	171.0	172.25	..	..	..	..	..	..	..	..	..
28th October .. .. .	..	..	..	..	37.83	37.83	1.8	96.2	98.0	0.33	37.67	38.0
4th November	3.0	217.75	220.75	..	..	..	..	..	..	..	..	..
11th November .. .. .	..	..	..	..	61.6	61.6	3.2	93.4	96.6	1.83	118.33	120.16
18th November	2.0	139.66	141.66	..	..	..	..	..	..	..	..	..
25th November .. .. .	..	..	..	..	53.0	53.0	6.6	118.4	125.0	4.2	97.4	101.6
2nd December	1.0	164.25	166.25	..	..	..	..	..	..	..	..	..
9th December .. .. .	..	..	..	0.2	85.4	85.6	7.6	206.0	213.6	3.4	177.2	180.6
16th December	1.0	119.5	120.5	..	..	..	..	..	..	..	..	..
23rd December .. .. .	..	..	..	0.75	113.0	113.75	3.0	194.5	197.5	4.0	104.25	108.25
30th December	1.33	186.67	188.0	..	..	..	..	..	..	..	..	..
6th January .. .. .	..	..	..	..	93.5	93.5	8.5	184.0	172.5	2.5	136.0	138.50
13th January	0.67	120.67	121.33	..	..	..	..	..	..	..	..	..
20th January .. .. .	..	..	..	0.75	114.0	114.75	5.25	235.75	241.0	5.25	165.0	170.25
27th January	1.0	181.66	182.67	..	..	..	..	..	..	..	..	..
3rd February .. .. .	..	..	..	0.25	91.0	91.25	2.50	212.25	214.75	5.25	149.25	154.50
10th February	2.0	136.5	138.5	..	..	..	..	..	..	..	..	..
17th February .. .. .	..	..	..	0.25	81.0	81.25	1.75	138.0	139.75	7.0	162.25	169.25
24th February	0.33	90.33	90.66	..	..	..	..	..	..	..	..	..
3rd March .. .. .	..	..	..	..	57.0	57.0	4.0	90.0	94.0	4.0	186.33	190.33

TABLE No. 52.

*Length in cms. of roots of the 3rd order for different years.
Plants exposed to the usual damage by the spotted boll-worm.*

(Average of 4 to 5 plants.)

Period ending	1926-27.	1928-29.	1929-30.	1930-31.	1931-32.
27th August
2nd September
9th September	..	1.5	..	..	..
16th September
23rd September	..	18.7	..	5.8	3.79
30th September	17.1	..
7th October	..	6.27	..	..	..
14th October	6.83	85.1	..
21st October	..	31.92	..	..	..
28th October	41.7	17.5
4th November	..	132.62	..	..	..
11th November	70.4	39.16
18th November	..	64.33	..	..	..
25th November	166.6	110.2
2nd December	..	38.47	..	..	..
9th December	5.40	190.4	85.6
16th December	..	27.87	..	..	..
23rd December	26.25	145.9	119.5
30th December	..	37.83	..	..	..
6th January	317.8	72.75
13th January	..	22.33	..	..	..
20th January	30.0	256.7	98.75
27th January	..	56.33	..	..	..
3rd February	5.50	91.0	134.0
10th February	..	62.75	..	..	..
17th February	4.50	89.3	175.25
25th February	..	7.33	..	..	..
3rd March	103.5	107.25
10th March	59.3	..
18th March	122.25

TABLE NO. 53.

*Number of developed and undeveloped roots of the 4th order.
Plants grown exposed to the usual damage by the spotted boll-worm.*

(Average of 4 to 5 plants.)

Date of sowing.	7-7-1928.			15-7-1929.			26-6-1930.			2-7-1931.		
	1928-29.			1929-30.			1930-31.			1931-32.		
	Dev.	Undev.	Total.	Dev.	Undev.	Total.	Dev.	Undev.	Total.	Dev.	Undev.	Total.
27th August
2nd September
9th September
18th September	5.5	5.5	..	..	..	..	2.60	2.60	..	1.16	1.16
23rd September	2.00	2.00	..	..	..
30th September
7th October	3.75	3.75	..	..	..	..	..	..	..	..	..
14th October	3.66	3.66	0.2	19.8	20.0	..	..	..
21st October	17.2	17.2	..	..	..	..	..	..	..	..	..
28th October	0.2	10.8	11.0	..	4.5	4.5
4th November	45.0	45.0	..	..	..	..	..	..	..	..	..
11th November	6.4	6.4	..	9.83	9.83
18th November	18.33	18.33	..	..	..	..	..	..	..	..	..
25th November	0.6	19.6	20.2	0.6	13.0	13.6
2nd December	10.25	10.25	..	..	..	..	..	..	..	..	..
9th December	1.60	1.60	..	23.0	23.0	..	17.4	17.4
16th December	5.25	5.25	..	..	..	..	..	..	..	..	..
23rd December	5.75	5.75	0.5	17.0	17.5	..	13.75	13.75
30th December	15.0	15.0	..	..	..	..	..	..	..	..	..
6th January	1.0	34.25	35.25	..	7.25	7.25
13th January	8.67	8.67	..	..	..	..	..	..	..	..	..
20th January	9.75	9.75	..	32.25	32.25	..	14.75	14.75
27th January	15.66	15.66	..	..	..	..	..	..	..	..	..
3rd February	1.50	1.50	0.25	10.25	10.50	..	13.75	13.75
10th February	10.5	10.5	..	..	..	..	..	..	..	..	..
17th February	1.25	1.25	0.25	7.25	7.50	..	32.25	32.25
24th February	2.33	2.33	..	..	..	..	..	..	..	..	..
3rd March	11.25	11.25	..	19.66	19.66

TABLE NO. 54.

Length in cms. of roots of the 4th order for different years.

Plants grown exposed to the usual damage by the spotted boll-worm.

(Average of 4 to 5 plants.)

Period ending	1926-27.	1928-29.	1929-30.	1930-31.	1931-32.
27th August
2nd September
9th September
16th September
23rd September
30th September
7th October
14th October	3.8	..
21st October
28th October	2.2	..
4th November
11th November
18th November
25th November	14.1	11.80
2nd December
9th December
16th December
23rd December	19.75	..
30th December
7th January	45.0	..
14th January
21st January
28th January
3rd February	3.5	..
10th February
17th February	7.8	..
25th February
3rd March
10th March	2.8	..
18th March

TABLE No. 55.

Total number of roots of all orders of the cotton plant grown exposed to the usual damage by the spotted boll-worm.

(Average of 4 to 5 plants.)

Date of sowing.	1928-29.			1929-30.			1930-31.			1931-32.		
	7-7-1928.			15-7-1929.			26-6-1930.			2-7-1931.		
Period ending	Dev.	Undev.	Total.	Dev.	Undev.	Total.	Dev.	Undev.	Total.	Dev.	Undev.	Total.
27th August	15·0	67·0	82·00	..	..	..	..	..	..	..	..	..
2nd September	..	..	..	8·60	120·40	129·00	10·40	173·8	184·2	..	..	..
9th September	16·75	232·00	248·75	..	..	..	..	Rain.	..	..	..	..
16th September	..	..	..	11·17	143·16	154·33	..	..	..	8·66	158·00	166·66
23rd September	24·50	320·50	345·00	..	..	..	15·80	174·8	190·6	7·59	135·97	143·56
30th September	..	..	..	14·83	251·50	266·33	18·8	161·4	170·2	..	..	..
7th October	24·00	362·25	386·25	..	..	..	..	..	..	14·75	173·00	187·75
14th October	..	..	..	15·50	344·16	359·66	33·0	353·4	386·4	..	..	..
21st October	24·25	527·45	551·70	..	..	..	..	..	..	..	..	..
28th October	..	..	..	19·49	322·67	342·16	39·0	397·8	436·8	20·99	174·51	195·50
4th November	31·50	551·50	583·00	..	..	..	..	..	..	..	..	..
11th November	..	..	..	21·60	361·40	383·00	39·8	318·8	358·6	35·16	376·33	411·49
18th November	34·66	539·98	574·64	..	..	..	..	..	..	..	..	..
25th November	..	..	..	21·00	320·20	341·20	57·8	464·4	522·2	49·80	377·80	427·60
2nd December	36·50	518·25	554·75	..	..	..	..	..	..	..	..	..
9th December	..	..	..	24·40	379·60	404·00	67·4	529·2	596·6	57·00	498·60	555·60
16th December	30·00	435·75	465·75	..	..	..	..	..	..	..	..	..
23rd December	..	..	..	27·75	438·25	466·00	56·25	586·25	642·5	55·50	385·75	441·25
30th December	34·99	597·33	632·32	..	..	..	..	..	..	..	..	..
6th January	..	..	..	26·75	617·75	644·50	60·5	480·5	541·0	64·70	492·25	556·95
13th January	26·67	387·66	414·33	..	..	..	..	..	..	..	..	..
20th January	..	..	..	29·75	584·25	614·00	59·5	613·0	672·5	59·00	500·75	559·75
27th January	30·67	420·65	451·32	..	..	..	..	..	..	..	..	..
3rd February	..	..	..	32·25	638·25	670·50	52·0	581·5	633·5	50·50	408·50	459·00
10th February	26·00	375·50	401·50	..	..	..	..	..	..	..	..	..
17th February	..	..	..	31·75	454·50	486·25	42·75	440·0	482·75	55·25	576·25	631·50
24th February	29·66	399·66	429·32	..	..	..	..	..	..	..	..	..
3rd March	..	..	..	26·25	338·00	364·25	38·75	297·25	336·0	52·66	540·66	593·32

TABLE No. 56.

Length in cms. of roots of all orders. Plants grown exposed to the usual damage by the spotted boll-worm.

(Average of 4 to 5 plants.)

Period ending	1926-27.	1928-29.	1929-30.	1930-31.	1931-32.
27th August	..	167.05	..	..	..
2nd September	..	..	253.30	262.3	..
9th September	..	312.10	..	..	..
16th September	..	..	336.67	..	277.32
23rd September	..	636.05	..	462.5	284.60
30th September	..	..	622.51	612.8	..
7th October	371-25	816.67	..	..	486.57
14th October	..	..	910.43	1409.8	..
21st October	749.33	1139.06	..	..	814.91
28th October	..	..	1081.91	1749.1	..
4th November	536.75	1525.34	..	..	..
11th November	..	..	1314.60	1972.8	1368.49
18th November	953.00	1624.92	..	..	..
25th November	..	..	1392.70	2886.0	2071.8
2nd December	1412.0	1865.07	..	..	..
9th December	..	..	1511.60	3585.3	2447.0
16th December	1513.0	1637.99	..	..	..
23rd December	..	..	1789.75	3488.6	2477.00
30th December	2718.0	2252.59	..	..	..
7th January	..	..	1975.75	3547.5	2888.45
14th January	2190.0	1689.67	..	..	..
21st January	..	..	1787.24	3412.5	2811.25
28th January	2392.0	1479.67	..	..	..
3rd February	..	..	1708.99	3248.4	2530.75
10th February	1553.0	1613.25	..	..	..
17th February	..	..	1691.70	2512.4	3331.50
25th February	1531.5	1639.33	..	..	..
4th March	..	..	1380.62	2204.8	2686.98
11th March	1994.0	..	..	..	..
18th March	..	..	..	..	..

TABLE No. 57.

*Average number of effective branches in different years.
Plants grown exposed to the damage by the spotted boll-worm.*

Year	No. of plants under counts.	Limbs.	Primary fruiting branches.	Auxiliary branches.	Total.
1923-24	99	7.0	11.5	7.8	26.3
1924-25	50	8.24	14.94	8.9	32.08
1925-26	10	5.2	6.0	2.1	13.3
1926-27	10	5.7	17.4	9.3	32.4
1927-28	20	7.1	8.05	5.05	20.2
1928-29	20	7.55	9.95	9.15	26.65
1929-30	18	10.3	9.8	8.4	28.5
1930-31	20	7.5	10.10	8.55	26.15
1931-32	20	7.35	4.3	2.5	14.15
Average	..	7.3	10.2	6.9	24.4

TABLE No. 58.

Different kinds of total and effective branches plant by plant. Plants grown exposed to the damage by the spotted boll-worm.

1923-24.

Plant No.	Total Branches.				Effective Branches.			
	Limbs.	Main Sympodial Branches.	Auxiliary Branches.	Total.	Limbs.	Main Sympodial Branches.	Auxiliary Branches.	Total.
1	9	11	8	28	6	11	7	24
2	11	14	13	38	5	14	10	29
3	9	19	16	44	6	19	15	40
4	11	10	9	30	7	10	9	26
5	11	1	1	13	7	1	1	9
6	9	16	13	38	7	16	13	36
7	10	12	10	32	6	12	10	28
8	11	..	..	11	9	..	..	9
9	9	..	..	9	6	..	..	6
10	7	11	8	26	7	11	8	26
11	7	17	8	32	6	17	6	29
12	10	18	14	42	7	18	12	37
13	7	16	10	33	6	16	10	32
14	8	26	10	44	7	26	9	42
15	9	6	5	20	7	6	5	18
16	8	14	11	33	6	14	9	29
17	9	13	12	34	5	13	11	29
18	9	9	9	27	5	9	9	23
19	8	14	11	33	8	14	9	31
20	7	11	10	28	5	11	10	26
21	11	9	8	28	6	9	6	21
22	10	15	8	33	6	15	9	30
23	10	12	11	33	5	12	9	26
24	8	11	10	29	8	11	10	29

TABLE No. 58—*contd.*
Different kinds of total and effective branches plant by plant. Plants grown exposed to the damage by the spotted boll-worm.
 1923-24.

Plant No.	Total Branches.				Effective Branches.			
	Limbs.	Main Sympodial Branches.	Auxiliary Branches.	Total.	Limbs.	Main Sympodial Branches.	Auxiliary Branches.	Total.
25	7	18	1	26	6	18	1	25
26	9	9	6	24	5	9	6	20
27	9	17	15	41	9	17	15	41
28	10	13	13	36	6	13	13	32
29	9	16	15	40	8	16	13	37
30	10	12	9	31	10	12	8	30
31	11	14	13	38	8	14	7	29
32	12	9	8	29	9	9	8	26
33	8	..	..	8	5	..	..	5
34	7	..	..	7	6	..	..	6
35	10	14	13	37	6	14	11	31
36	5	..	..	5	4	..	..	4
37	11	8	6	25	10	8	6	24
38	10	15	8	33	8	15	6	29
39	9	5	9	14	6	5	..	11
40	10	18	14	42	8	18	12	38
41	10	16	10	36	7	16	9	32
42	6	..	..	6	5	..	..	5
43	11	16	12	39	4	16	9	29
44	11	15	14	40	7	15	12	31
45	8	14	12	34	5	14	12	31
46	10	9	7	26	9	9	5	23
47	11	3	2	16	7	3	2	12
48	11	9	8	28	10	9	7	26
49	12	14	14	40	9	14	12	35

TABLE No. 58—*contd.*
Different kinds of total and effective branches plant by plant. Plants grown exposed to the damage by the spotted boll-worm.
 1923-24.

Plant No.	Total Branches.				Effective Branches.			
	Limbs.	Main Sympodial Branches.	Auxiliary Branches.	Total.	Limbs.	Main Sympodial Branches.	Auxiliary Branches.	Total.
50	9	11	10	30	8	11	10	29
51	9	10	9	28	5	10	8	23
52	8	15	13	36	5	15	8	28
53	9	11	8	28	6	11	6	23
54	10	13	11	34	6	13	10	29
55	11	10	9	30	8	10	6	24
56	9	9	9	27	9	9	6	24
57	9	9	7	25	6	9	6	24
58	10	1	1	12	8	1	1	24
59	8	16	13	37	6	16	12	34
60	11	6	6	23	8	6	5	19
61	11	11	10	32	8	11	10	29
62	11	2	2	15	8	2	2	12
63	11	8	6	25	9	8	4	21
64	12	18	3	33	7	18	1	26
65	12	9	6	27	6	9	6	21
66	10	15	13	38	10	15	12	37
67	9	6	6	21	8	6	5	19
68	10	23	15	48	8	23	15	46
69	11	2	2	15	7	2	2	11
70	10	15	12	37	10	15	11	36
71	10	27	15	52	7	27	15	49
72	12	7	8	27	7	7	8	23
73	12	9	7	28	10	9	7	26
74	11	3	4	18	9	3	4	16

TABLE No. 58—concl'd.

Different kinds of total and effective branches plant by plant. Plants grown exposed to the damage by the spotted boll-worm.

1923-24.

Plant No.	Total Branches.				Effective Branches.			
	Limbs.	Main Sympodial Branches.	Auxiliary Branches.	Total.	Limbs.	Main Sympodial Branches.	Auxiliary Branches.	Total.
75	8	15	11	34	5	15	11	31
76	11	11	12	34	7	11	12	30
77	12	19	17	48	11	19	13	43
78	9	7	5	21	7	7	5	19
79	10	20	18	48	9	20	15	44
80	10	7	4	21	6	7	2	15
81	10	19	14	43	6	19	12	37
82	9	19	14	42	7	19	13	39
83	10	13	8	31	9	10	8	27
84	7	17	16	40	6	17	15	38
85	7	14	14	35	7	14	11	32
87	8	8	7	23	6	8	6	20
88	7	17	10	34	6	17	9	32
89	6	13	11	30	5	13	6	24
90	10	14	8	32	6	14	7	27
91	11	6	5	22	8	6	5	19
92	8	21	12	41	6	21	11	38
93	6	8	7	21	3	8	7	18
94	10	7	5	22	8	7	4	19
95	13	5	3	21	7	5	3	15
96	13	8	8	29	9	8	4	21
97	11	20	12	43	10	20	10	40
98	9	15	13	37	5	15	12	32
99	10	18	15	43	4	18	15	37
100	9	9	6	24	7	9	6	22
Average	9.6	11.5	8.8	29.9	7.0	11.5	7.8	26.3

TABLE NO. 59.

Different kinds of branching plant by plant. Plants grown exposed to the damage by the spotted boll-worm.

1924-25.

Plant No.	Total Branches.				Effective Branches.			
	Limbs.	Main Sympodial Branches.	Auxiliary Branches.	Total.	Limbs.	Main Sympodial Branches.	Auxiliary Branches.	Total.
1	12	19	15	46	8	19	9	36
2	13	15	12	40	11	15	9	35
3	8	14	10	32	7	14	8	29
4	12	18	12	42	8	18	10	36
5	12	9	6	27	7	9	5	21
6	12	24	18	54	9	24	12	45
7	11	15	8	34	7	15	5	27
8	17	7	8	32	12	7	5	24
9	7	13	9	29	5	13	7	25
10	13	19	11	43	7	19	9	35
11	5	22	22	49	4	22	11	37
12	6	15	11	32	6	15	8	29
13	11	21	17	49	7	21	9	37
14	17	13	13	43	10	13	11	34
15	13	18	15	46	11	18	12	41
16	10	23	12	45	9	23	9	41
17	17	11	10	38	13	11	7	31
18	10	2	2	14	8	2	1	11
19	5	11	8	24	5	11	8	24
20	12	3	..	15	11	3	..	14
31	6	16	15	37	4	16	13	33
32	9	20	19	48	7	20	14	41
33	12	2	1	15	10	2	1	13
34	16	14	9	39	10	14	8	32
35	10	13	12	35	8	13	10	31

TABLE No. 59—(contd.)
Different kinds of branching plant by plant. Plants grown exposed to the damage by the spotted boll-worm.
 1924-25.

Plant No.	Total Branches.				Effective Branches.			
	Limbs.	Main Sympodial Branches.	Auxiliary Branches.	Total.	Limbs.	Main Sympodial Branches.	Auxiliary Branches.	Total.
36	9	22	21	52	8	22	16	46
37	8	17	15	40	6	17	12	35
38	10	26	24	60	8	26	22	56
39	9	4	5	18	9	4	4	17
40	11	12	10	33	8	12	7	27
41	10	8	5	23	8	8	4	20
42	10	28	18	56	8	28	17	53
43	10	17	11	38	9	17	8	34
44	11	18	16	45	11	18	10	39
45	9	15	11	35	7	15	8	30
46	7	27	21	55	6	27	14	47
47	8	14	11	33	7	14	10	31
48	12	20	17	49	10	20	16	46
49	12	18	11	41	10	18	6	34
50	12	15	14	41	9	15	13	37
51	12	21	17	50	9	21	15	45
52	9	8	2	19	7	8	1	16
53	7	22	18	47	6	22	14	42
54	13	12	7	32	11	12	7	30
55	9	3	..	12	7	3	..	10
56	2	16	16	34	1	16	14	31
57	9	21	18	48	8	21	14	43
58	20	4	..	24	14	4	..	18
59	12	4	..	16	11	4	..	15
60	12	18	14	44	10	18	12	40
Average	10.58	14.94	11.54	37.06	8.24	14.94	8.90	32.08

TABLE NO. 60.

Periodical average leaf formation in plants exposed to the damage by the spotted boll-worm.

1923-24.		1924-25.		1925-26.		1926-27.	
Number of plants under counts. 99		50		10		10	
Period ending.	Leaves.	Period ending.	Leaves.	Period ending.	Leaves.	Period ending.	Leaves.
..	..	..	..	22nd August ..	13.9	..	..
..	..	..	..	29th August ..	11.3	..	..
..	..	7th September..	29.5	5th September..	23.6	..	..
..	..	14th September	18.9	12th September	23.7	..	..
23rd September.	17.9	21st September ..	51.2	19th September.	41.3	..	..
30th September.	14.6	28th September.	41.5	26th September	61.0	..	..
7th October ..	22.2	5th October ..	65.3	3rd October ..	82.8	1st October ..	31.1
14th October ..	26.5	12th October ..	34.6	10th October ..	77.7	8th October ..	33.2
21st October ..	37.4	19th October ..	62.6	17th October ..	111.9	15th October ..	30.3
28th October ..	51.9	26th October ..	90.0	24th October ..	115.1	22nd October ..	47.4
4th November ..	54.3	2nd November.	66.2	31st October ..	88.1	29th October ..	43.9
..	..	9th November ..	83.8	7th November ..	92.4	6th November ..	49.1
18th November	103.6	16th November	46.9	14th November.	81.1	13th November.	50.8
..	..	23rd November.	36.2	21st November ..	61.2	20th November.	54.0
2nd December ..	90.6	..	..	28th November.	31.7	27th November.	43.0
..	..	7th December ..	33.5	5th December.	15.2	4th December ..	68.5
16th December ..	83.3	..	..	12th December ..	6.9	9th December ..	34.6
..	..	21st December ..	38.9	19th December ..	1.3	..	..
30th December ..	38.7	..	..	26th December ..	..	23rd December ..	60.5
..	..	4th January ..	16.9	..	..	..	..
..	..	..	..	..	..	6th January ..	56.5
..	..	18th January ..	3.8	..	..	..	..
20th January ..	21.9	..	..	..	..	20th January ..	21.8
..	..	1st February ..	14.8	..	..	..	..
3rd February ..	2.7	..	..	..	..	3rd February ..	12.9
..
17th February ..	2.0	..	..	..	..	17th February ..	3.9
Total ..	567.6	Total ..	784.6	Total ..	945.2	Total ..	641.5

TABLE No. 60—(contd.)

Periodical average leaf formation in plants exposed to the damage by the spotted ball-worm.

1927-28.		1928-29.		1929-30.		1930-31.		1931-32.	
Number of plants under counts. 10		20		18		20		20	
Period ending	Leaves.	Period ending	Leaves.	Period ending	Leaves.	Period ending	Leaves.	Period ending	Leaves.
..
..
..	..	6th Sept. ..	24.70	3rd Sept. ..	13.7	2nd Sept. ..	12.50	..	..
12th Sept. ..	37.30	13th Sept.	17.10	10th Sept. ..	12.5	9th Sept. ..	5.95	..	..
19th Sept. ..	27.50	..	..	17th Sept. ..	26.1	..	..	14th Sept. ..	18.50
..	..	27th Sept. ..	59.15	24th Sept. ..	31.0	23rd Sept. ..	34.15	..	..
4th Oct. ..	78.05	4th Oct. ..	50.70	1st Oct. ..	44.8	30th Sept. ..	28.75	28th Sept. ..	24.65
10th Oct. ..	79.75	11th Oct. ..	50.40	8th Oct. ..	56.5	7th Oct. ..	42.20	..	..
17th Oct. ..	65.90	18th Oct. ..	63.65	15th Oct. ..	59.1	14th Oct. ..	44.60	..	..
24th Oct. ..	69.00	25th Oct. ..	91.50	22nd Oct. ..	53.3	21st Oct. ..	55.65	20th Oct. ..	90.20
31st Oct. ..	74.50	1st Nov. ..	91.10	29th Oct. ..	47.9	28th Oct. ..	73.30	26th Oct. ..	31.45
7th Nov. ..	151.15	8th Nov. ..	64.60	5th Nov. ..	45.4	4th Nov. ..	46.35	2nd Nov. ..	48.85
..	..	15th Nov. ..	49.60	12th Nov. ..	71.8	11th Nov. ..	52.05	9th Nov. ..	62.65
21st Nov. ..	136.35	22nd Nov. ..	50.95	19th Nov. ..	76.1	18th Nov. ..	56.95	16th Nov. ..	61.65
..	..	29th Nov. ..	89.00	26th Nov. ..	51.6	25th Nov. ..	53.05	23rd Nov. ..	47.50
5th Dec. ..	72.45	6th Dec. ..	23.80	3rd Dec. ..	32.4	2nd Dec. ..	39.50	30th Nov. ..	41.60
..	..	13th Dec. ..	19.35	10th Dec. ..	19.8	9th Dec. ..	34.55	7th Dec. ..	35.50
19th Dec. ..	80.45	20th Dec. ..	11.40	17th Dec. ..	8.3	16th Dec. ..	23.85	14th Dec. ..	32.45
..	..	27th Dec. ..	8.90	24th Dec. ..	12.8	23rd Dec. ..	12.95	21st Dec. ..	31.05
2nd Jan. ..	85.85	3rd Jan. ..	7.20	31st Dec. ..	4.5	30th Dec. ..	4.30	28th Dec. ..	25.45
..	..	10th Jan. ..	3.50	7th Jan. ..	1.0	6th Jan. ..	1.10	4th Jan. ..	12.50
16th Jan. ..	23.30	17th Jan. ..	3.70	14th Jan. ..	0.1	13th Jan. ..	0.35	11th Jan. ..	8.20
..	..	24th Jan. ..	3.50	21st Jan. ..	..	..	..	18th Jan. ..	2.75
30th Jan. ..	7.30	31st Jan. ..	0.20	28th Jan. ..	..	..	..	25th Jan. ..	0.25
..	..	7th Feb. ..	0.10	4th Feb. ..	..	..	..	..	..
13th Feb. ..	0.65	..	..	11th Feb. ..	..	..	..	..	..
..
Total ..	939.50	Total ..	734.10	Total ..	668.3	Total ..	621.60	Total ..	575.20

TABLE No. 61.

Periodical average vegetative bud formation in plants exposed to the damage by the spotted boll-worm.

1923-24.		1924-25.		1925-26.		1926-27.	
Number of plants under counts. 99		50		10		10	
Period ending.	Veg. buds.	Period ending.	Veg. buds.	Period ending.	Veg buds.	Period ending	Veg. buds.
..	..	..	..	22nd Aug.	13.6	..	..
..	..	..	..	29th Aug.	9.2	..	..
..	..	7th Sept.	27.1	5th Sept.	18.9	..	..
..	..	14th Sept.	15.2	12th Sept.	23.0	..	..
23rd Sept.	17.7	21st Sept.	38.5	19th Sept.	35.4	..	..
30th Sept.	12.4	28th Sept.	26.7	26th Sept.	50.5	..	..
7th Oct.	17.3	5th Oct.	41.3	3rd Oct.	66.2	1st Oct.	26.8
14th Oct.	17.1	12th Oct.	17.8	10th Oct.	58.5	8th Oct.	22.7
21st Oct.	23.3	19th Oct.	35.3	17th Oct.	80.1	15th Oct.	17.9
28th Oct.	30.9	26th Oct.	40.7	24th Oct.	83.3	22nd Oct.	26.9
4th Nov.	28.7	2nd Nov.	28.2	31st Oct.	55.1	29th Oct.	22.5
..	..	9th Nov.	35.9	7th Nov.	52.9	6th Nov.	26.3
18th Nov.	52.4	16th Nov.	18.6	14th Nov.	40.4	13th Nov.	27.2
..	..	23rd Nov.	14.2	21st Nov.	30.3	20th Nov.	25.7
2nd Dec.	32.0	..	..	28th Nov.	17.3	27th Nov.	20.3
..	..	7th Dec.	13.8	5th Dec.	7.9	4th Dec.	27.2
16th Dec.	40.3	..	..	12th Dec.	3.4	9th Dec.	13.9
..	..	21st Dec.	15.2	19th Dec.	0.8	..	..
30th Dec.	8.0	..	..	..	..	23rd Dec.	27.1
..	..	4th Jan.	8.0	..	..	..	..
..	..	..	..	..	..	6th Jan.	23.3
20th Jan.	12.2	18th Jan.	2.4	..	..	..	..
..	..	..	..	..	..	20th Jan.	9.8
3rd Feb.	..	1st Feb.	11.8	..	..	..	..
..	..	..	..	..	..	3rd Feb.	8.2
17th Feb.	..	..	..	..	..	..	..
..	..	..	..	..	..	17th Feb.	3.0
Total	292.3	Total	390.7	Total	646.8	Total	328.8

TABLE No. 61—(contd.)

Periodical average vegetative bud formation in plants exposed to the damage by the spotted boll-worm.

1927-28.		1928-29.		1929-30.		1930-31.		1931-32.	
Number of plants under counts. 20		20		18		20		20	
Period ending	Veg. buds.	Period ending	Veg. buds.	Period ending	Veg. buds.	Period ending	Veg. buds.	Period ending	Veg. buds.
..
..
..	..	6th Sept. ..	23.45	3rd Sept. ..	13.6	2nd Sept. ..	12.50	..	..
12th Sept. ..	33.30	13th Sept. ..	12.65	10th Sept. ..	11.4	9th Sept. ..	5.65	..	..
19th Sept. ..	19.75	..	..	17th Sept. ..	21.5	..	..	14th Sept. ..	18.35
..	..	27th Sept. ..	37.85	24th Sept. ..	23.8	23rd Sept. ..	27.25	..	..
4th Oct. ..	57.05	4th Oct. ..	30.95	1st Oct. ..	34.2	30th Sept. ..	20.50	28th Sept. ..	23.20
10th Oct. ..	63.55	11th Oct. ..	31.10	8th Oct. ..	37.6	7th Oct. ..	26.65	..	..
17th Oct. ..	52.45	18th Oct. ..	34.95	15th Oct. ..	30.9	14th Oct. ..	23.45	..	..
24th Oct. ..	50.65	25th Oct. ..	52.50	22nd Oct. ..	26.1	21st Oct. ..	29.55	20th Oct. ..	69.65
31st Oct. ..	49.35	1st Nov. ..	54.60	29th Oct. ..	19.3	28th Oct. ..	36.65	26th Oct. ..	18.95
7th Nov. ..	90.85	8th Nov. ..	34.80	5th Nov. ..	20.1	4th Nov. ..	26.85	2nd Nov. ..	29.95
..	..	15th Nov. ..	24.15	12th Nov. ..	33.4	11th Nov. ..	26.40	9th Nov. ..	48.15
21st Nov. ..	80.70	22nd Nov. ..	23.10	19th Nov. ..	37.6	18th Nov. ..	26.05	16th Nov. ..	39.40
..	..	29th Nov. ..	18.75	26th Nov. ..	22.8	25th Nov. ..	22.15	23rd Nov. ..	25.00
5th Dec. ..	34.15	6th Dec. ..	11.80	3rd Dec. ..	13.1	2nd Dec. ..	14.95	30th Nov. ..	23.80
..	..	13th Dec. ..	11.05	10th Dec. ..	8.1	9th Dec. ..	12.90	7th Dec. ..	18.50
19th Dec. ..	45.50	20th Dec. ..	7.30	17th Dec. ..	3.4	16th Dec. ..	9.25	14th Dec. ..	17.60
..	..	27th Dec. ..	6.45	24th Dec. ..	9.6	23rd Dec. ..	5.30	21st Dec. ..	15.30
2nd Jan. ..	23.35	3rd Jan. ..	5.85	31st Dec. ..	3.3	30th Dec. ..	2.00	28th Dec. ..	13.90
..	..	10th Jan. ..	2.75	7th Jan. ..	0.8	6th Jan. ..	0.60	4th Jan. ..	7.35
16th Jan. ..	18.90	17th Jan. ..	3.20	14th Jan. ..	0.1	13th Jan. ..	0.35	11th Jan. ..	4.75
..	..	24th Jan. ..	3.45	..	..	..	..	18th Jan. ..	2.30
30th Jan. ..	6.80	31st Jan. ..	0.20	..	..	..	..	25th Jan. ..	0.20
..	..	7th Feb. ..	0.19	..	..	..	..	..	..
13th Feb. ..	0.50	..	..	..	..	..	..	..	..
..
Total ..	626.85	Total ..	431.0	Total ..	370.8	Total ..	328.50	Total ..	371.35

TABLE No. 62.

Periodical average flower-bud formation in plants exposed to the damage by the spotted boll-worm.

1923-24.		1924-25.		1925-26.		1926-27.	
Number of plants under counts. 99		50		10		10	
Period ending	Flower buds.	Period ending	Flower buds.	Period ending.	Flower buds.	Period ending	Flower buds.
..	..	..	..	22nd Aug.	0.3	..	..
..	..	..	..	29th Aug.	2.1	..	..
..	..	7th Sept.	2.4	5th Sept.	4.7	..	..
..	..	14th Sept.	3.7	12th Sept.	5.7	..	..
23rd Sept.	0.2	21st Sept.	12.7	19th Sept.	5.9	..	..
30th Sept.	2.2	28th Sept.	14.8	26th Sept.	10.5	..	..
7th Oct.	4.9	5th Oct.	24.0	3rd Oct.	16.6	1st Oct.	4.4
14th Oct.	9.4	12th Oct.	16.8	10th Oct.	19.2	8th Oct.	10.4
21st Oct.	14.1	19th Oct.	27.3	17th Oct.	31.8	15th Oct.	12.4
28th Oct.	21.0	26th Oct.	49.3	24th Oct.	31.8	22nd Oct.	20.5
4th Nov.	25.6	2nd Nov.	38.0	31st Oct.	33.0	29th Oct.	21.4
..	..	9th Nov.	47.9	7th Nov.	39.5	6th Nov.	22.8
18th Nov.	51.2	16th Nov.	28.3	14th Nov.	40.7	13th Nov.	28.6
..	..	23rd Nov.	22.0	21st Nov.	30.9	20th Nov.	28.3
2nd Dec.	58.6	..	..	28th Nov.	14.4	27th Nov.	22.7
..	..	7th Dec.	19.7	5th Dec.	7.3	4th Dec.	41.3
16th Dec.	43.0	..	..	12th Dec.	3.5	9th Dec.	20.7
..	..	21st Dec.	23.7	19th Dec.	0.5	..	..
30th Dec.	30.7	..	..	..	..	23rd Dec.	33.4
..	..	4th Jan.	8.9	..	..	..	..
..	..	..	..	..	..	6th Jan.	33.2
20th Jan.	9.7	18th Jan.	1.4	..	..	..	..
..	..	..	..	..	..	20th Jan.	12.0
3rd Feb.	2.7	1st Feb.	3.0	..	..	..	..
..	..	..	..	..	..	3rd Feb.	4.7
17th Feb.	2.0	..	..	..	..	..	..
..	..	..	..	..	..	17th Feb.	0.9
Total	275.3	Total	343.9	Total	298.4	Total	312.7

TABLE No. 62—(contd.)

Periodical average flower-bud formation in plants exposed to the damage by the spotted boll-worm.

1927-28.		1928-29.		1929-30.		1930-31.		1931-32.	
Number of plants under counts, 20		20		18		20		20	
Period ending	Flower buds.	Period ending	Flower buds.	Period ending	Flower buds.	Period ending	Flower buds.	Period ending	Flower buds.
..
..
..	..	6th Sept. ..	1.25	8rd Sept. ..	0.1	..	..	..	..
12th Sept. ..	4.00	13th Sept. ..	4.45	10th Sept. ..	1.1	9th Sept. ..	0.30	..	..
19th Sept. ..	7.75	..	..	17th Sept. ..	4.6	..	..	14th Sept. ..	0.15
..	..	27th Sept. ..	21.30	24th Sept. ..	7.2	23rd Sept. ..	6.90	..	..
4th Oct. ..	21.00	4th Oct. ..	19.75	1st Oct. ..	10.6	30th Sept. ..	8.25	28th Sept. ..	1.45
10th Oct. ..	16.20	11th Oct. ..	19.30	8th Oct. ..	18.9	7th Oct. ..	15.55	..	..
17th Oct. ..	13.45	18th Oct. ..	23.70	15th Oct. ..	23.2	14th Oct. ..	21.15	..	..
24th Oct. ..	18.35	25th Oct. ..	39.00	22nd Oct. ..	27.2	21st Oct. ..	26.10	20th Oct. ..	20.55
31st Oct. ..	25.15	1st Nov. ..	36.50	29th Oct. ..	28.6	28th Oct. ..	36.65	26th Oct. ..	12.50
7th Nov. ..	60.30	8th Nov. ..	29.80	5th Nov. ..	25.3	4th Nov. ..	20.00	2nd Nov. ..	18.90
..	..	15th Nov. ..	25.45	12th Nov. ..	38.4	11th Nov. ..	25.65	9th Nov. ..	19.50
21st Nov. ..	55.65	22nd Nov. ..	27.85	19th Nov. ..	38.5	18th Nov. ..	30.90	16th Nov. ..	22.25
..	..	29th Nov. ..	20.25	26th Nov. ..	23.8	25th Nov. ..	30.90	23rd Nov. ..	22.50
5th Dec. ..	38.30	6th Dec. ..	12.00	3rd Dec. ..	19.3	2nd Dec. ..	24.55	30th Nov. ..	17.80
..	..	13th Dec. ..	8.30	10th Dec. ..	11.7	9th Dec. ..	21.65	7th Dec. ..	17.00
19th Dec. ..	84.95	20th Dec. ..	4.10	17th Dec. ..	4.9	16th Dec. ..	14.10	14th Dec. ..	14.85
..	..	27th Dec. ..	2.45	24th Dec. ..	3.2	23rd Dec. ..	7.65	21st Dec. ..	15.75
2nd Jan. ..	12.50	3rd Jan. ..	1.95	31st Dec. ..	1.2	30th Dec. ..	2.30	28th Dec. ..	11.55
..	..	10th Jan. ..	0.75	7th Jan. ..	0.2	6th Jan. ..	6.50	4th Jan. ..	5.15
16th Jan. ..	4.40	17th Jan. ..	0.50	..	..	..	..	11th Jan. ..	3.45
..	..	24th Jan. ..	0.05	..	..	..	..	18th Jan. ..	0.45
30th Jan. ..	0.50	..	..	..	..	..	..	25th Jan. ..	0.05
..
13th Feb. ..	0.15	..	..	..	..	..	..	..	..
..
Total ..	312.65	Total ..	303.10	Total ..	297.5	Total ..	293.10	Total ..	203.85

TABLE No. 62A.

Specimen page reduced from the original large field register, showing the method of sketching the plant-scaffolding and noting the history of buds.

Bud Number.	Date of bud.		Number of weeks for a bud to shed.	Date of flowering.	Number of days for flowering	Date of boll-shedding.	Number of days for a boll to shed.
	Inception.	Shedding.					
1	10th Sept. ..	24th Sept. ..	2	..	..	..	..
2	17th Sept. ..	2nd Oct. ..	2	..	..	..	..
3	Do. ..	17th Sept. ..	..	..	..	..	..
*	*	*		*	*	*	
7	24th Sept. ..	9th Oct. ..	2	..	..	..	..
8	Do. ..	2nd Oct. ..	1	..	..	..	..
9	Do. ..	9th Oct. ..	2	..	..	..	..
*	*	*		*	*	*	
17	2nd Oct. ..	16th Oct. ..	2	..	..	..	..
18	Do. ..	9th Oct. ..	1	..	..	..	..
19	Do. ..	..	..	4th Nov. ..	33	6th Nov. ..	2
20	Do. ..	16th Oct. ..	2	..	..	..	..
*	*	*		*	*	*	
36	9th Oct. ..	30th Oct. ..	3	..	..	..	..
37	Do. ..	..	..	8th Nov. ..	30	12th Nov. ..	4
38	Do. ..	30th Oct. ..	3	..	..	..	..
39	Do. ..	..	..	8th Nov. ..	30	11th Nov. ..	4
40	Do. ..	16th Oct. ..	1	..	..	..	..
*	*	*		*	*	*	
58	16th Oct. ..	12th Nov. ..	4	..	..	..	..
59	Do. ..	Do. ..	4	..	..	..	..
60	Do. ..	30th Oct. ..	2	..	..	..	..
61	Do. ..	..	..	14th Nov. ..	29	19th Nov. ..	5
62	Do. ..	..	..	15th Nov. ..	30	20th Nov. ..	5
63	Do. ..	30th Oct. ..	2	..	..	..	..
64	Do. ..	23rd Oct. ..	1	..	..	..	..
65	Do. ..	30th Oct. ..	2	..	..	..	..
66	Do. ..	Do. ..	2	..	..	..	..
67	Do. ..	23rd Oct. ..	1	..	..	..	..
68	16th Oct. ..	30th Oct. ..	2	..	..	..	..
69	Do. ..	..	..	12th Nov. ..	27	19th Nov. ..	7
*	*	*		*	*	*	
91	23rd Oct. ..	12th Nov. ..	3	..	..	..	..
92	Do. ..	Do. ..	3	..	..	..	..
93	Do. ..	..	..	22nd Nov. ..	30	..	..

TABLE No. 62A--(contd.)

Specimen page reduced from the original large field register showing the method of sketching the plant-scaffolding and noting the history of buds.

Bud Number.	Date of bud.		Number of weeks for a bud to shed.	Date of flowering.	Number of days for flowering	Date of boll-shedding.	Number of days for a boll to shed.
	Inception.	Shedding.					
94	23rd Oct. ..	30th Oct. ..	1	..	..	..	..
95	Do. ..	19th Nov. ..	4	..	..	..	..
96	Do. ..	30th Oct. ..	1	..	..	..	..
97	Do. ..	..	..	23rd Nov. ..	31	..	..
98	Do. ..	12th Nov. ..	3	..	..	..	..
99	Do. ..	Do. ..	3	..	..	..	..
129	30th Oct. ..	12th Nov. ..	2	..	..	..	..
130	Do. ..	Do. ..	2	..	..	..	..
131	Do. ..	Do. ..	2	..	..	..	..
132	Do. ..	19th Nov. ..	3	..	..	..	..
133	Do. ..	12th Nov. ..	2	..	..	..	..
134	Do. ..	Do. ..	2	..	..	..	..
135	Do. ..	Do. ..	2	..	..	..	..
136	Do. ..	Do. ..	2	..	..	..	..
137	Do. ..	Do. ..	2	..	..	..	..
*	*	*	..	*	*	*	*
160	5th Nov. ..	..	..	15th Dec. ..	40	19th Dec. ..	4
161	Do. ..	19th Nov. ..	2	..	..	..	..
162	Do. ..	12th Nov. ..	1	..	..	..	..
*	*	*	..	*	*	*	*
177	12th Nov. ..	26th Nov. ..	2	..	..	..	..
178	Do. ..	19th Nov. ..	1	..	..	..	..
179	Do. ..	26th Nov. ..	2	..	..	..	..
180	Do. ..	Do. ..	2	..	..	..	..
181	Do. ..	..	..	15th Dec. ..	33	10th Jan. ..	26
182	Do. ..	26th Nov. ..	2	..	..	..	..
*	*	*	..	*	*	*	*
210	19th Nov. ..	26th Nov. ..	1	..	..	..	..
211	Do. ..	..	..	25th Dec. ..	37	7th Jan. ..	13
*	*	*	..	*	*	*	*
239	26th Nov. ..	26th Nov. ..	..	..	..	..	..
240	Do. ..	..	..	3rd Jan. ..	38	13th Jan. ..	10
241	Do. ..	..	..	3rd Jan. ..	38	13th Jan. ..	10
*	*	*	..	*	*	*	*
263	3rd Dec. ..	3rd Dec. ..	..	..	..	..	..
264	Do. ..	7th Jan. ..	5	..	..	..	..
286	10th Dec. ..	21st Jan. ..	6	..	..	..	..
293	17th Dec. ..	31st Dec. ..	2	..	..	..	..
*	*	*	..	*	*	*	*

TABLE NO. 63.

Periodical average rate of flower opening in plants grown exposed to the usual damage by the spotted boll-worm.

1923-24.		1924-25.		1925-26.		1926-27.	
Number of plants under counts. 99		50		10		10	
Period.	Flowers.	Period.	Flowers.	Period.	Flowers.	Period.	Flowers.
..
..	..	..	..	25th Oct.	0.5	..	..
4th Nov.	0.3	..	..	1st Nov.	0.4	31st Oct.	0.3
11th Nov.	0.8	9th Nov.	0.06	8th Nov.	1.2	7th Nov.	1.0
18th Nov.	1.3	16th Nov.	1.06	15th Nov.	3.1	14th Nov.	1.3
25th Nov.	1.5	23rd Nov.	2.24	22nd Nov.	8.8	21st Nov.	2.3
2nd Dec.	3.4	30th Nov.	11.18	29th Nov.	17.8	28th Nov.	2.4
9th Dec.	5.2	7th Dec.	15.38	6th Dec.	19.2	5th Dec.	1.6
16th Dec.	6.4	14th Dec.	16.82	13th Dec.	16.7	12th Dec.	1.4
23rd Dec.	8.0	21st Dec.	19.08	20th Dec.	9.9	19th Dec.	3.1
30th Dec.	9.1	28th Dec.	13.46	27th Dec.	5.5	26th Dec.	2.6
6th Jan.	9.5	4th Jan.	6.10	3rd Jan.	3.5	2nd Jan.	3.5
13th Jan.	8.2	11th Jan.	1.54	10th Jan.	0.8	9th Jan.	4.4
20th Jan.	5.6	18th Jan.	0.34	..	..	16th Jan.	5.0
27th Jan.	8.0	25th Jan.	0.02	..	..	23rd Jan.	7.6
3rd Feb.	1.7	1st Feb.	0.02	..	..	30th Jan.	7.3
10th Feb.	0.3	..	..	..	..	6th Feb.	9.0
..	..	..	..	..	..	13th Feb.	8.5
..	..	..	..	..	..	20th Feb.	6.1
..	..	..	..	..	..	27th Feb.	1.8
..	..	..	..	..	..	6th Mar.	0.4
Total	64.3	Total	87.30	Total	87.4	Total	69.6

TABLE NO. 63—(contd.)

Periodical average rate of flower opening in plants grown exposed to the usual damage by the spotted boll-worm.

1927-28.		1928-29.		1929-30.		1930-31.		1931-32.	
Number of plants under counts. 20		20		18		20		20	
Period.	Flowers.	Period.	Flowers.	Period.	Flowers.	Period.	Flowers.	Period.	Flowers.
..	..	..	..	20th Oct. ..	0·1	19th Oct. ..	0·10	..	..
..	..	28th Oct. ..	0·05	27th Oct. ..	0·1	26th Oct. ..	0·75	..	..
..	..	4th Nov. ..	..	3rd Nov. ..	0·4	2nd Nov. ..	1·05	..	..
..	..	11th Nov. ..	0·90	10th Nov. ..	1·6	9th Nov. ..	0·30	..	..
..	..	18th Nov. ..	4·25	17th Nov. ..	4·5	16th Nov. ..	0·15	..	..
20th Nov. ..	0·05	25th Nov. ..	5·95	24th Nov. ..	5·2	23rd Nov. ..	0·20	22nd Nov. ..	0·15
27th Nov. ..	0·35	2nd Dec. ..	7·35	1st Dec. ..	5·9	30th Nov. ..	0·95	29th Nov. ..	0·85
4th Dec. ..	1·50	9th Dec. ..	8·80	8th Dec. ..	8·6	7th Dec. ..	3·10	6th Dec. ..	1·60
11th Dec. ..	4·20	16th Dec. ..	12·60	15th Dec. ..	11·9	14th Dec. ..	7·35	13th Dec. ..	3·80
18th Dec. ..	4·95	23rd Dec. ..	9·05	22nd Dec. ..	10·5	21st Dec. ..	13·60	20th Dec. ..	5·75
25th Dec. ..	9·20	30th Dec. ..	7·65	29th Dec. ..	6·9	28th Dec. ..	19·70	27th Dec. ..	10·20
1st Jan. ..	11·05	6th Jan. ..	4·45	5th Jan. ..	10·5	4th Jan. ..	16·25	3rd Jan. ..	8·00
8th Jan. ..	13·45	13th Jan. ..	3·60	12th Jan. ..	7·1	11th Jan. ..	15·05	10th Jan. ..	10·10
15th Jan. ..	14·15	20th Jan. ..	1·65	19th Jan. ..	3·5	18th Jan. ..	7·35	17th Jan. ..	10·75
22nd Jan. ..	11·90	27th Jan. ..	1·20	26th Jan. ..	0·8	25th Jan. ..	1·05	24th Jan. ..	7·75
29th Jan. ..	7·65	3rd Feb. ..	0·45	2nd Feb. ..	..	1st Feb. ..	0·05	31st Jan. ..	3·95
5th Feb. ..	2·15	10th Feb. ..	0·35	9th Feb. ..	0·1	..	..	7th Feb. ..	1·50
12th Feb. ..	0·95	17th Feb. ..	0·30	..	..	..	..	14th Feb. ..	0·40
19th Feb. ..	0·25	24th Feb. ..	0·05	..	..	..	..	..	..
..
..
Total ..	81·8	Total ..	68·65	Total ..	77·7	Total ..	87·0	Total ..	64·80

TABLE No. 64.

*Periodical average rate of flower-bud shedding as it occurred in different years.
Plants grown exposed to the damage by the spotted boll-worm.*

1923-24.		1924-25.		1925-26.		1928-29.	
Number of plants under counts. 99		50		10		20	
Period ending	Bud- shed- ding.	Period ending	Bud- shed- ding.	Period ending	Bud- shed- ding.	Period ending	Bud- shed- ding.
..	..	..	..	29th Aug. ..	0.2	..	..
..	..	..	..	5th Sept. ..	0.9	..	..
..	..	14th Sept. ..	0.7	12th Sept. ..	3.2	13th Sept. ..	0.20
..	..	21st Sept. ..	3.8	19th Sept. ..	4.4	..	..
..	..	28th Sept. ..	7.9	26th Sept. ..	4.0	27th Sept. ..	9.95
7th Oct. ..	0.3	5th Oct. ..	3.1	3rd Oct. ..	5.2	4th Oct. ..	9.35
14th Oct. ..	1.8	12th Oct. ..	15.3	10th Oct. ..	10.6	11th Oct. ..	17.75
21st Oct. ..	2.8	19th Oct. ..	14.7	17th Oct. ..	11.5	18th Oct. ..	13.80
28th Oct. ..	8.1	26th Oct. ..	23.4	24th Oct. ..	26.7	25th Oct. ..	13.05
4th Nov. ..	13.4	2nd Nov. ..	21.6	31st Oct. ..	23.6	1st Nov. ..	22.70
..	..	9th Nov. ..	21.0	7th Nov. ..	14.4	8th Nov. ..	21.70
18th Nov. ..	24.6	16th Nov. ..	16.7	14th Nov. ..	13.7	15th Nov. ..	20.65
..	..	23rd Nov. ..	18.4	21st Nov. ..	19.1	22nd Nov. ..	19.80
2nd Dec. ..	27.5	..	..	28th Nov. ..	13.5	29th Nov. ..	21.10
..	..	7th Dec. ..	17.4	5th Dec. ..	15.1	6th Dec. ..	16.75
16th Dec. ..	26.4	..	..	12th Dec. ..	19.3	13th Dec. ..	18.90
..	..	21st Dec. ..	27.0	19th Dec. ..	12.2	20th Dec. ..	12.70
30th Dec. ..	27.4	..	..	26th Dec. ..	1.5	27th Dec. ..	5.40
..	..	4th Jan. ..	16.4	2nd Jan. ..	0.3	3rd Jan. ..	4.00
..	..	..	..	..	..	10th Jan. ..	2.45
20th Jan. ..	29.4	18th Jan. ..	20.0	..	..	17th Jan. ..	1.90
..	..	..	..	..	..	24th Jan. ..	1.25
2nd Feb. ..	16.5	1st Feb. ..	28.4	..	..	31st Jan. ..	0.25
..
17th Feb. ..	21.5	..	..	..	..	..	..
..
Rest.	11.3	Rest.	0.8	Rest.	11.6	Rest.	0.80
Total	211.0	Total	256.6	Total	211.0	Total	234.45

TABLE No. 64—(contd.)

Periodical average rate of flower-bud shedding as it occurred in different years.
Plants grown exposed to the damage by the spotted boll-worm.

1929-30.		1930-31.		1931-32.	
Number of plants under counts. 18		20		20	
Period ending	Bud-shedding	Period ending	Bud-shedding.	Period ending	Bud-shedding.
..
17th Sept.	0.2	..	..	..	..
24th Sept.	2.1	23rd Sept. ..	1.00	..	..
1st Oct.	4.8	30th Sept. ..	2.20	Sept. 28th.. ..	0.30
8th Oct.	9.8	7th Oct.	4.45	..	..
15th Oct.	9.2	14th Oct.	10.10	..	..
22nd Oct.	11.7	21st Oct.	16.05	20th Oct.	10.60
29th Oct.	14.7	28th Oct.	26.45	26th Oct.	7.30
5th Nov.	23.3	4th Nov.	41.10	2nd Nov.	10.70
12th Nov.	30.7	11th Nov.	18.45	9th Nov.	11.00
19th Nov.	29.6	18th Nov.	11.20	16th Nov.	14.00
26th Nov.	18.1	25th Nov.	11.90	23rd Nov.	7.65
3rd Dec.	13.4	2nd Dec.	10.25	30th Nov.	6.30
10th Dec.	14.6	9th Dec.	7.85	7th Dec.	5.80
17th Dec.	10.2	16th Dec.	5.80	14th Dec.	6.00
24th Dec.	6.0	23rd Dec.	4.35	21st Dec.	7.50
31st Dec.	9.1	30th Dec.	10.85	28th Dec.	9.90
7th Jan.	6.3	6th Jan.	13.70	4th Jan.	9.65
14th Jan.	4.6	13th Jan.	7.30	11th Jan.	8.50
21st Jan.	1.1	20th Jan.	2.75	18th Jan.	13.70
28th Jan.	0.3	27th Jan.	0.35	25th Jan.	8.20
.. ..	..	..	..	1st Feb.	1.45
.. ..	..	..	..	8th Feb.	0.30
.. ..	..	..	..	15th Feb.	0.15
Rest. .. ..	..	..	..	Rest.	0.05
Total	219.8	Total	206.10	Total	139.05

TABLE No. 65.

Periodical average rate of flower-bud shedding relative to flower-bud formation in different years. Plants grown exposed to the damage by the spotted boll-worm.

1924-25.		1925-26.		1928-29.	
Number of plants under counts.		10	10	20	
Period ending	Relative bud-shedding	Period ending	Relative bud-shedding	Period ending	Relative bud-shedding
..	..	22nd Aug.	0.3	..	..
..	..	29th Aug.	2.1	..	..
..	..	5th Sept.	4.7	6th Sept.	1.25
..	..	12th Sept.	5.6	13th Sept.	4.45
21st Sept.	19.5	19th Sept.	5.8	..	..
28th Sept.	16.7	26th Sept.	10.1	27th Sept.	21.25
5th Oct.	23.5	3rd Oct.	16.0	4th Oct.	19.05
12th Oct.	27.3	10th Oct.	17.7	11th Oct.	16.45
19th Oct.	18.1	17th Oct.	26.4	18th Oct.	23.50
25th Oct.	18.0	24th Oct.	19.3	25th Oct.	29.65
1st Nov.	16.0	31st Oct.	15.3	1st Nov.	26.20
8th Nov.	14.5	7th Nov.	17.4	8th Nov.	19.50
15th Nov.	15.8	14th Nov.	22.6	15th Nov.	16.25
22nd Nov.	16.6	21st Nov.	23.7	22nd Nov.	18.35
29th Nov.	11.3	28th Nov.	12.7	29th Nov.	14.65
6th Dec.	9.9	5th Dec.	7.3	6th Dec.	9.50
13th Dec.	10.2	12th Dec.	3.5	13th Dec.	6.50
26th Dec.	2.7	19th Dec.	0.5	20th Dec.	3.55
27th Dec.	2.9	..	..	27th Dec.	2.05
3rd Jan.	2.2	..	..	3rd Jan.	1.20
10th Jan.	0.2	..	..	10th Jan.	0.65
..	..	..	..	17th Jan.	0.40
..	..	..	..	24th Jan.	0.05
..
Total ..	225.4	Total ..	211.0	Total ..	234.45

TABLE No. 65—(contd.)

Periodical average rate of flower-bud shedding relative to flower-bud formation in different years. Plants grown exposed to the damage by the spotted boll-worm.

1929-30.		1930-31.		1931-32.	
Number of plants under counts. 18		20		20	
Period ending	Relative bud-shedding.	Period ending	Relative bud-shedding.	Period ending	Relative bud-shedding.
..
3rd Sept.	0.1	9th Sept.	0.30	..	..
10th Sept.	1.1	..	..	14th Sept.	0.15
17th Sept.	4.5	23rd Sept.	6.15	..	..
24th Sept.	6.9	30th Sept.	7.25	28th Sept.	1.45
1st Oct.	9.8	7th Oct.	15.10	..	..
8th Oct.	16.5	14th Oct.	20.90	20th Oct.	19.80
15th Oct.	24.4	21st Oct.	25.70	28th Oct.	11.15
22nd Oct.	23.4	28th Oct.	34.70	2nd Nov.	14.95
29th Oct.	23.0	4th Nov.	15.60	9th Nov.	12.10
5th Nov.	17.7	11th Nov.	13.85	16th Nov.	10.55
12th Nov.	24.5	18th Nov.	12.15	23rd Nov.	10.00
19th Nov.	21.3	25th Nov.	10.65	30th Nov.	7.40
26th Nov.	15.7	2nd Dec.	8.45	7th Dec.	9.00
3rd Dec.	13.0	9th Dec.	13.30	14th Dec.	9.50
10th Dec.	9.4	16th Dec.	12.05	21st Dec.	13.30
17th Dec.	4.7	23rd Dec.	7.20	28th Dec.	10.80
24th Dec.	2.9	30th Dec.	2.25	4th Jan.	5.00
31st Dec.	1.2	6th Jan.	0.50	11th Jan.	3.40
7th Jan.	0.2	..	..	18th Jan.	0.45
..	..	..	..	25th Jan.	0.05
..		
..		
Total ..	219.8	Total ..	206.10	Total ..	139.05

TABLE NO. 66.

*Periodical average rate of the shedding of bolls as collected
in different years.*

1923-24.		1924-25.		1925-26.		1928-29.	
Number of plants ⁹⁹ under counts.		50		10		20	
Period ending	Bolls shed.	Period ending	Bolls shed.	Period ending	Bolls shed.	Period ending	Bolls shed.
..
..	..	..	..	1st Nov. ..	0.4	1st Nov. ..	0.05
11th Nov. ..	0.3	..	..	8th Nov. ..	0.5	8th Nov. ..	..
18th Nov. ..	0.3	..	..	15th Nov. ..	0.3	15th Nov. ..	0.40
25th Nov. ..	0.5	23rd Nov. ..	0.06	22nd Nov. ..	1.6	22nd Nov. ..	1.85
2nd Dec. ..	1.3	30th Nov. ..	0.40	29th Nov. ..	2.1	29th Nov. ..	3.90
9th Dec. ..	1.9	7th Dec. ..	0.62	6th Dec. ..	4.6	6th Dec. ..	3.95
16th Dec. ..	3.7	14th Dec. ..	4.48	13th Dec. ..	9.5	13th Dec. ..	4.95
23th Dec. ..	2.4	21st Dec. ..	7.98	20th Dec. ..	13.7	20th Dec. ..	5.25
30th Dec. ..	2.7	28th Dec. ..	10.66	27th Dec. ..	9.1	27th Dec. ..	4.15
6th Jan. ..	2.3	4th Jan. ..	9.18	3rd Jan. ...	10.2	3rd Jan. ..	4.45
13th Jan. ..	4.1	11th Jan. ..	8.62	10th Jan. ..	3.3	10th Jan. ..	6.15
20th Jan. ..	3.6	18th Jan. ..	3.72	..	..	17th Jan. ..	4.25
27th Jan. ..	3.8	25th Jan. ..	1.46	..	..	24th Jan. ..	2.55
3rd Feb. ..	4.0	1st Feb. ..	0.70	..	..	31st Jan. ..	0.65
10th Feb. ..	1.8	..	..	..	..	..	..
17th Feb. ..	0.5	..	..	..	..	..	..
24th Feb. ..	0.2	..	..	..	..	..	..
2nd Mar. ..	0.1	..	..	..	..	..	..
Rest.	1.2	Rest.	3.62	Rest.	2.1	Rest.	1.95
Total ..	34.7	Total ..	51.50	Total ..	57.4	Total ..	44.50

TABLE NO. 66—(contd.)

Periodical average rate of the shedding of bolls as collected
in different years.

1929-30.		1930-31.		1931-32.	
Number of plants under counts. 18		20		20	
Period ending:	Bolls shed.	Period ending	Bolls shed.	Period ending	Bolls shed.
..	..	21st Oct.	.. 0·10	..	..
29th Oct.	.. 0·1	28th Oct.	.. 0·40	..	..
5th Nov.	.. 0·1	4th Nov.	.. 1·15	..	..
12th Nov.	.. 1·1	11th Nov.	.. 0·45	..	..
19th Nov.	.. 2·9	18th Nov.	.. 0·25	..	..
26th Nov.	.. 2·3	25th Nov.	.. 0·05	..	..
3rd Dec.	.. 2·9	2nd Dec.	.. 0·10	30th Nov.	.. 0·10
10th Dec.	.. 3·7	9th Dec.	.. 0·50	7th Dec.	.. 0·25
17th Dec.	.. 2·6	16th Dec.	.. 0·75	14th Dec.	.. 0·50
24th Dec.	.. 2·2	23rd Dec.	.. 2·10	21st Dec.	.. 0·95
31st Dec.	.. 4·9	30th Dec.	.. 2·05	28th Dec.	.. 1·35
7th Jan.	.. 7·6	6th Jan.	.. 10·90	4th Jan.	.. 1·45
14th Jan.	.. 11·8	13th Jan.	.. 22·00	11th Jan.	.. 3·00
21st Jan.	.. 4·8	20th Jan.	.. 13·95	18th Jan.	.. 6·25
28th Jan.	.. 2·8	27th Jan.	.. 3·45	25th Jan.	.. 10·45
4th Feb.	.. 0·7	3rd Feb.	.. 0·55	1st Feb.	.. 5·15
..	..	..	..	8th Feb.	.. 3·15
..	..	..	..	15th Feb.	.. 1·10
..
Rest.	0·2	Rest.	..	Rest.	0·75
Total ..	50·7	Total ..	58·75	Total ..	34·45

TABLE NO. 67.

Periodical average rate of the shedding of bolls as related to flower opening in different years. Plants grown exposed to the damage by the spotted boll-worm.

Years 1923-24.		1924-25.		1925-26.		1926-27.	
Number of plants, under counts.		99		50		10	
Period ending	Relative bolls shed.	Period ending	Relative bolls shed.	Period ending	Relative bolls shed.	Period ending	Relative bolls shed.
..	..	..	..	25th Oct	0.5	..	..
4th Nov.	0.2	..	..	1st Nov.	0.4	31st Oct.	0.3
11th Nov.	0.6	..	..	8th Nov.	0.8	7th Nov.	0.9
18th Nov.	1.0	16th Nov.	0.36	15th Nov.	1.2	14th Nov.	1.0
25th Nov.	1.0	23rd Nov.	0.86	22nd Nov.	3.0	21st Nov.	2.3
2nd Dec.	2.2	30th Nov.	4.00	29th Nov.	6.2	28th Nov.	1.9
9th Dec.	3.1	7th Dec.	6.40	6th Dec.	12.8	5th Dec.	1.5
16th Dec.	2.9	14th Dec.	8.88	13th Dec.	13.6	12th Dec.	1.1
23rd Dec.	3.0	21st Dec.	13.00	20th Dec.	9.6	19th Dec.	2.8
30th Dec.	3.5	28th Dec.	11.04	27th Dec.	5.3	26th Dec.	1.7
6th Jan.	4.4	4th Jan.	5.22	3rd Jan.	3.2	2nd Jan.	2.0
13th Jan.	4.5	11th Jan.	1.38	10th Jan.	0.8	9th Jan.	1.9
20th Jan.	4.1	18th Jan.	0.82	..	..	16th Jan.	2.2
27th Jan.	2.6	25th Jan.	0.02	..	..	23rd Jan.	2.5
3rd Feb.	1.5	1st Feb.	0.02	..	..	30th Jan.	3.5
10th Feb.	0.3	..	..	..	..	6th Feb.	4.8
..	..	..	..	..	..	13th Feb.	6.5
..	..	..	..	..	..	20th Feb.	5.1
..	..	..	..	..	..	27th Feb.	1.5
..	..	..	..	..	..	6th Mar.	0.3
Total	84.7	Total	51.60	Total	57.4	Total	43.8

TABLE NO. 67—(contd.)

Periodical average rate of the shedding of bolls as related to flower opening in different years. Plants grown exposed to the damage by the spotted boll-worm.

Years 1927-28.		1928-29.		1929-30.		1930-31.		1931-32.	
Number of plants under counts. 20		20		18		20		20	
Period ending	Relative bolls shed.	Period ending	Relative bolls shed.	Period ending	Relative bolls shed.	Period ending	Relative bolls shed.	Period ending	Relative bolls shed.
.. ..	.. ..	.. ..	.. ..	20th Oct. ..	0·1	19th Oct. ..	0·10	.. ..	.. ..
.. ..	.. ..	28th Oct. ..	0·05	27th Oct. ..	0·1	26th Oct. ..	0·75	.. ..	.. ..
.. ..	.. ..	4th Nov. ..	.. ..	3rd Nov. ..	0·4	2nd Nov. ..	1·05	.. ..	.. ..
.. ..	.. ..	11th Nov. ..	0·55	10th Nov. ..	1·4	9th Nov. ..	0·30	.. ..	.. ..
20th Nov. ..	0·05	18th Nov. ..	3·45	17th Nov. ..	3·6	16th Nov. ..	0·15	.. ..	.. ..
27th Nov. ..	0·10	25th Nov. ..	4·35	24th Nov. ..	3·5	23rd Nov. ..	0·05	22nd Nov. ..	0·05
4th Dec. ..	0·70	2nd Dec. ..	4·55	1st Dec. ..	3·1	30th Nov. ..	0·40	27th Nov. ..	0·45
11th Dec. ..	1·65	9th Dec. ..	4·95	8th Dec. ..	3·3	7th Dec. ..	1·20	6th Dec. ..	0·55
18th Dec. ..	2·20	16th Dec. ..	6·00	15th Dec. ..	4·0	14th Dec. ..	1·55	13th Dec. ..	0·70
25th Dec. ..	3·85	23rd Dec. ..	5·35	22nd Dec. ..	6·6	21st Dec. ..	3·40	20th Dec. ..	1·50
1st Jan. ..	4·70	30th Dec. ..	6·00	29th Dec. ..	5·5	28th Dec. ..	11·95	27th Dec. ..	2·55
8th Jan. ..	6·65	6th Jan. ..	3·40	5th Jan. ..	9·1	4th Jan. ..	14·75	3rd Jan. ..	2·70
15th Jan. ..	10·35	13th Jan. ..	2·95	12th Jan. ..	6·4	11th Jan. ..	14·75	10th Jan. ..	5·80
22nd Jan. ..	9·85	20th Jan. ..	1·05	19th Jan. ..	2·8	18th Jan. ..	7·25	17th Jan. ..	8·80
29th Jan. ..	6·40	27th Jan. ..	0·95	26th Jan. ..	0·8	25th Jan. ..	1·05	24th Jan. ..	6·80
5th Feb. ..	2·10	3rd Feb. ..	0·85	2nd Feb. ..	.. ..	1st Feb. ..	0·05	31st Jan. ..	3·05
12th Feb. ..	0·95	10th Feb. ..	0·25	9th Feb. ..	0·1	.. ..	.. ..	7th Feb. ..	1·15
19th Feb. ..	0·25	17th Feb. ..	0·25	.. ..	.. ..	.. ..	.. ..	14th Feb. ..	0·35
.. ..	.. ..	24th Feb. ..	0·05	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..
..
Total ..	49·8	Total ..	44·50	Total ..	50·7	Total ..	58·75	Total ..	34·45

TABLE NO. 68.

Mean length and breadth of normal bolls. Flowers ticketed on 16th and 17th January, 1925.

Age of normal bolls in days.	No. of cases.	Mean length in mm.	Standard deviation of the length.	Mean breadth in mm.	Standard deviation of the breadth.
1	10	6.95±0.1045	0.49	4.95±0.1045	0.49
2	10	7.25±0.0960	0.45	5.25±0.0960	0.45
3	10	7.55±0.0939	0.44	5.45±0.0640	0.30
4	10	8.55±0.0939	0.44	6.15±0.1045	0.49
5	10	9.25±0.2134	1.00	6.45±0.1771	0.83
6	10	9.25±0.0960	0.45	6.75±0.1280	0.60
7	10	9.55±0.0000	0.00	7.35±0.0853	0.40
8	10	9.55±0.1643	0.77	7.35±0.1280	0.60
9	..	..	..	..	..
10	10	10.45±0.2219	1.04	7.75±0.1578	0.74
11	10	10.95±0.1045	0.49	8.55±0.0939	0.44
12	10	11.95±0.1408	0.86	9.45±0.1152	0.54
13	10	12.33±0.1416	0.63	9.85±0.1528	0.68
14	10	12.65±0.2219	1.04	10.35±0.1857	0.87
15	10	13.75±0.1280	0.60	10.75±0.1578	0.74
16	10	14.95±0.1942	0.91	11.65±0.1771	0.83
17	10	15.65±0.0640	0.30	12.05±0.1067	0.50
18	9	15.95±0.3012	1.34	12.67±0.2450	1.09
19	9	17.77±0.2045	0.91	13.44±0.1239	0.56
20	10	20.05±0.3201	1.50	15.05±0.1995	0.92

TABLE No. 69.

Mean length and breadth of the shed bolls from 1502 flowers ticketed between 13th to 17th January, 1925.

Age of shed-bolls in days.	Cases measured for length.	Mean length in mm.	Standard deviation of the length.	Cases measured for the breadth.	Mean breadth in mm.	Standard deviation of the breadth.
1	0	0	0	0	0	0
2	0	0	0	1	5.00±0.0000	0
3	0	0	0	1	4.50±0.0000	0
4	0	0	0	3	4.89±0.1871	0.48
5	3	7.55±0.0000	0	9	5.22±0.1483	0.66
6	9	7.22±0.1056	0.57	15	4.75±0.1132	0.65
7	14	7.41±0.1150	0.639	17	5.14±0.1260	0.77
8	25	7.67±0.1160	0.86	28	5.09±0.0929	0.73
9	64	8.26±0.0699	0.83	64	5.30±0.0649	0.77
10	120	8.37±0.0837	1.36	120	5.52±0.0800	1.30
11	143	8.85±0.0722	1.28	143	5.87±0.0629	1.12
12	133	9.17±0.0760	1.30	133	6.22±0.0707	1.21
13	110	9.89±0.0974	1.51	110	6.61±0.0959	1.49
14	89	10.42±0.1151	1.61	89	7.18±0.1108	1.55
15	50	10.69±0.1497	1.57	50	7.33±0.1144	1.20
16	46	11.16±0.1611	1.62	46	7.507±0.1671	1.68
17	18	11.44±0.3261	2.05	18	8.11±0.2768	1.74
18	28	11.62±0.2663	2.09	28	8.05±0.2748	2.16
19	16	12.74±0.2934	1.74	16	8.55±0.2967	1.76
20	17	12.49±0.3240	1.98	17	8.79±0.3349	2.04

TABLE NO. 70.

Pedicel length of the normal and shed bolls. Flowers ticketed in the middle of January, 1925.

Age of bolls in days.	Cases measured.	Normal Bolls.	Standard deviation of the length.	Cases examined.	Shed-Bolls.	Standard deviation of the length.
		Mean length in mm.			Mean length in mm.	
1	0	0	0	0	0	0
2	0	0	0	0	0	0
3	0	0	0	0	0	0
4	0	0	0	0	0	0
5	10	12.45±0.6339	2.97	7	13.90±0.6029	2.36
6	10	13.85±0.6285	2.85	15	11.58±0.4479	2.57
7	10	13.85±0.5763	2.70	17	11.87±0.5642	3.43
8	10	15.25±0.6723	3.15	28	12.19±0.3003	2.36
9	0	0 0	0	64	12.27±0.2529	2.99
10	10	15.25±0.7257	3.40	120	12.64±0.1680	2.74
11	10	15.45±0.4973	2.33	143	13.15±0.1529	2.72
12	10	17.25±0.7257	3.40	133	13.32±0.1901	3.25
13	10	16.25±0.6616	3.10	110	14.03±0.1543	3.41
14	10	15.45±1.0030	4.70	89	15.27±0.2238	3.12
15	10	17.45±0.7342	3.44	50	14.69±0.2843	2.98
16	10	18.25±0.8751	4.10	46	15.09±0.3004	3.02
17	10	17.25±0.6445	3.02	18	15.60±0.5942	3.70
18	9	18.17±0.7532	3.35	28	16.55±0.4492	3.53
19	9	16.65±0.7734	3.44	16	15.45±0.3187	1.89
20	10	17.05±0.8111	3.80	17	14.45±0.5238	3.20

TABLE NO. 71.
Rate of the normal development of the ovules in growing bolls.
 (Average of ten daily measured.)

Age of normal bolls in days.	Average of 10 ovules (taken from 10 different bolls), excluding lint and fuzz.		Growth rate of the ovules.	
	Length in mm.	Breadth in mm.	Length in mm.	Breadth in mm.
0	1.19	0.79	..	..
1	1.22	0.88	0.03	0.09
2	1.50	1.10	0.28	0.22
3	1.54	1.14	0.04	0.04
4	1.58	1.15	0.04	0.01
5	1.60	1.20	0.02	0.05
6	1.66	1.22	0.06	0.02
7	1.73	1.30	0.07	0.08
8	1.76	1.30	0.03	0.00
9	..	..	0.65	0.08
10	1.89	1.46	0.65	0.08
11	1.99	1.55	0.10	0.09
12	2.54	1.89	0.55	0.34
13	2.70	2.13	0.16	0.24
14	2.71	2.08	0.01	0.05
15	3.04	2.22	0.33	0.14
16	3.10	2.30	0.06	0.08
17	3.21	2.29	0.11	0.01
18	3.40	2.23	0.19	0.06
19	3.95	2.54	0.55	0.31
20	4.60	2.81	0.65	0.27
21	4.60	3.05	..	0.24
22	5.20	3.46	0.60	0.41
23	..	..	0.35	0.07
24	5.90	3.61	0.35	0.07
25	6.60	4.20	0.70	0.59

TABLES FOR CHAPTER IV.

TABLE No. 72.

Production of various organs on plants grown inside the field cage, i.e., free from boll-worm.

1924-25.

Plant No.	1	2	3	4	5	6	7	8	9	10	Average.
Height of main stem in cms.	..	135.5	145.0	152.0	150.2	160.0	..	151.8	118.0	..	143.9
Height in nodes	55	52	53	44	51	..	51	33	..	48.4
Leaves	668	753	713	798	668	857	626	706	..	723.6
Vegetative buds	314	394	377	388	329	409	319	347	..	359.6
Flower buds	354	359	336	410	339	448	307	359	..	364.0
Shed buds	294	298	272	346	268	378	256	308	..	302.5
Percentage bud-shedding	83.1	83.0	81.0	84.4	79.1	84.4	83.4	85.8	..	83.1
Flowers	60	61	64	64	71	70	51	51	..	61.5
Shed bolls	39	35	38	38	39	32	27	29	..	34.6
Percentage boll-shedding	65.0	57.4	59.4	59.4	64.9	45.7	52.9	56.9	..	56.3
Ripe bolls	21	26	26	26	32	38	24	22	..	26.9
Percentage total shedding	94.1	92.8	92.3	93.7	90.6	91.5	92.2	93.9	..	92.6

Production of various organs on plants grown exposed to the damage by the spotted boll-worm.

1924-25.

Plant No.	1	2	3	4	5	6	7	8	9	10	Average.
Height of main stem in cms.	33.8	62.5	52.1	19.5	23.0	70.5	68.0	85.5	71.0	60.5	56.6
Height in nodes	21	33	27	15	16	40	33	41	33	32	29.1
Leaves	530	592	405	691	449	603	619	828	676	694	608.7
Vegetative buds	327	331	236	356	285	296	337	349	353	324	319.7
Flower buds	203	261	169	335	164	307	282	479	323	370	289.3
Shed buds	161	208	135	260	127	225	201	375	264	296	225.4
Percentage bud-shedding ..	79.3	79.7	79.9	77.6	77.4	73.3	71.3	78.3	81.7	80.5	77.9
Flowers	42	53	34	75	37	82	81	104	59	72	63.9
Shed bolls	21	33	18	49	20	53	52	63	34	35	37.8
Percentage boll-shedding ..	50.0	62.3	52.9	65.3	54.1	64.6	64.2	60.8	57.6	48.6	59.2
Ripe bolls	21	20	16	26	17	29	29	41	25	37	26.1
Percentage total shedding ..	89.7	92.3	90.5	92.2	91.6	90.6	90.7	91.4	92.3	90.0	91.0

TABLE NO. 73.

Production of various organs on plants grown inside the field cage, i.e., free from boll-worm.

1925-26.

Plant No.	1	2	3	4	5	6	7	8	9	10	Average.
Height of main stem in cms.	..	181.5	150.5	143.0	147.0	153.5	173.5	117.5	183.0	170.5	157.8
Height in nodes .. ..	..	53	46	45	53	49	51	36	52	50	48.3
Leaves	883	941	679	543	437	648	944	811	883	656	742.5
Vegetative buds	465	431	389	286	282	371	505	462	458	358	400.7
Flower buds	418	510	290	257	255	277	439	349	425	298	341.8
Shed buds	341	423	233	202	127	228	362	281	338	234	276.9
Percentage bud-shedding ..	81.6	82.9	80.3	78.6	81.9	82.3	82.5	80.3	79.5	78.5	81.0
Flowers	77	87	57	55	28	49	77	68	87	64	64.9
Shed bolls	45	48	30	30	13	24	47	40	44	39	36.0
Percentage boll-shedding ..	58.4	55.2	52.6	54.5	46.4	49.0	61.0	58.8	50.6	60.9	55.5
Ripe bolls	32	39	27	25	15	25	30	28	43	25	28.9
Percentage total shedding	92.3	92.4	90.7	90.3	90.3	91.0	93.2	92.0	89.9	91.6	91.5

Production of various organs on plants grown outside the field cage (exposed to boll-worm).

1925-26.

Plant No.	1	2	3	4	5	6	7	8	9	10	Average.
Height of main stem in cms.	23.0	36.0	31.5	37.0	40.0	41.0	25.5	42.5	34.5	33.0	34.4
Height in nodes	13	20	16	22	20	20	14	21	21	18	18.5
Leaves	691	967	1522	716	1062	1091	770	1058	593	982	945.2
Vegetative buds	517	638	1045	510	735	735	486	709	369	724	646.8
Flower buds	174	329	477	206	327	356	284	349	224	258	298.4
Shed buds	122	239	356	159	217	276	185	240	152	173	211.0
Percentage bud-shedding ..	70.1	72.6	74.6	77.2	66.4	75.0	65.1	68.8	67.9	67.1	70.7
Flowers	52	90	121	47	110	89	99	109	72	85	87.4
Shed bolls	32	53	79	26	71	62	72	77	49	53	57.4
Percentage boll-shedding ..	61.5	58.9	65.3	55.3	60.5	69.7	72.7	70.6	68.1	62.4	65.7
Ripe bolls	20	37	42	21	39	27	27	32	23	32	30.0
Percentage total shedding	88.5	88.8	91.2	89.8	88.1	92.4	90.5	90.8	89.7	87.6	89.9

TABLE No. 74.

Periodical average rate of production of leaves, flower-buds and flowers on plants grown in the cage and outside the cage for the years 1924-25 and 1925-26.

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1924-25.					1925-26.					1924-25.			1925-26.						
Number of plants		8		10		Number of plants		10		10		Number of plants		8		10		10	
Period ending	Inside the cage.		Outside the cage.		Period ending	Inside the cage.		Outside the cage.		Period ending	Inside the cage.		Outside the cage.		Period ending	Inside the cage.		Outside the cage.	
	Leaves.	Flower buds.	Leaves.	Flower buds.		Leaves.	Flower buds.	Leaves.	Flower buds.		Leaves.	Flower buds.	Flowers opened.	Flowers opened.		Flowers opened.	Flowers opened.	Flowers opened.	Flowers opened.
29th Aug.	..	..	..	..	22nd Aug.	9.2	..	13.9	0.3	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	29th Aug.	3.4	0.9	11.3	2.1	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	5th Sept.	12.2	3.9	23.6	4.7	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	12th Sept.	20.5	6.9	28.7	5.7	..	..	..	..	..	..	..	..	..	..
20th Sept.	..	..	89.8	19.5	19th Sept.	30.6	11.2	41.3	5.9	..	..	..	..	..	..	..	..	..	..
27th Sept.	49.1	18.9	47.6	17.3	26th Sept.	42.9	17.3	61.0	10.5	..	..	..	..	..	..	..	..	..	..
4th Oct.	24.1	12.5	69.0	25.0	3rd Oct.	52.5	23.7	82.8	16.6	..	..	..	..	..	..	..	..	..	..
11th Oct.	45.8	18.8	52.1	35.1	10th Oct.	42.6	18.7	77.7	19.2	..	..	..	..	..	..	..	..	..	..
18th Oct.	45.1	21.6	60.6	29.3	17th Oct.	55.4	26.7	111.9	61.8	..	..	..	..	..	..	..	..	..	..
25th Oct.	50.8	24.0	62.5	27.1	24th Oct.	50.2	23.2	115.1	31.8	..	..	..	..	25th Oct.	..	..	..	..	0.5
1st Nov.	60.9	28.4	60.8	30.4	31st Oct.	69.6	30.7	88.1	33.0	..	..	..	..	1st Nov.	0.1	..	..	..	0.4
8th Nov.	57.6	31.2	38.9	22.8	7th Nov.	72.1	35.0	92.4	39.5	9th Nov.	..	0.2	..	8th Nov.	5.6	..	..	..	1.2
15th Nov.	52.8	29.8	35.0	22.6	14th Nov.	75.4	36.4	81.1	40.7	16th Nov.	..	1.0	..	15th Nov.	4.1	..	..	..	3.1
22nd Nov.	52.4	25.9	33.1	18.6	21st Nov.	57.5	28.3	61.2	30.9	23rd Nov.	0.25	1.4	..	22nd Nov.	4.4	..	..	..	8.8
29th Nov.	40.5	24.9	19.6	13.2	28th Nov.	40.4	19.5	31.7	14.4	30th Nov.	1.12	10.4	..	29th Nov.	0.5	..	..	..	17.8
6th Dec.	44.1	26.5	14.4	10.2	5th Dec.	39.7	21.9	15.2	7.3	7th Dec.	1.37	10.5	..	6th Dec.	1.2	..	..	..	19.2
13th Dec.	32.6	20.2	16.0	10.2	12th Dec.	25.2	14.7	6.9	3.5	14th Dec.	2.37	14.9	..	13th Dec.	3.4	..	..	..	16.7
20th Dec.	30.4	19.6	5.3	2.7	19th Dec.	19.2	10.6	1.3	0.5	21st Dec.	4.62	11.3	..	20th Dec.	7.6	..	..	..	9.9
27th Dec.	36.6	19.1	5.0	2.9	16th Dec.	12.0	5.5	..	..	22th Dec.	5.87	8.7	..	27th Dec.	10.6	..	..	..	5.5
3rd Jan.	35.1	19.4	3.4	2.2	2nd Jan.	6.4	4.4	..	..	4th Jan.	7.12	3.7	..	3rd Jan.	14.0	..	..	..	3.5
10th Jan.	19.7	13.1	0.3	0.2	9th Jan.	3.6	2.1	..	..	11th Jan.	7.12	1.4	..	10th Jan.	8.5	..	..	..	0.8
17th Jan.	10.8	..	1.1	..	16th Jan.	0.6	0.1	..	..	18th Jan.	6.37	0.2	..	17th Jan.	8.6	..	..	..	..
24th Jan.	8.4	3.5	..	..	23rd Jan.	0.1	..	..	..	25th Jan.	3.75	0.2	..	24th Jan.	0.8	..	..	..	..
31st Jan.	6.5	2.0	..	..	30th Jan.	..	..	..	..	1st Feb.	7.50	..	..	31st Jan.	0.3	..	..	..	..
7th Feb.	2.4	0.9	..	..	6th Feb.	1.2	0.1	..	..	8th Feb.	6.37	..	..	7th Feb.	0.2	..	..	..	..
14th Feb.	9.8	1.4	..	..	..	..	..	..	..	15th Feb.	4.00	..	..	..	..	..	..	..	..
21st Feb.	4.8	0.8	..	..	..	..	..	..	..	22nd Feb.	3.25	..	..	..	..	..	..	..	..
28th Feb.	1.0	0.1	..	..	..	..	..	..	..	1st Mar.	0.37	..	..	..	..	..	..	..	..
.. Total	723.6	304.0	608.7	289.3	.. Total	742.5	341.8	945.2	298.4	.. Total	61.5	63.9	.. Total	64.9	87.4	..	..	..	..

TABLE NO. 75.

Periodical average rate of shedding of flower-buds relative to formation in plants grown inside and outside the cage.

Period ending	1924-25.				Period ending	1925-26.			
	Inside the cage.		Outside the cage.			Inside the cage.		Outside the cage.	
	Buds formed.	Relative bud-shedding.	Buds formed.	Relative bud-shedding.		Buds formed.	Relative bud-shedding.	Buds formed.	Relative bud-shedding.
Number of plants	8		10		Number of plants	10		10	
....	..	..	..	..	22nd August	0.0	0.0	0.3	0.3
....	..	..	..	..	29th August	0.9	0.9	2.1	2.1
....	..	..	..	..	5th September	3.9	3.9	4.7	4.7
....	..	..	..	..	12th September	6.9	6.9	5.7	5.6
20th September	0.0	0.0	19.5	19.5	19th September	11.2	11.2	5.9	5.8
27th September	13.9	15.9	17.3	16.7	27th September	17.3	17.0	10.5	10.1
4th October	12.5	12.5	25.0	23.5	3rd October	23.7	19.9	16.6	16.0
11th October	18.8	18.3	35.1	27.3	10th October	18.7	14.9	19.2	17.7
18th October	21.6	19.9	29.3	18.1	17th October	26.7	22.5	31.8	26.4
25th October	24.0	21.6	27.1	18.0	24th October	23.2	21.1	31.8	19.3
1st November	28.4	28.9	30.4	16.0	31st October	30.7	29.7	33.0	15.3
8th November	31.2	24.4	22.8	14.5	7th November	35.0	31.4	39.5	17.4
15th November	29.8	21.5	22.6	15.8	14th November	36.4	25.5	40.7	22.6
22nd November	25.9	17.9	18.6	16.6	21st November	28.3	11.7	30.9	23.7
29th November	24.9	15.1	13.2	11.3	28th November	19.5	11.1	14.4	12.7
6th December	26.5	17.4	10.2	9.9	5th December	21.9	14.5	7.3	7.3
13th December	20.2	15.2	10.2	10.2	12th December	14.7	12.5	3.5	3.5
20th December	19.6	15.9	2.7	2.7	19th December	10.6	10.1	0.5	0.5
27th December	19.1	17.6	2.9	2.9	26th December	5.5	5.4	..	..
3rd January	19.4	19.3	2.2	2.2	2nd January	4.4	4.4	..	..
10th January	13.1	13.0	0.2	0.2	9th January	2.1	2.1	..	..
17th January	6.5	6.5	..	..	16th January	0.1	0.1	..	..
24th January	3.5	3.5	..	..	23rd January	..	..	..	..
31st January	2.0	2.0	..	..	30th January	..	..	..	..
7th February	0.9	0.9	..	..	6th February	0.1	0.1	..	..
14th February	1.4	1.4	..	..	....	..	..	..	..
21st February	0.8	0.8	..	..	....	..	..	..	..
28th February	0.1	0.1	..	..	....	..	..	..	..
Total	364.0	302.5	289.3	225.4	Total	341.8	276.9	298.4	211.0

TABLE NO. 76.

Weekly average rate of boll-shedding relative to flower-formation in plants grown inside and outside the cage.

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Week ending	1924-25.				Week ending	1925-26.			
	Inside the cage.		Outside the cage.			Inside the cage.		Outside the cage.	
	Flowers opened.	Relative bolls shed.	Flowers opened.	Relative bolls shed.		Flowers opened.	Relative bolls shed.	Flowers opened.	Relative bolls shed.
Number of plants	8		10		Number of plants	10		10	
.....	..	..	..	..	25th October	..	..	0.5	0.5
9th November	..	..	0.2	0.1	1st November	0.1	..	0.4	0.4
16th November	..	..	1.0	0.1	8th November	5.6	3.1	1.2	0.8
23rd November	0.25	0.12	1.4	0.6	15th November	4.1	3.7	3.1	1.2
30th November	1.12	0.37	10.4	3.7	22nd November	4.4	1.5	8.8	3.0
7th December	1.37	0.25	10.5	4.8	29th November	0.5	0.2	17.8	6.2
14th December	2.37	0.50	14.9	9.4	6th December	1.2	0.1	19.2	12.8
21st December	4.62	1.75	11.3	7.9	13th December	3.4	0.5	16.7	13.6
28th December	5.87	2.50	8.7	6.5	20th December	7.6	3.2	9.9	9.6
4th January	7.12	2.25	3.7	3.0	27th December	10.6	4.6	5.5	5.3
11th January	7.12	2.75	1.4	1.3	3rd January	14.0	8.4	3.5	3.2
18th January	6.37	3.00	0.2	0.2	10th January	8.5	6.5	0.8	0.8
25th January	3.75	2.87	0.2	0.2	17th January	3.6	2.9	..	..
1st February	7.50	6.12	..	..	24th January	0.3	0.3	..	..
8th February	6.37	4.87	..	..	31st January	0.3	0.3	..	..
15th February	4.00	3.75	..	..	7th February	0.2	0.2	..	..
22nd February	3.25	3.12	..	..	.....	..	..	..	..
1st March	0.37	0.37	..	..	.....	..	..	..	..
Total ..	61.5	34.6	63.9	37.8	Total ..	64.9	36.0	37.4	57.4

TABLE No. 77.

Weekly total rainfall in inches at the Agricultural Station, Surat.

Month	May.		June.			July.					August.				September.				October.			Rest.	Total.	
Week ending	27	3	10	17	24	1	8	15	22	29	5	12	19	26	2	9	16	23	30	7	14			21
1924-25	..	..	..	0.87	1.68	4.81	5.11	4.62	0.08	1.57	3.36	0.29	0.57	1.94	9.39	0.73	1.67	1.92	1.71	0.71	..	0.10	..	41.13
1925-26	0.06	4.14	6.01	2.93	2.09	3.85	0.09	1.32	0.68	0.77	2.08	1.33	0.36	0.33	..	0.84	0.20	..	..	..	..	..	0.06*	27.19

*On 15th November 1925.

TABLE No. 78.

Weekly maximum and minimum temperatures (in Fahrenheit).

(Hygrograph readings.)

1924-25.

Month	June.				July.				August.				September.				October.				November.				December.				January.				February.						
Week ending	8	10	17	24	1	8	15	22	29	5	12	19	26	2	9	16	23	30	7	14	21	28	4	11	18	25	2	9	16	23	31	7	14	21	28	4	11	18	25
Maximum	87	88	86	90	84	88	87	90	89	89	92	91	93	91	86	86	88	85	84	84	89	90	85	85	76	81	87	82	79	93
Minimum	80	80	78	78	77	78	77	77	76	72	74	70	65	62	64	59	63	58	59	63	62	58	56	54	51	51	51	52	52	58
Difference	7	8	8	12	7	10	10	13	13	17	18	21	28	29	22	27	25	27	25	21	27	32	29	31	25	30	36	30	27	35

1925-26.

Maximum	..	88	85	86	87	85	85	83	82	82	83	84	85	..	86	86	87	89	97	99	99	93	98	96	93	91	95	90	88	91	87	91	84	87	88	92	85	92	94	97
Minimum	..	79	78	78	79	78	80	78	77	78	76	78	78	77	82	78	77	75	77	74	75	78	71	74	72	73	65	64	61	63	59	65	65	57	60	61	63	63	62	64
Difference	..	9	7	8	8	7	5	5	4	7	6	7	4	8	10	14	20	25	24	15	27	22	21	18	30	26	27	28	28	26	19	30	28	31	22	29	32	33

TABLE NO. 79.

Relative humidity per cent.

At 8 A.M.

Month	September.					October.				November.				December.				January.				February.					
Week ending	2	9	16	23	30	7	14	21	28	4	11	18	25	2	9	16	23	31	7	14	21	28	4	11	18	25	
1924-25	88	80	71	66	70	62	64	61	76	82	78	79	87	74	79	65	72	75	61	55
1925-26	82	88	86	82	84	81	71	83	78	74	77	82	66	59	63	73	64	63	88	67	71	60	87	61	63	81	
Difference.. .. .	..	..	..	..	..	..	17	-3	-7	-8	-7	-20	-2	2	13	9	14	16	-1	7	8	5	-15	14	-2	-21

At 11 A.M.

1924-25 .. .. .	..	..	..	..	..	..	63	54	49	42	46	40	40	40	54	57	54	43	47	41	45	48	37	44	34	26
1925-26	65	70	66	59	55	46	45	60	43	42	55	58	41	34	38	44	38	47	53	43	44	41	60	36	31	45
Difference .. .. .	..	..	..	..	..	..	18	-6	6	..	-9	-18	-1	6	16	13	16	-4	-6	-2	1	7	-23	8	8	-19

At 2-30 P.M.

1924-25 .. .. .	..	..	..	..	..	..	55	50	36	34	39	32	38	37	46	50	48	34	35	36	39	36	28	33	24	21
1925-26	56	58	55	53	47	38	39	..	37	36	45	58	35	32	35	38	33	42	40	35	33	36	43	29	26	..
Difference .. .. .	..	..	..	..	..	..	10	..	-1	-2	-6	-26	3	5	11	12	15	-8	-5	1	6	0	-16	4	-2	..

At 6 P.M.

1924-25 .. .. .	..	..	..	..	..	..	64	62	53	51	58	53	50	54	62	62	62	57	50	49	45	47	35	38	34	26
1925-26	67	66	64	58	53	47	49	..	54	51	59	70	48	48	49	59	52	60	46	42	41	43	54	30	27	..
Difference .. .. .	..	..	..	..	..	..	15	..	-1	0	-1	-17	2	6	13	8	10	-8	4	7	4	4	19	8	7	..

TABLE NO. 80.

Wind velocity in miles per hour.

Week ending	June.				July.					August.			
	3	10	17	24	1	8	15	22	29	5	12	19	26
1924-25	6.4	6.3	6.3	6.1	7.7	3.9	6.0	8.1	6.0	6.6	4.7	5.7	1.6
1925-26	5.9	6.4	5.1	3.9	6.6	4.9	5.6	4.7	7.1	3.0	1.9	1.3	0.7
Difference	0.5	-0.1	1.2	2.2	1.1	-1.0	0.4	3.4	0.9	3.6	2.8	4.6	0.9

Week ending	September.					October.				November.			
	2	9	16	23	30	7	14	21	28	4	11	18	25
1924-25	3.4	2.1	3.0	2.6	5.9	2.7	1.7	1.4	1.6	1.7	1.9	1.9	2.7
1925-26	1.9	1.7	1.1	1.6	2.1	1.9	2.6	4.4	1.1	0.7	1.7	2.3	1.4
Difference	1.5	0.4	1.9	1.0	3.8	0.8	-0.9	-3.0	0.5	1.0	0.2	-0.4	1.3

Week ending	December.					January.				February.			
	2	9	16	23	31	7	14	21	28	4	11	18	25
1924-25	2.3	0.6	2.3	0.9	1.3	1.3	2.0	1.4	1.6	1.3	1.1	1.6	3.6
1925-26	2.4	2.7	1.3	1.3	1.1	0.4	1.1	2.0	2.0	1.7	2.7	2.7	1.6
Difference	-0.1	-2.1	1.0	-0.4	0.2	0.9	0.9	-0.6	-0.4	-0.4	-1.6	-1.1	2.0

TABLE No. 81.
Evaporating power of the air in c.cs.
 (Outside the cage.)

Year.	September.					October.				November.			
	2	9	16	23	30	7	14	21	28	4	11	18	25
1924-25	471	491	575
1925-26	594	659	696	745	647	588	558	520	485	501
Difference	-49	6	74

Year.	December.					January.				February.			
	2	9	16	23	31	7	14	21	28	4	11	18	25
1924-25	497	343	365	385	426	421	464	404	421	442	448	535	756
1925-26	602	574	462	515	441	417	549	559	563	397	667	721	592
Difference	-105	-231	-97	-130	-15	4	-85	-155	-142	45	-219	-186	164

TABLE No. 82.
Comparison of relative humidity per cent inside and outside the cage.
 (Instrument used—Hygrometer.)
 1924-25.
 At 8 A.M.

Month	September.					October.					November.					December.					January.				February.				March.			
Week ending	2	9	16	23	30	7	14	21	28	4	11	18	25	2	9	16	23	31	7	14	21	28	4	11	18	25	4	11	18	4	11	18
Inside the cage	01	87	79	74	75	71	69	70	83	83	82	80	85	77	83	75	75	77	66	57	..	..	..	..	..	..
Outside the cage	88	80	71	66	70	62	64	61	76	82	78	79	87	74	79	65	72	75	61	55	..	..	..	..	..	..
Difference	3	7	8	8	5	9	5	9	7	1	4	1	-2	3	4	10	3	2	5	2	..	..	..	..	..	..

At 11 A.M.

Inside the cage ..	..	..	..	..	..	65	60	41	46	48	41	43	42	55	60	62	43	51	41	50	49	42	48	35	25	..	..	..
Outside the cage ..	..	..	..	..	..	63	54	49	42	46	40	40	40	54	57	54	43	47	41	45	48	37	44	34	26	..	..	..
Difference ..	..	..	..	..	..	2	6	-8	4	2	1	3	2	1	3	8	..	4	..	5	1	5	4	1	-1	..	..	..

At 2-30 P.M.

Inside the cage ..	..	..	..	..	..	53	49	35	34	33	36	37	35	43	49	48	33	35	36	38	36	29	37	25	22	..	..	..
Outside the cage ..	..	..	..	..	..	55	50	36	34	39	32	33	37	46	50	48	34	35	36	39	36	28	33	24	21	..	..	..
Difference ..	..	..	..	..	..	-2	-1	-1	..	-1	4	-1	-2	-3	-2	..	-1	..	..	-1	..	-1	4	1	1	..	..	..

At 6 P.M.

Inside the cage ..	..	..	..	..	..	64	60	50	49	50	53	53	53	63	62	63	57	51	48	49	46	36	37	35	26	..	..	..
Outside the cage ..	..	..	..	..	..	64	62	53	51	58	53	50	54	62	62	62	57	50	49	45	47	35	38	34	26	..	..	..
Difference ..	..	..	..	..	..	0	-2	-3	-2	-8	..	2	-1	1	..	1	..	1	-1	3	-1	1	-1	1	..	..	..	..

TABLE NO. 82—(contd.)

Comparison of relative humidity per cent inside and outside the cage.

(Instrument used—Hygrometer.)

1925-26.

At 8 A.M.

Month	September.					October.				November.				December.					January.				February.				March.		
Weak ending.	2	9	16	23	30	7	14	21	28	4	11	18	25	2	9	16	23	31	7	14	21	28	4	11	18	25	4	11	18
Inside the cage ..	88	88	89	86	90	81	74	87	80	79	82	86	75	61	65	76	66	79	87	70	83	64	90	61	..	..	..	..	..
Outside the cage.	82	88	86	82	84	81	71	83	78	74	77	82	66	59	63	73	64	63	88	67	71	60	87	61	..	..	..	..	..
Difference ..	6	5	3	4	6	..	3	4	2	5	5	4	9	2	2	3	2	16	-1	3	12	4	3	..	..	..	..	..	..

At 11 A.M.

Inside the cage ..	68	74	72	57	56	49	48	61	43	45	57	59	44	37	39	46	41	53	57	44	43	43	62	36	..	..	..	..	..
Outside the cage.	65	70	66	59	55	46	45	60	43	42	55	58	41	34	38	44	38	47	53	43	44	41	60	36	..	..	..	..	..
Difference ..	3	4	6	-2	1	3	3	1	0	3	2	1	3	3	1	2	3	6	4	1	-1	2	2	..	..	..	..	..	..

At 2-30 P.M.

Inside the cage ..	61	61	58	54	47	37	38	..	38	38	46	56	36	32	35	39	34	43	42	37	34	36	45	31	..	..	..	..	..
Outside the cage.	56	58	55	53	47	38	39	..	37	36	45	58	35	32	35	38	33	42	40	35	33	36	43	29	..	..	..	..	..
Difference ..	5	3	3	1	0	-1	-1	..	1	2	1	-2	1	..	..	1	1	1	2	2	1	..	2	2	..	..	..	..	..

At 6 P.M.

Inside the cage..	70	75	69	61	55	45	50	..	53	48	60	61	46	49	42	57	48	52	44	42	40	43	59	39	..	..	..	..	..
Outside the cage	67	66	64	58	53	47	49	..	54	51	59	70	48	48	49	59	52	60	46	42	41	43	54	30	..	..	..	..	..
Difference ..	3	9	5	3	2	-2	1	..	-1	-3	1	-9	-2	1	-7	-2	-4	-8	-2	..	-1	..	5	9	..	..	..	..	..

TABLE No. 83.

Comparison of the weekly mean maximum temperatures in Fahrenheit inside and outside cage. (Six's Maximum and Minimum Thermometer.)
1924-25.

Month	September.					October.					November.					December.					January.					February.				
Week ending	2	9	16	23	30	7	14	21	28	4	11	18	25	2	9	16	23	31	7	14	21	28	4	11	18					
Inside the cage	90.6	92.5	94.1	94.1	90.1	89.0	89.4	86.9	86.9	85.6	88.0	90.0	83.3	85.4	76.5	81.6	89.1	82.9	83.3					
Outside the cage	91.3	93.0	95.1	95.3	91.5	89.4	90.3	87.1	87.2	86.7	91.0	91.6	84.4	87.3	77.3	82.0	89.7	84.4	85.3					
Difference	-0.7	-0.5	-1.0	-1.2	-1.4	-0.4	-0.9	-0.2	-0.3	-1.1	-3.0	-1.6	-1.1	-2.0	-0.8	-0.4	-0.6	-1.6	-2.0					

Weekly mean minimum temperature in Fahrenheit.
1924-25.

Inside the cage	..	..	..	..	..	..	67.4	68.4	60.7	59.6	59.0	54.8	58.1	54.1	53.3	57.2	57.3	52.6	49.4	47.4	45.1	44.4	44.8	47.0	45.9
Outside the cage	..	..	..	..	..	..	66.7	67.8	58.3	56.6	57.7	50.6	56.7	50.7	50.6	56.7	54.9	49.0	47.3	45.1	43.0	41.6	41.1	43.4	43.5
Difference	..	..	..	..	..	..	0.7	0.6	2.4	3.0	1.3	3.2	1.4	3.4	2.7	0.5	2.4	3.6	2.1	2.3	2.1	2.8	3.7	3.6	2.4

Weekly mean maximum temperature in Fahrenheit.
1925-26.

Inside the cage	..	91.6	90.8	91.4	94.4	100.4	103.1	101.3	94.3	100.5	99.3	95.9	93.7	94.8	91.4	88.2	91.2	87.1	91.9	84.6	85.6	87.9	92.9	85.7	92.5	95.1	
Outside the cage	..	91.9	90.8	90.5	93.9	100.4	101.6	100.3	93.3	98.6	99.3	94.2	92.8	84.8	88.4	90.4	86.4	91.6	84.8	85.5	88.6	93.2	85.1	93.1	95.6	..	
Difference	-0.3	..	0.9	0.5	..	1.5	1.0	1.0	1.9	..	1.7	0.9	0.7	6.6	-0.2	0.8	0.7	0.3	-0.2	0.1	-0.9	-0.3	0.6	-0.6	-0.5

Weekly mean minimum temperature in Fahrenheit.
1925-26.

Inside the cage	..	77.4	74.0	73.0	71.5	72.6	68.4	68.9	66.6	65.6	68.1	67.0	68.5	59.4	56.5	55.0	57.4	51.3	59.4	58.8	51.7	53.0	52.1	58.4	57.9	58.1	
Outside the cage	..	75.3	73.7	71.8	70.1	72.0	65.8	67.3	65.8	63.3	66.0	64.6	65.9	55.6	53.4	52.0	54.1	48.1	56.7	57.1	49.6	50.1	49.2	55.1	54.4	53.6	
Difference	2.1	0.3	1.2	1.4	0.6	2.6	1.6	0.8	2.3	2.1	2.4	2.6	3.8	3.1	3.0	3.3	3.2	2.7	1.7	2.1	2.9	2.9	3.3	3.5	5.5

TABLE NO. 83A.

Comparison of the evaporating power of the air in c.cs., inside and outside the cage for the years 1924-25 and 1925-26.

1924-25.

Month	Septem-ber.		October.				November.				December.				January.				February.					
	23	30	7	14	21	28	4	11	18	25	2	9	16	23	31	7	14	21	28	4	11	18	25	
Week ending																								
Inside the cage	230	257	263	248	186	172	200	230	177	239	252	221	189	231	267	313
Outside the cage	471	491	575	497	343	365	385	426	421	464	404	421	442	448	535	756
Difference	-141	-234	-312	-249	-157	-193	-185	-196	-244	-225	-152	-200	-253	-217	-268	-443
% evaporation of inside the cage.	48.8	52.3	45.6	49.9	54.2	47.1	51.9	54.0	42.0	51.5	62.4	52.5	42.8	51.6	49.9	41.4

1925-26.

Inside the cage	322	372	381	390	311	294	275	226	236	239	275	271	198	239	180	188	265	273	255	177	307	366	310
Outside the cage	594	659	696	745	647	588	558	520	485	501	602	574	462	515	441	417	549	559	563	397	667	721	592
Difference	-272	-287	-295	-355	-336	-294	-283	-294	-249	-262	-327	-303	-264	-276	-261	-229	-284	-286	-308	-220	-360	-355	-282
% low evaporation of outside the cage.	54.2	56.4	54.7	52.3	48.1	50.0	49.3	43.5	48.7	47.7	45.7	47.2	42.9	46.4	40.8	45.1	48.3	48.8	45.3	44.6	46.0	50.8	52.4

TABLE No. 84.
Comparison of the depth and length of the tap-root.
 Protected plants.
 (Average of 4 to 5 plants.)

Date of sowing	15-7-1929.		3-7-1930.		2-7-1931.	
Period ending	1929-30.		1930-31.		1931-32.	
	Depth. cms.	Length cms.	Depth. cms.	Length. cms.	Depth. cms.	Length. cms.
2nd September ..	..	..	45·6	50·2	..	..
9th September ..	45·58	57·33	..	..	..	..
23rd September ..	56·33	66·33	..	..	47·21	53·21
7th October ..	76·33	87·50	65·00	82·50	52·25	54·95
21st October ..	87·67	102·17	70·90	87·40	54·16	64·16
4th November ..	87·50	112·58	91·20	109·90	54·75	75·50
18th November ..	94·90	110·50	93·00	117·40	63·83	74·33
2nd December ..	95·10	109·20	99·00	117·00	76·40	70·20
16th December ..	85·50	108·75	113·80	124·00	90·50	98·75
30th December ..	101·00	120·20	70·50	97·40	91·00	95·50
14th January ..	87·60	109·60	78·20	84·80	86·50	103·75
28th January ..	91·70	118·90	97·60	117·00	81·25	97·25
10th February ..	84·25	101·75	84·20	102·00	86·75	105·70
25th February ..	..	..	87·4	109·3	95·50	106·50

TABLE No. 85.
Number of large and small roots of the 1st order.
 Protected plants.
 (Average of 4 to 5 plants.)

Date of sowing	15-7-1929.			3-7-1930.			2-7-1931.		
Period ending	1929-30.			1930-31.			1931-32.		
	Large.	Small.	Total.	Large.	Small.	Total.	Large.	Small.	Total.
2nd September ..	7·2	25·60	32·8	8·8	33·4	42·4	..	..	..
9th September ..	9·83	18·83	28·66	..	..	..	..	..	..
16th September ..	9·67	20·83	30·50	..	..	..	6·33	35·5	41·83
23rd September ..	10·17	22·83	33·00	10·0	34·0	44·0	5·60	37·06	42·66
30th September ..	13·0	24·50	37·50	11·2	24·2	35·4	..	..	..
7th October ..	13·50	37·33	50·83	18·6	38·2	56·8	12·00	38·00	50·00
21st October ..	15·84	41·67	57·51	19·0	26·0	45·0	12·5	29·33	41·83
4th November ..	16·33	56·50	72·83	20·4	40·0	60·4	17·83	41·0	58·83
18th November ..	17·00	56·60	73·60	28·0	32·6	60·6	19·5	34·5	54·0
2nd December ..	20·60	47·80	68·40	21·6	34·4	56·0	21·2	29·2	50·4
16th December ..	22·75	42·75	65·5	21·0	31·8	52·8	23·75	31·75	55·5
30th December ..	22·4	41·80	64·20	19·0	25·8	44·8	23·75	33·5	57·25
14th January ..	20·4	47·80	68·20	20·6	33·4	54·0	22·25	33·5	55·75
28th January ..	19·8	39·20	59·00	21·4	30·6	52·0	25·00	29·25	54·25
10th February ..	21·25	45·00	66·25	20·4	21·0	41·4	19·25	23·25	42·50
25th February ..	..	..	..	21·4	27·4	48·8	25·75	28·25	54·00

TABLE No. 86.
Length in cms. of roots of the 1st order.
Protected plants.
(Average of 4 to 5 plants.)

Date of sowing	15-7-1929.	26-6-1930.	2-7-1931.
Period ending	1929-30.	1930-31.	1931-32.
2nd September	182·3	192·5	..
9th September	238·5	rain.	..
16th September	237·25	..	190·33
23rd September	299·67	266·0	193·43
30th September	491·42	359·6	..
7th October	537·53	655·2	358·37
21st October	770·42	891·6	374·83
4th November	1006·55	895·2	463·41
18th November	1062·5	1457·6	896·75
2nd December	1175·3	1461·5	1286·60
18th December	1228·0	1277·5	1494·25
30th December	1342·6	1005·9	1302·25
14th January	1196·6	1085·6	1366·0
28th January	934·1	1382·9	1353·25
10th February	1199·36	1193·2	1133·75
25th February .. .. .	..	1074·6	1582·0

TABLE No. 87.
Number of large and small roots of the 2nd order.
Protected plants.
(Average of 4 to 5 plants.)

Date of sowing	15-7-1929.			3-7-1930.			2-7-1931.		
Year	1929-30.			1930-31.			1931-32.		
Period ending	Large.	Small.	Total.	Large.	Small.	Total.	Large.	Small.	Total.
2nd September ..	1·4	88·4	89·8	1·6	129·0	130·6	..	..	..
9th September ..	0·33	135·33	135·66	..	..	rain.	..	..	..
16th September ..	1·5	107·33	108·83	..	..	..	2·33	107·67	110·01
23rd September ..	2·67	138·66	141·33	5·6	107·2	112·8	1·83	85·08	86·91
30th September ..	1·83	202·17	204·00	6·6	93·0	99·6	..	..	..
7th October ..	2·33	221·0	223·33	10·2	244·0	254·2	2·75	110·0	112·75
21st October ..	4·33	259·17	263·5	9·2	206·2	215·4	5·83	111·5	117·33
4th November ..	8·5	350·0	358·5	14·2	156·8	171·0	14·33	234·5	248·83
18th November ..	7·4	411·6	419·0	23·4	286·4	309·8	23·33	202·67	226·0
2nd December ..	8·0	461·5	469·5	30·8	274·6	305·4	25·8	269·8	295·6
16th December ..	5·5	337·0	342·5	25·0	160·4	185·4	28·0	260·0	288·0
30th December ..	7·0	374·4	381·4	20·0	190·4	210·4	27·0	316·0	343·0
14th January ..	5·4	456·4	461·8	18·2	227·8	246·0	31·0	295·0	326·0
28th January ..	6·8	273·6	280·4	22·8	277·0	299·8	19·75	239·25	259·0
10th February ..	6·25	388·5	394·75	16·4	261·0	277·4	25·25	191·75	217·0
25th February ..	..	..	..	14·8	186·2	201·0	28·25	325·25	353·50

TABLE No. 87A.
Length in cms. of roots of the 2nd order.
 Protected plants.
 (Average of 4 to 5 plants.)

Date of sowing	15-7-1929.	26-6-1930.	2-7-1931.
Period ending	1929-30.	1930-31.	1931-32.
2nd September	15.8	19.6	..
9th September	8.17	..	..
16th September	41.67	..	33.83
23rd September	52.08	113.0	34.17
30th September	57.92	163.6	..
7th October	81.92	247.1	73.25
21st October	177.06	345.4	140.66
4th November	337.17	444.8	379.0
18th November	364.5	886.4	804.91
2nd December	300.0	1135.8	972.4
18th December	214.5	1105.2	1059.0
30th December	284.10	821.5	946.75
14th January	146.20	784.6	1267.25
28th January	268.1	1082.0	697.5
10th February	308.75	689.0	845.25
25th February .. .. .	..	542.0	1037.75

TABLE No. 88.
Number of large and small roots of the 3rd order.
 Protected plants.
 (Average figures of 4 to 5 plants.)

Date of sowing	15-7-1929.			26-6-1930.			2-7-1931.		
Year	1929-30.			1930-31.			1931-32.		
Period ending	Large.	Small.	Total.	Large.	Small.	Total.	Large.	Small.	Total.
2nd September .. .. .	..	6.4	6.4	0.0	11.4	11.4	..	..	..
9th September .. .. .	..	2.5	2.5	..	..	rain.	..	..	..
16th September .. .. .	..	15.00	15.00	..	..	..	..	14.83	14.83
23rd September .. .. .	..	24.67	24.67	0.2	31.0	31.2	0.16	12.67	12.83
30th September .. .. .	..	24.83	24.83	1.0	32.2	33.2	..	..	..
7th October .. .. .	..	43.83	43.83	2.2	62.4	64.6	..	25.0	25.0
21st October .. .. .	..	63.50	63.50	0.4	67.6	68.0	1.33	28.83	30.16
4th November	0.33	129.17	129.50	2.2	72.8	75.0	0.83	134.67	135.5
18th November	0.40	144.0	144.4	3.6	153.6	157.2	7.66	159.34	167.00
2nd December	0.20	126.60	126.8	4.0	170.8	174.8	3.0	122.2	125.20
16th December	0.25	67.25	67.5	7.0	119.0	126.0	6.25	129.5	135.75
30th December .. .. .	..	84.40	84.40	2.6	112.6	115.2	9.50	139.25	148.75
14th January	0.20	57.80	58.0	2.8	110.6	113.4	4.0	218.0	222.00
28th January	0.20	76.0	76.2	4.0	180.6	184.6	3.0	113.25	116.25
10th February	0.25	101.0	101.25	1.8	101.2	103.0	5.50	122.25	127.75
25th February .. .. .	..	..	..	0.8	75.6	76.4	3.50	171.75	175.25

TABLE NO. 89.
Length in cms. of roots of 3rd order.
Protected plants.
(Average of 4 to 5 plants.)

Date of sowing	15-7-1929.	26-6-1930.	2-7-1931.
Period ending	1929-30.	1930-31.	1931-32.
2nd September .. .. .	..	..	..
9th September .. .. .	..	..	..
16th September .. .. .	..	rain.	..
23rd September .. .. .	..	5.8	3.79
30th September	Not measured	17.1	..
7th October	roots	34.6	..
21st October	so far.	4.0	17.58
4th November	5.58	61.0	40.25
18th November	5.60	136.4	179.83
2nd December	6.0	81.3	125.4
16th December	3.0	238.6	179.5
30th December	0.0	64.6	384.75
14th January	2.40	64.8	71.0
28th January	2.80	105.2	69.75
10th February	6.5	56.2	158.0
25th February .. .. .	..	12.0	106.25

TABLE NO. 90.
Total number of large and small roots of all orders.
Protected plants.
(Average of 4 to 5 plants.)

Period ending	1929-30.			1930-31.			1931-32.		
	Large.	Small.	Total.	Large.	Small.	Total.	Large.	Small.	Total.
2nd September ..	8.60	120.40	129.0	10.4	173.8	184.2	..	..	..
9th September ..	10.16	156.65	166.82	..	..	..	8.66	158.00	166.66
16th September ..	11.17	143.16	154.33	..	..	..	7.59	135.97	143.56
23rd September ..	12.84	186.16	199.00	15.8	174.8	190.6	..	..	..
30th September ..	14.83	251.50	266.33	18.8	151.4	170.2	..	..	..
7th October ..	15.83	302.16	317.99	31.0	350.0	381.0	14.75	173.00	187.75
21st October ..	20.17	364.34	384.51	28.6	300.8	329.4	19.67	170.50	190.17
4th November ..	25.16	537.67	562.83	37.0	281.0	318.0	32.99	426.16	459.15
18th November ..	24.80	614.20	639.00	55.2	503.8	559.0	50.50	432.17	482.67
2nd December ..	28.80	638.50	667.30	56.4	491.0	547.4	50.20	437.60	487.80
16th December ..	28.50	454.50	483.00	53.8	338.0	391.8	58.00	444.50	502.50
30th December ..	29.40	500.6	530.00	41.6	337.2	378.8	60.25	534.0	594.25
14th January ..	26.00	562.8	588.80	41.6	377.6	419.2	57.25	555.50	612.75
25th January ..	26.8	390.2	417.00	48.4	511.0	559.4	47.75	391.25	439.00
10th February ..	27.75	535.75	563.50	38.6	393.0	431.6	50.0	358.0	408.00
25th February ..	..	..	..	37.0	301.0	338.0	57.5	541.25	598.75

TABLE No. 91.
Total length in cms. of all roots.
 Protected plants.
 (Average of 4 to 5 plants.)

Date of sowing	15-7-1929.	26-6-1930.	2-7-1931.
Period ending	1929-30.	1930-31.	1931-32.
2nd September	253·30	262·30	..
9th September	304·0	rain.	..
16th September	336·67	..	277·22
23rd September	418·08	462·50	284·6
30th September	622·51	612·8	..
7th October	706·95	1019·5	486·57
21st October	1049·65	1328·4	597·23
4th November	1461·88	1512·6	958·16
18th November	1543·10	2601·4	1955·82
2nd December	1590·50	2795·6	2459·0
16th December	1554·25	2757·3	2831·50
30th December	1746·90	1889·4	2729·25
14th January	1454·80	2019·8	2808·0
28th January	1323·90	2694·5	2217·75
10th February	1616·36	1940·4	2242·7
25th February .. .. .	..	1737·8	2832·5

TABLE NO. 92.

*Periodical feeding zones of roots. Number of root-tips of large roots found in different layers of the soil.
Plants grown protected against the spotted boll-worm.*

1929-30.

Depth in cms.	9/9	23/9	7/10	21/10	4/11	18/11	2/12	16/12	30/12	14/1	28/1	10/2
1—10	2.5	0.67	0.33	0.66	0.66	0.25	..	1.5	0.4	0.6	3.4	0.75
11—20	5.67	9.17	4.99	9.99	5.16	7.25	8.0	10.5	6.6	6.6	10.0	6.25
21—30	1.67	2.67	7.99	3.88	5.83	6.50	7.6	4.25	8.6	6.0	4.8	7.5
31—40	0.5	0.33	2.33	2.66	4.66	2.50	8.4	3.75	2.8	3.4	1.2	3.75
41—50	0.17	..	0.5	2.0	4.5	3.5	2.2	4.25	3.2	3.0	2.4	3.5
51—60	0.5	0.83	0.66	0.33	1.49	1.25	0.4	1.75	3.2	1.2	1.2	4.0
61—70 .. ..	..	..	..	0.16	0.99	1.50	1.0	1.25	2.0	2.0	1.6	0.75
71—80 .. ..	..	..	1.0	0.16	1.16	0.5	0.6	..	1.2	0.6	0.8	0.25
81—90 .. ..	..	..	..	1.33	1.82	0.75	..	1.25	0.25	1.6	0.4	2.0
91—100.. ..	..	..	..	..	0.16	1.25	1.4	0.25	0.80	..	1.6	..
101—110.. ..	..	..	..	..	..	..	0.2	0.25	1.4	..	0.2	..
111—120.. ..	..	..	..	..	..	..	..	..	0.20	..	..	..

TABLE NO. 93.

*Periodical feeding zones of roots. Number of root-tips of large roots found in different layers of the soil.
Plants grown protected against the spotted boll-worm.*

1930-31.

Depth in cms.	8/10	22/10	5/11	19/11	3/12	17/12	31/12	14/1	28/1	11/2	25/2
1—10	2.4	2.2	0.4	2.8	2.4	1.2	0.4	0.4	0.6	0.4	1.0
11—20	15.8	11.4	15.6	19.4	15.4	15.6	13.0	9.4	6.2	10.0	12.0
21—30	8.2	5.0	10.0	12.4	9.6	10.4	9.2	9.8	13.2	8.6	6.8
31—40	1.8	3.4	3.8	5.6	6.0	5.0	6.0	7.0	6.2	3.8	4.8
41—50	1.2	3.0	2.2	3.2	5.4	5.2	2.2	2.8	4.6	2.6	2.4
51—60	1.2	1.6	1.4	1.8	2.8	2.8	3.2	2.6	3.6	2.6	3.2
61—70	1.0	1.6	0.8	1.8	4.0	3.8	3.8	2.2	3.6	3.2	2.6
71—80	0.2	0.6	1.2	4.0	3.2	1.8	2.6	2.8	1.6	1.4	1.2
81—90	0.2	0.4	1.4	3.0	3.0	3.4	1.6	2.8	3.4	2.4	1.8
91—100 .. .. .	..	0.4	0.6	0.6	1.4	1.8	0.2	2.2	4.6	3.0	1.4
101—110 .. .. .	..	..	0.6	0.6	2.2	1.2	0.4	0.2	0.6	0.6	0.4
111—120 .. .. .	..	..	0.2	0.8	1.4	1.6	..	..	0.6	0.6	0.2
121—130 .. .. .	..	..	..	..	0.6	0.4	..	..	0.4	0.2	..
131—140 .. .. .	..	..	..	0.2	0.2	0.6	..	..	0.2	..	..
141—150 .. .. .	..	..	..	..	..	..	..	0.2	..	..	..
171—180 .. .. .	..	..	..	..	..	..	..	..	..	0.2	..
221—230 .. .. .	..	..	..	..	..	..	..	0.2	..	..	..

TABLE NO. 94.

*Periodical feeding zones of roots. Number of root-tips of large roots found in different layers of the soil.
Plants grown protected against the spotted boll-worm.*

1931-32.

Depth in cms.	22/10	5/11	19/11	3/12	16/12	30/12	13/1	27/1	10/2	24/2
1—10	1·83	1·67	1·67	0·4	..	0·25	0·25	..	0·25	..
11—20	9·5	15·5	16·0	13·4	9·25	10·75	8·5	6·0	8·5	7·0
21—30	5·67	8·83	12·33	9·8	15·5	16·25	15·0	9·0	10·75	13·25
31—40	2·0	3·67	7·5	7·8	7·75	8·5	10·25	11·5	10·25	12·25
41—50	0·67	2·83	5·67	8·4	8·0	3·5	7·75	5·75	6·5	7·75
51—60	1·0	1·17	4·5	4·8	5·25	6·5	5·25	5·5	4·5	3·75
61—70 .. .. .	..	0·17	2·83	3·6	5·5	3·25	3·0	3·25	4·0	5·75
71—80 .. .. .	..	..	0·67	1·8	3·75	5·75	1·75	5·0	2·5	3·5
81—90 .. .. .	..	..	0·33	1·0	2·25	4·25	2·75	2·0	2·0	3·25
91—100 .. .. .	..	..	..	0·2	1·5	2·0	3·0	0·75	1·5	1·75
101—110 .. .. .	..	..	..	..	0·25	0·25	0·75	..	0·25	0·25

TABLE NO. 95.

Dry matter of roots in grammes.

Date of sowing	Protected.			Unprotected.		
	15-7-29.	26-6-30.	2-7-31.	15-7-29.	26-6-30.	2-7-31.
Period ending	1929-30.	1930-31.	1931-32.	1929-30.	1930-31.	1931-32.
2nd September	0.62	..	..
9th September	..	0.81	..	..	..	..
16th September	0.67	1.0	..	0.67
23rd September	..	2.53	1.4	1.00	1.4	1.0
30th September	2.08	..	2.38	1.06
7th October	..	3.74	3.44	2.49	..	2.49
14th October	5.45	4.9	..
21st October	..	7.79	4.60	2.67	..	..
28th October	7.48	6.6	4.75
4th November	..	13.55	7.04	4.67	..	..
11th November	11.5	8.0	7.5
18th November	..	12.92	9.60	12.67	..	..
25th November	21.0	16.0	14.6
2nd December	..	13.6	13.00	18.00	..	..
9th December	25.2	25.6	19.0
16th December	..	15.8	16.20	18.75	..	..
23rd December	38.5	24.0	21.25
30th December	..	19.5	18.00	17.50	..	..
7th January	41.63	24.25	26.25
14th January	..	19.0	17.60	19.50	..	..
21st January	41.5	30.0	25.13
28th January	..	20.0	20.00	20.00	..	..
3rd February	45.0	24.00	26.0
11th February	..	21.4	19.80	21.50	..	..
17th February	37.0	28.25	28.0
25th February	19.40	20.00	..	..
4th March	31.75	28.75	29.75
11th March	26.25	27.67

TABLE No. 96.

Average progressive height of the main stem, in centimeters, in protected plants.

Years 1926-27.		1927-28.		1928-29.		1929-30.		1930-31.		1931-32.							
Period Ending	Height cms.	Period ending	Height cms.	Period ending	Height cms.	Period ending	Height cms.	Period ending	Height cms.	Period ending	Height cms.						
Number of plants 9		9		19		18		20		15							
	..	..	..	31st..	Aug.	19·7	2nd..	Sept.	16·9	1st..	Sept.	13·9	..	..	
	..	..	..	7th..	Sept.	29·9	9th..	Sept.	24·9	9th..	Sept.	20·5	..	..	
	..	18th..	Sept.	29·1	14th..	Sept.	44·6	16th..	Sept.	35·6	..	..	14th..	Sept.	14·4		
25th..	Sept.	19·1	25th..	Sept.	38·8	28th..	Sept.	76·2	23rd..	Sept.	46·4	22nd..	Sept.	41·2	..		
1st..	Oct.	23·5	..	..	..	..	..	..	30th..	Sept.	56·2	29th..	Sept.	52·8	28th..	Sept.	26·5
8th..	Oct.	29·7	9th..	Oct.	51·4	5th..	Oct.	88·5	7th..	Oct.	63·1	6th..	Oct.	64·6	..	..
15th..	Oct.	37·4	16th..	Oct.	58·6	12th..	Oct.	96·9	14th..	Oct.	71·8	13th..	Oct.	75·3	..	..
22nd..	Oct.	45·4	23rd..	Oct.	65·6	19th..	Oct.	106·2	21st..	Oct.	81·5	20th..	Oct.	85·8	20th..	Oct.	53·2
29th..	Oct.	52·4	30th..	Oct.	72·7	26th..	Oct.	116·9	28th..	Oct.	88·8	27th..	Oct.	93·6	26th..	Oct.	59·3
5th..	Nov.	58·2	6th..	Nov.	79·3	2nd..	Nov.	122·9	6th..	Nov.	96·3	3rd..	Nov.	98·4	2nd..	Nov.	67·0
12th..	Nov.	64·2	13th..	Nov.	86·8	9th..	Nov.	129·9	13th..	Nov.	100·9	10th..	Nov.	103·9	9th..	Nov.	76·8
19th..	Nov.	70·9	..	..	..	16th..	Nov.	135·3	20th..	Nov.	102·5	17th..	Nov.	107·8	16th..	Nov.	85·6
26th..	Nov.	76·3	27th..	Nov.	95·4	23rd..	Nov.	138·4	27th..	Nov.	102·8	24th..	Nov.	110·2	23rd..	Nov.	94·5
3rd..	Dec.	80·1	..	..	..	30th..	Nov.	139·3	..	..	..	1st..	Dec.	110·6	30th..	Nov.	100·2
10th..	Dec.	82·8	11th..	Dec.	103·5	7th..	Dec.	139·6	..	..	..	8th..	Dec.	110·8	7th..	Dec.	104·0
17th..	Dec.	84·0	..	..	..	14th..	Dec.	..	..	..	..	15th..	Dec.	111·0	14th..	Dec.	107·4
24th..	Dec.	84·6	25th..	Dec.	108·3	..	..	..	..	..	..	22nd..	Dec.	111·1	21st..	Dec.	110·5
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	28th..	Dec.	112·9
..	..	..	8th..	Jan.	110·5	..	..	..	..	..	..	..	..	..	4th..	Jan.	114·1
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	10th..	Jan.	114·2
..	..	..	22nd..	Jan.	110·7	..	..	..	..	..	..	..	..	..	18th..	Jan.	..

TABLE NO. 97.
Large and small branches on the main stem in protected plants.
 1926-27.

Plant number.	No. of Limbs.			No. of Primary fruiting branches.	No. of Auxiliary branches.		
	Large.	Small.	Total.		Large.	Small.	Total.
1	7	8	15	31	6	8	14
2	7	16	23	27	4	7	11
3	4	6	10	34	9	5	14
4	7	9	16	29	8	8	16
5	6	8	14	35	7	13	20
6	3	11	14	42	8	10	18
7	4	9	13	31	14	9	23
8	3	8	11	35	10	7	17
9	9	3	12	25	7	2	9
Average of nine plants.	5.5	8.7	14.2	32.1	8.1	7.7	15.8

1927-28.

12	7	4	11	33	14	8	22
14	7	3	10	34	15	12	27
15	2	4	6	37	16	17	33
17	4	5	9	35	18	9	27
19	7	6	13	30	13	11	24
20	4	5	9	38	12	12	24
21	4	3	7	41	18	13	31
22	6	3	9	33	19	10	29
25	4	5	9	32	14	9	23
Average of nine plants.	5.0	4.2	9.2	34.8	15.4	11.2	26.6

TABLE NO. 98.

Large and small branches on the main stem in protected plants.

1928-29.

Plant number.	No. of Limbs.			No. of Primary fruiting branches.	No. of Auxiliary branches.		
	Large.	Small.	Total.		Large.	Small.	Total.
1	9	5	14	35	20	9	29
2	7	5	12	36	12	5	17
3	9	5	14	32	12	6	18
4	6	8	14	33	14	8	22
5	10	6	16	36	15	6	21
6	..	4	4	40	18	13	31
7	11	1	12	35	15	8	23
8	9	6	15	38	19	8	27
9	5	6	11	39	20	17	37
10	10	3	13	38	17	13	30
12	7	4	11	33	17	6	23
13	6	6	12	33	22	7	29
14	4	5	9	34	19	16	35
15	4	7	11	34	18	9	27
16	4	8	12	31	14	7	21
17	7	5	12	30	16	5	21
18	10	6	16	34	14	8	22
19	5	6	11	33	17	9	26
20	10	5	15	28	11	3	14
Average of 19 plants.	7.0	5.3	12.3	34.3	16.3	8.6	24.9

TABLE NO. 99.

Large and small branches on the main stem in protected plants.

1929-30.

Plant number.	No. of Limbs.			No. of Primary fruiting branches.	No. of Auxiliary branches.		
	Large.	Small.	Total.		Large.	Small.	Total.
1	8	6	14	31	11	5	16
2	7	9	16	27	7	6	13
3	9	5	14	31	9	4	13
4	5	1	6	31	8	5	13
5	4	8	12	28	5	4	9
6	10	2	12	31	10	8	18
7	7	8	15	28	10	4	14
8	8	5	13	23	7	6	13
9	9	7	16	28	8	3	11
10	5	4	9	28	11	6	17
11	7	9	16	27	12	6	18
12	8	9	17	30	15	6	21
13	9	6	15	24	8	7	15
14	11	9	20	25	8	8	16
16	6	8	14	26	9	6	15
17	6	9	15	30	6	6	12
19	5	4	9	28	6	6	12
20	8	7	15	25	11	3	14
Average per plant ..	7.3	6.4	13.7	27.8	8.9	5.5	14.4

TABLE No. 100.

Large and small branches on the main stem in protected plants.

1930-31.

Plant number.	No. of Limbs.			No. of Primary fruiting branches.	No. of Auxiliary branches.		
	Large.	Small.	Total.		Large.	Small.	Total.
1	6	8	14	31	9	7	16
2	2	7	9	28	5	3	8
3	7	6	13	26	9	3	12
4	8	7	15	25	12	2	14
5	4	10	14	21	10	2	12
6	5	7	12	24	12	5	17
7	6	7	13	30	10	2	12
8	3	2	5	30	13	3	16
9	6	7	13	35	11	5	16
10	6	5	11	33	12	3	15
11	9	3	12	32	7	7	14
12	3	5	8	25	11	..	11
13	7	4	11	35	14	8	22
14	4	5	9	25	13	1	14
15	7	7	14	31	10	7	17
16	7	7	14	27	8	4	12
17	6	5	11	31	7	6	13
18	4	6	10	27	10	3	13
19	5	3	8	29	11	3	14
20	5	4	9	28	10	2	12
Average per plant	5.50	5.75	11.25	28.65	10.20	3.80	14.00

TABLE No. 101.

Large and small branches on the main stem in protected plants.

1931-32.

Plant number.	No. of Limbs.			No. of Primary fruiting branches.	No. of Auxiliary branches.		
	Large.	Small.	Total.		Large.	Small.	Total.
2	13	2	15	34	4	9	13
3	8	5	13	36	7	12	19
4	9	6	15	33	7	13	20
5	7	4	11	36	7	9	16
8	9	5	14	34	7	9	16
9	10	6	16	36	6	6	12
10	11	6	17	35	7	8	15
11	11	5	16	40	10	8	18
12	5	7	12	30	9	7	16
13	6	8	14	35	6	10	16
14	3	7	10	30	6	8	14
16	5	9	14	38	9	9	18
17	6	5	11	29	5	6	11
18	10	6	16	32	5	6	11
20	13	3	16	30	10	4	14
Average per plant..	8.4	5.6	14.0	33.9	7.0	8.3	15.3

TABLE No. 102.

Average progressive vegetative bud-production in the protected and unprotected plants.

1926-27.			1927-28.			1928-29.			
Period ending	Vegetative buds.		Period ending	Vegetative buds.		Period ending	Vegetative buds.		
	Prot.	Unprot.		Prot.	Unprot.		Prot.	Unprot.	
Number of plants	10	10	Number of plants	14	20	Number of plants	20	20	
..	31st Aug.	..	17-20	..
..	7th Sept.	..	33-30	7th Sept.	..	28-65	23-45
..	14th Sept.	..	32-07	14th Sept.	..	48-15	36-10
24th Sept.	..	18-7	21st Sept.	..	51-07	..	..	..	..
1st Oct.	..	23-6	28th Sept.	..	110-10	28th Sept.	..	107-20	73-95
8th Oct.	..	42-9	5th Oct.	..	102-00	5th Oct.	..	144-70	104-90
15th Oct.	..	67-2	12th Oct.	..	149-07	12th Oct.	..	178-40	136-00
22nd Oct.	..	91-3	19th Oct.	..	203-64	19th Oct.	..	219-50	170-95
29th Oct.	..	116-6	26th Oct.	..	249-93	26th Oct.	..	285-05	223-45
5th Nov.	..	138-9	2nd Nov.	..	291-64	2nd Nov.	..	329-90	278-05
12th Nov.	..	163-2	11th Nov.	..	356-00	9th Nov.	..	366-40	312-85
19th Nov.	..	190-0	18th Nov.	..	497-65	16th Nov.	..	390-90	337-00
26th Nov.	..	205-3	25th Nov.	..	428-00	23rd Nov.	..	410-00	360-10
3rd Dec.	..	226-8	2nd Dec.	..	531-80	30th Nov.	..	421-70	378-85
10th Dec.	..	239-5	9th Dec.	..	481-50	7th Dec.	..	424-90	390-65
17th Dec.	..	246-1	16th Dec.	..	577-30	14th Dec.	..	425-85	401-70
24th Dec.	..	249-9	23rd Dec.	..	512-71	21st Dec.	..	426-35	409-00
31st Dec.	..	252-2	30th Dec.	..	600-65	28th Dec.	..	426-55	415-45
7th Jan.	..	254-6	6th Jan.	..	527-28	4th Jan.	..	..	421-30
14th Jan.	..	256-0	13th Jan.	..	619-55	11th Jan.	..	..	424-05
21st Jan.	..	257-0	20th Jan.	..	534-14	18th Jan.	..	..	427-25
28th Jan.	..	257-8	27th Jan.	..	626-35	25th Jan.	..	..	430-70
4th Feb.	..	325-8	3rd Feb.	..	535-50	1st Feb.	..	..	430-90
11th Feb.	10th Feb.	..	626-85	8th Feb.	..	..	431-00
18th Feb.	..	328-8	..	..	..	..	..	..	..

TABLE NO. 103.

Average progressive flower-bud production in the protected and the unprotected plants.

1926-27.			1927-28.			1928-29.			
Period ending	Flower buds.		Period ending	Flower buds.		Period ending	Flower buds.		
	Prot.	Unprot.		Prot.	Unprot.		Prot.	Unprot.	
Number of plants	10	10	Number of plants	14	20	Number of plants	20	20	
..	..	..	..	..	..	31st Aug.	..	0.60	..
..	..	..	7th Sept.	..	4.0	7th Sept.	..	4.25	1.25
..	..	..	14th Sept.	..	4.43	14th Sept.	..	14.20	5.70
24th Sept.	1.3	..	21st Sept.	..	14.64	..	..	..	..
1st Oct.	3.7	4.4	28th Sept.	..	..	28th Sept.	..	57.85	27.00
8th Oct.	10.4	14.8	5th Oct.	..	44.42	5th Oct.	..	92.85	46.75
15th Oct.	23.0	27.2	12th Oct.	..	68.71	12th Oct.	..	138.05	66.05
22nd Oct.	41.5	47.7	19th Oct.	..	96.71	19th Oct.	..	205.65	94.75
29th Oct.	66.3	69.1	26th Oct.	..	134.56	26th Oct.	..	308.35	133.75
5th Nov.	89.6	91.9	2nd Nov.	..	185.06	2nd Nov.	..	366.45	170.25
12th Nov.	116.8	115.5	11th Nov.	..	284.84	9th Nov.	..	425.30	200.05
19th Nov.	146.3	143.8	18th Nov.	..	..	16th Nov.	..	476.20	225.50
26th Nov.	172.1	166.5	25th Nov.	..	393.84	23rd Nov.	..	507.90	253.35
3rd Dec.	191.9	207.8	2nd Dec.	..	..	30th Nov.	..	523.35	273.60
10th Dec.	207.7	228.5	9th Dec.	..	476.20	7th Dec.	..	527.60	285.60
17th Dec.	212.2	..	16th Dec.	..	..	14th Dec.	..	528.35	293.90
24th Dec.	214.4	261.9	23rd Dec.	..	510.35	21st Dec.	..	528.40	298.00
31st Dec.	215.5	..	30th Dec.	..	..	28th Dec.	..	..	300.45
7th Jan.	215.7	295.1	6th Jan.	..	524.21	4th Jan.	..	..	301.80
14th Jan.	..	..	13th Jan.	..	..	11th Jan.	..	..	302.55
21st Jan.	..	307.1	20th Jan.	..	525.78	18th Jan.	..	..	303.05
28th Jan.	..	..	27th Jan.	..	..	25th Jan.	..	..	303.10
4th Feb.	..	311.8	3rd Feb.	..	525.9	1st Feb.	..	..	..
11th Feb.	..	..	10th Feb.	..	..	8th Feb.	..	..	..
18th Feb.	..	312.7	..	..	..	..	..	..	..

TABLE No. 104.

Average progressive production of flowers in the protected and unprotected plants.

1926-27.			1927-28.			1928-29.		
Period ending	Flowers.		Period ending	Flowers.		Period ending	Flowers.	
	Prot.	Unprot.		Prot.	Unprot.		Prot.	Unprot.
Number of plants	10	10	Number of plants	14	20	Number of plants	20	20
24th Oct.	0.1	..	..	..	..	..	..	..
31st Oct.	1.8	0.3	..	..	..	28th Oct.	..	0.05
7th Nov.	5.2	1.3	..	..	..	4th Nov.	1.20	0.05
14th Nov.	8.7	2.6	13th Nov.	0.07	..	11th Nov.	7.70	0.95
21st Nov.	13.6	4.9	20th Nov.	2.21	0.05	18th Nov.	31.90	5.20
28th Nov.	21.0	7.3	27th Nov.	6.14	0.40	25th Nov.	62.00	11.15
5th Dec.	62.0	8.9	4th Dec.	13.57	1.90	2nd Dec.	88.85	18.50
12th Dec.	42.6	10.3	11th Dec.	28.57	6.10	9th Dec.	126.40	27.30
19th Dec.	55.0	13.4	18th Dec.	47.78	11.05	16th Dec.	166.50	39.90
26th Dec.	65.0	16.0	25th Dec.	72.07	20.25	23rd Dec.	180.25	48.95
2nd Jan.	71.7	19.5	1st Jan.	104.07	31.30	30th Dec.	182.35	56.60
9th Jan.	77.3	23.9	8th Jan.	129.71	44.75	6th Jan.	182.55	61.05
16th Jan.	79.6	28.9	15th Jan.	153.50	58.90	13th Jan.	182.60	64.65
23rd Jan.	80.2	36.5	22nd Jan.	164.29	70.80	20th Jan.	..	68.30
30th Jan.	80.4	43.8	29th Jan.	168.29	78.45	27th Jan.	..	67.50
6th Feb.	..	52.8	5th Feb.	169.00	80.60	3rd Feb.	..	67.95
13th Feb.	..	61.3	12th Feb.	169.2	81.55	10th Feb.	..	68.30
20th Feb.	..	67.4	19th Feb.	..	81.8	17th Feb.	..	68.60
27th Feb.	..	69.2	..	..	..	24th Feb.	..	68.65
6th Mar.	..	69.6	..	..	..	..	..	..

TABLE No. 104—(contd.)

Average progressive production of flowers in the protected and unprotected plants.

1929-30.			1930-31.			1931-32.		
Period ending	Flowers.		Period ending	Flowers.		Period ending	Flowers.	
	Prot.	Unprot.		Prot.	Unprot.		Prot.	Unprot.
Number of plants	20	18	Number of plants	20	20	Number of plants	20	20
13th Oct.	0.05	..	..	..	..	..	..	..
20th Oct.	0.75	0.1	19th Oct.	0.20	0.10	..	..	..
27th Oct.	3.30	0.2	26th Oct.	7.70	0.85	..	..	..
3rd Nov.	6.55	0.6	2nd Nov.	22.40	1.90	..	..	..
10th Nov.	16.95	2.2	9th Nov.	32.65	2.20	..	..	..
17th Nov.	44.65	6.7	16th Nov.	33.85	2.35	..	..	..
24th Nov.	84.15	11.9	23rd Nov.	36.95	2.55	22nd Nov.	0.25	0.15
1st Dec.	114.95	17.8	30th Nov.	42.30	3.50	29th Nov.	2.50	1.00
8th Dec.	134.50	26.4	7th Dec.	55.75	6.60	6th Dec.	9.50	2.60
15th Dec.	139.15	38.3	14th Dec.	69.50	13.95	13th Dec.	20.00	6.40
22nd Dec.	139.25	48.8	21st Dec.	78.75	27.55	20th Dec.	35.60	12.15
29th Dec.	..	55.7	28th Dec.	83.25	47.25	27th Dec.	60.20	22.35
5th Jan.	..	66.2	4th Jan.	84.95	63.50	3rd Jan.	78.50	30.35
12th Jan.	..	73.3	11th Jan.	85.35	78.55	10th Jan.	98.75	40.45
19th Jan.	..	76.8	18th Jan.	85.90	85.90	17th Jan.	111.30	51.20
26th Jan.	..	77.4	25th Jan.	..	..	24th Jan.	118.75	58.95
2nd Feb.	..	77.6	1st Feb.	..	87.00	31st Jan.	120.65	62.90
9th Feb.	..	77.7	..	..	..	7th Feb.	120.85	64.40
..	..	..	..	..	..	14th Feb.	120.90	64.80
..
..
..

TABLE No. 105.

Average periodical formation of flower-buds and the absolute and relative shedding of buds in the protected plants.

1926-27.				1928-29.				1929-30.			
Period ending	Buds-formed.	Bud-shedding		Period ending	Buds-formed.	Bud-shedding.		Period ending	Buds-formed	Bud-shedding.	
		Relative.	Absolute.			Relative.	Absolute.			Relative.	Absolute.
Number of plants 10				Number of plants 20				Number of plants 20			
..	..	..	..	31st Aug.	0.60	0.60	..	..	..	..	..
..	..	..	..	7th Sept.	3.65	3.65	..	9th Sept.	1.10	1.10	..
..	..	..	..	14th Sept.	10.15	10.15	0.70	16th Sept.	5.40	5.25	..
24th Sept.	1.3	0.5	..	..	..	..	..	23rd Sept.	11.80	9.35	0.70
1st Oct.	2.4	0.2	..	28th Sept.	43.45	42.85	20.10	30th Sept.	16.40	12.20	5.30
8th Oct.	6.7	2.3	0.2	5th Oct.	34.90	30.55	16.15	7th Oct.	28.20	16.30	14.60
15th Oct.	12.6	6.8	0.9	12th Oct.	45.30	34.45	35.05	14th Oct.	37.50	12.75	12.60
22nd Oct.	18.5	9.5	0.7	19th Oct.	67.60	35.70	14.15	21st Oct.	38.65	10.00	14.15
29th Oct.	24.8	11.2	2.5	26th Oct.	102.70	55.00	16.05	28th Oct.	38.10	8.35	9.30
5th Nov.	23.3	11.2	7.4	2nd Nov.	58.10	21.80	79.55	4th Nov.	38.35	15.80	6.40
12th Nov.	27.2	14.0	8.8	9th Nov.	58.85	27.25	29.05	11th Nov.	35.15	22.80	11.65
19th Nov.	29.5	18.9	12.9	16th Nov.	50.90	34.90	13.60	18th Nov.	20.55	18.10	19.40
26th Nov.	25.8	19.8	11.0	23rd Nov.	31.70	23.80	21.25	25th Nov.	6.30	6.25	17.00
3rd Dec.	19.8	17.6	12.1	30th Nov.	15.45	15.10	23.55	2nd Dec.	0.90	0.90	14.90
10th Dec.	15.8	15.4	18.2	7th Dec.	4.25	4.20	37.80	9th Dec.	..	..	10.10
17th Dec.	4.5	4.4	20.9	14th Dec.	0.75	0.75	34.30	16th Dec.	..	..	2.80
24th Dec.	2.2	2.2	19.1	21st Dec.	0.05	0.05	3.40	23rd Dec.	..	..	0.25
31st Dec.	1.1	1.1	12.8	28th Dec.	..	..	0.50	..	..	..	..
7th Jan.	0.2	0.2	5.4	4th Jan.	..	..	0.05	..	..	..	..
14th Jan.	..	..	1.7	..	..	..	..	..	..	..	..
21st Jan.	..	..	0.3	..	..	..	..	..	..	..	..
28th Jan.	..	..	0.3	..	..	..	..	..	..	..	..
Rest ..	..	..	0.1	..	..	..	0.55	..	..	..	..
Total ..	215.7	135.3	135.3	Total ..	528.40	345.80	345.80	Total ..	278.40	139.15	139.15

TABLE NO. 105—(contd.)

Average periodical formation of flower-buds and the absolute and relative shedding of buds in the protected plants.

1930-31.				1931-32.			
Period ending	Buds-formed.	Bud-shedding.		Period ending	Buds-formed.	Bud-shedding.	
		Relative.	Absolute.			Relative.	Absolute.
Number of plants		20		Number of plants		20	
1st Sept.	0·10	1·10	..	..	..	..	..
8th Sept.	0·50	0·50	..	..	..	..	..
..
22nd Sept.	9·00	5·35	0·80	..	..	..	..
29th Sept.	11·95	3·40	3·05	28th Sept.	0·95	0·95	..
6th Oct.	23·60	8·55	2·20	..	..	..	..
13th Oct.	29·30	23·05	1·90	..	..	..	..
20th Oct.	36·15	33·05	5·35	19th Oct.	19·05	18·10	8·20
27th Oct.	29·80	22·45	10·40	26th Oct.	12·90	9·10	6·25
3rd Nov.	17·85	7·05	63·55	2nd Nov.	21·45	10·40	7·35
10th Nov.	32·05	14·15	13·35	9th Nov.	29·50	8·60	7·55
17th Nov.	22·90	14·35	4·35	16th Nov.	41·00	10·55	9·10
24th Nov.	9·80	6·50	11·65	23rd Nov.	37·40	13·30	10·00
1st Dec.	6·05	5·30	13·25	30th Nov.	33·00	16·75	6·60
8th Dec.	1·35	1·25	8·00	7th Dec.	29·20	20·20	6·30
15th Dec.	0·40	0·35	4·30	14th Dec.	25·30	21·90	7·25
22nd Dec.	0·15	0·15	1·00	21st Dec.	21·75	20·10	23·45
.. .. ..	..	..	1·90	28th Dec.	13·15	13·05	19·75
.. .. ..	..	..	0·40	4th Jan.	6·30	6·25	18·45
.. .. ..	..	..	0·10	11th Jan.	3·90	3·90	19·95
.. .. ..	..	..	..	18th Jan. .. ..	..	..	19·95
.. .. ..	..	..	..	25th Jan. .. ..	..	..	3·45
.. .. ..	..	..	..	1st Feb. .. ..	..	..	0·35
Total	230·95	145·55	145·55	Total	294·85	173·95	173·95

TABLE No. 106.

Average periodical flower opening and relative and absolute shedding of bolls in the protected plants.

1926-27.				1927-28.				1928-29.			
Boll-shedding.				Boll-shedding.				Boll-shedding.			
Period ending	Flowers opened.	Relative.	Absolute.	Period ending	Flowers opened.	Relative.	Absolute.	Period ending	Flowers opened.	Relative.	Absolute.
24th Oct.	0.1	0.1	..	..	..	..	..	..	..	..	..
31st Oct.	1.7	0.8	..	..	..	..	..	..	..	..	..
7th Nov.	3.4	1.1	0.5	..	..	..	..	4th Nov.	1.20	0.45	..
14th Nov.	3.5	1.1	0.9	13th Nov.	0.07	0.07	..	11th Nov.	6.50	1.50	0.30
21st Nov.	4.9	1.4	0.8	20th Nov.	2.14	0.93	..	18th Nov.	24.20	5.35	0.50
28th Nov.	7.4	1.5	1.3	27th Nov.	3.93	0.72	..	25th Nov.	30.10	12.65	2.65
5th Dec.	11.0	3.1	1.2	4th Dec.	7.43	0.93	..	2nd Dec.	26.85	23.10	6.00
12th Dec.	10.6	4.6	1.9	11th Dec.	15.00	5.07	..	9th Dec.	37.55	34.50	18.20
19th Dec.	12.4	8.0	3.1	18th Dec.	19.21	8.71	..	16th Dec.	40.10	34.15	44.75
26th Dec.	10.0	5.8	4.6	25th Dec.	24.20	16.68	..	23rd Dec.	13.75	13.15	24.95
2nd Jan.	6.7	3.4	8.3	32nd Dec.	32.00	27.14	..	30th Dec.	2.10	2.05	17.75
9th Jan.	5.6	3.1	4.5	1st Jan.	32.00	27.14	..	6th Jan.	0.20	0.15	7.05
16th Jan.	2.3	1.8	2.7	8th Jan.	25.64	24.50	..	13th Jan.	0.05	..	2.75
23rd Jan.	0.6	0.6	3.4	15th Jan.	23.79	22.93	..	Rest	..	..	2.15
30th Jan.	0.2	0.1	2.4	22nd Jan.	10.79	9.22	..	..	..	..	..
Rest	..	..	0.9	28th Jan.	4.00	3.14	..	..	..	..	..
..	..	..	..	5th Feb.	0.71	0.64	..	..	..	..	..
..	..	..	..	12th Feb.	0.21	0.21	..	..	..	..	..
.. Total	80.4	36.5	36.5	.. Total	169.2	120.8	..	.. Total	182.60	127.05	127.05

TABLE No. 106—(contd.)

Average periodical flower opening and relative and absolute shedding of bolls in the protected plants.

1929-30.				1930-31.				1931-32.			
Boll-shedding.				Boll-shedding.				Boll-shedding.			
Period ending	Flowers opened.	Relative.	Absolute.	Period ending	Flowers opened.	Relative.	Absolute.	Period ending	Flowers opened.	Relative.	Absolute.
13th Oct.	0.05	0.05	..	19th Oct.	0.20	0.20	0.05	..	..	..	..
20th Oct.	0.70	0.15	0.10	26th Oct.	7.50	5.75	1.05	..	..	..	..
27th Oct.	2.55	0.20	0.25	2nd Nov.	14.70	6.95	10.35	..	..	..	..
3rd Nov.	8.25	0.55	0.15	9th Nov.	10.25	1.15	1.85	..	..	..	..
10th Nov.	10.40	3.40	1.30	16th Nov.	1.20	0.40	0.60	..	..	..	..
17th Nov.	27.70	17.20	10.00	23rd Nov.	3.10	1.45	0.25	22nd Nov.	0.25	..	..
24th Nov.	39.50	19.10	10.25	30th Nov.	5.35	1.70	1.00	29th Nov.	2.25	0.45	..
1st Dec.	30.80	29.90	18.55	7th Dec.	13.45	4.50	2.30	6th Dec.	7.00	1.35	0.20
8th Dec.	19.55	19.55	31.35	14th Dec.	13.75	6.90	3.30	13th Dec.	10.50	3.90	0.75
15th Dec.	4.65	4.60	18.75	21st Dec.	9.25	7.75	5.05	20th Dec.	15.60	5.35	5.35
22nd Dec.	0.10	0.10	3.70	28th Dec.	4.50	4.25	11.55	27th Dec.	24.60	9.60	4.70
29th Dec.	..	..	0.05	4th Jan.	1.70	1.70	4.05	3rd Jan.	18.30	12.90	0.45
5th Jan.	..	..	..	11th Jan.	0.40	0.40	1.50	10th Jan.	20.25	19.75	20.65
..	..	..	..	18th Jan.	0.05	0.05	0.25	17th Jan.	12.55	12.40	20.85
..	..	..	..	..	..	..	..	24th Jan.	7.45	7.30	9.95
..	..	..	..	..	..	..	..	31st Jan.	1.90	1.85	3.75
..	..	..	..	..	..	..	..	7th Feb.	0.20	0.15	2.40
..	..	..	..	..	..	..	..	14th Feb.	0.05	0.05	..
.. Total	139.25	94.80	94.80	.. Total	85.40	43.15	43.15	.. Total	120.90	75.05	75.05

TABLE No. 107.

Relative percentage boll shedding in protected plants.

Week after flowering.	1926-27.	1927-28.	1928-29.	1929-30.	1930-31.	1931-32.
1	100.0	100.0	37.5	100.0	100.0	..
2	47.1	43.3	23.1	21.4	76.7	20.0
3	32.4	18.2	22.1	7.8	47.3	19.3
4	31.4	12.4	42.0	16.9	11.2	37.1
5	28.6	33.8	86.0	32.7	33.3	34.3
6	20.3	45.3	91.9	62.1	46.8	39.0
7	28.2	68.2	85.2	48.4	31.8	70.5
8	43.4	84.8	95.6	97.1	33.5	97.5
9	65.1	95.5	97.6	100.0	50.2	98.8
0	58.0	96.4	75.0	98.9	83.8	98.0
1	56.6	85.4	..	100.0	94.4	97.4
2	55.4	78.2	..	..	100.0	75.0
3	78.3	90.0	..	..	100.0	100.0
4	100.0	100.0	..	..	100.0	..
5	50.0	..	..	..	..	..

TABLES FOR CHAPTER V.

TABLE No. 108.
Periodical percentage moisture in different organs of unprotected plants.
 1926-27.

Date.	LEAVES.		Young flowerbuds.	Flowers.	Young Bolls.
	Young.	Developed.			
11th October	73·87	75·43	..	..	Not deter- mined.
21st October	73·50	74·00	70·96	..	Do.
1st November	65·95	70·82	73·48	..	Do.
11th November	73·45	74·04	74·42	78·91	Do.
25th November	66·52	72·35	72·89	76·22	Do.
11th December	69·12	73·34	72·81	78·46	Do.
25th December	70·15	72·70	74·4	78·07	Do.
10th January	66·53	71·54	73·77	76·91	Do.
25th January	63·49	69·56	71·76	78·19	Do.
9th February	65·64	70·82	..	78·63	Do.
24th February	67·24	70·26	..	78·06	Do.
11th March	65·06	67·60	..	..	Do.

TABLE No. 109.
Periodical percentage moisture in different organs of unprotected plants.
 1927-28.

Date.	LEAVES.		Young flowerbuds.	Flowers.	Young Bolls.
	Young.	Developed.			
5th September	80·75	..	..	..	..
15th September	77·67	80·2	..	..	..
27th September	80·18	79·14	..	..	..
13th October	78·40	76·1	..	..	..
28th October	78·32	79·1	64·23	..	..
14th November	80·14	79·7	77·82	..	..
28th November	71·18	74·38	83·20	..	..
12th December	73·45	76·12	81·47	83·07	..
26th December	73·12	76·5	79·06	81·60	69·80
9th January	71·37	72·62	76·53	77·10	76·79
23rd January	71·16	74·52	75·39	79·47	76·26
6th February	70·80	68·99	74·26	78·16	74·88

TABLE No. 110.

Periodical percentage moisture in different organs of unprotected plants.
1928-29.

Period ending	Stem & branches.	Leaves on the plant.	Flowerbuds.	Flowers.	Bolls. (growing).
27th August	81.53	82.77	..	..	..
10th September	80.61	81.06	..	..	..
24th September	79.02	78.23	..	..	..
8th October	73.47	77.67	..	..	..
22nd October	72.10	78.20	71.74	..	..
5th November	66.97	75.95	75.82	..	..
19th November	66.10	76.14	77.38	77.13	81.24
3rd December	62.16	74.40	75.19	75.19	79.00
17th December	60.30	71.21	76.04	77.73	77.55
31st December	67.14	66.52	74.44	70.00	79.78
14th January	65.21	69.20	75.00	75.00	78.95
28th January	55.43	69.05	76.92	75.00	80.85
11th February	64.25	68.26	..	..	83.92
25th February	61.59	58.04	..	..	70.55

TABLE No. 111.

Periodical percentage moisture in different organs of unprotected plants.
1929-30.

Period ending	Stem & branches.	Leaves on the plant.	Flowerbuds.	Flowers.	Bolls. (growing).
2nd September	80.31	76.82	..	..	..
16th September	81.46	79.47	..	..	..
30th September	77.74	78.75	..	..	..
14th October	78.95	78.01	71.64	..	..
28th October	68.95	75.75	76.32	..	..
11th November	73.90	No figure.	76.78	..	..
25th November	61.79	71.82	74.54	82.50	..
9th December	61.54	71.84	75.59	80.00	85.00
23rd December	57.40	68.40	No figure.	No figure.	80.19
6th January	62.17	71.29	70.66	81.25	80.00
20th January	54.16	67.79	..	80.00	81.96
3rd February	41.85	64.34	..	..	80.00
17th February	51.94	64.11	..	..	..
3rd March	50.99	64.04	..	..	..

TABLE No. 112.

Periodical percentage moisture in different organs of unprotected plants.
1930-31.

Period ending	Stem & branches.	Leaves on the plant.	Flowerbuds.	Flowers.	Bolls. (growing).
1st October	67.54	82.55	..	..	..
15th October	75.98	80.51	77.12	..	..
29th October	72.34	82.62	74.44	..	..
12th November	69.55	75.13	70.79	..	..
26th November	65.94	74.56	74.59	..	80.00
11th December	71.10	73.56	76.56	79.73	..
24th December	76.12	76.85	80.73	86.55	85.74
7th January	65.49	73.02	78.76	..	87.39
21st January	56.72	71.00	..	..	87.24
4th February	65.50	68.23	..	..	75.01
18th February	66.14	68.63	..	..	72.06
3rd March	54.29	66.12	..	..	..
17th March	50.43	67.12	..	..	..

TABLE No. 113.

Periodical percentage moisture in different organs of unprotected plants.
1931-32.

Period ending	Stem & branches.	Leaves on the plant.	Flowerbuds.	Flowers.	Bolls. (growing).
18th September	77.82	79.66	..	..	..
25th September	79.18	78.92	..	..	..
1st October	79.43	78.43	..	..	..
8th October	77.98	79.22	..	..	..
29th October	74.86	76.69	..	..	..
12th November	75.89	77.18	75.39	..	..
26th November	72.34	78.47	76.55	74.29	59.01
10th December	71.17	75.13	76.82	76.27	75.39
24th December	69.53	76.58	79.03	81.25	84.69
7th January	73.35	75.44	77.78	77.84	84.00
21st January	71.79	75.02	77.68	77.24	87.53
4th February	58.16	74.38	77.95	89.73	81.60
18th February	57.67	72.39	..	..	82.58
3rd March	62.71	72.41	..	..	..
17th March	53.49	68.42	..	..	..

TABLE NO. 114.

Dry matter in grammes in the different organs of the cotton plant. (Unprotected.)

1927-28.

(Average of 3 to 4 plants.)

Date.	Roots.	Stem and branches	Green leaves.	Flower-buds.	Flowers.	Bolls.	Shed leaves.	Shed buds.	Shed bolls.	Total.
5th September ..	0.33	0.73	1.91	..	..	..	..	..	..	2.97
15th September ..	1.43	3.61	7.00	..	..	..	..	..	..	12.04
27th September ..	1.85	5.08	8.06	..	..	..	..	..	..	14.99
24th October ..	16.77	37.35	43.58	..	..	..	..	..	..	97.70
7th November ..	17.56	35.63	45.50	0.48	..	..	..	..	..	99.17
21st November ..	25.63	48.98	56.10	2.18	0.08	..	..	..	..	132.97
5th December ..	45.33	69.10	80.10	6.48	0.81	0.76	..	..	..	202.58
19th December ..	45.52	67.00	59.30	4.98	1.23	3.09	..	..	..	181.12
2nd January ..	61.60	89.46	72.16	7.33	2.42	18.76	..	..	..	251.73
16th January ..	62.53	77.33	68.33	4.36	2.37	40.86	..	..	..	255.78
30th January ..	60.66	72.33	56.20	0.99	0.83	74.10	..	..	..	265.11
13th February ..	54.16	82.86	30.45	..	..	75.20	..	..	..	242.67

TABLE No. 115.

Dry matter in grammes in the different organs of the cotton plant. (Unprotected.)

1928-29.

(Average of 3 to 4 plants.)

Date.	Roots.	Stem and branches.	Green leaves.	Flower-buds.	Flowers.	Bolls.	Shed leaves.	Shed buds.	Shed bolls.	Total.
27th August	0.5800	0.3150	1.9000	..	..	..	..	..	..	2.7950
10th September ..	1.0992	0.8112	3.6025	..	..	..	..	..	..	5.5129
24th September ..	3.9890	4.6020	13.7275	..	..	..	..	..	..	22.3185
8th October	8.1030	11.3050	24.4450	..	..	..	..	..	..	43.8530
22nd October	11.9660	16.2590	28.5850	0.4165	..	..	..	..	..	57.2265
5th November .. .	25.7225	40.6000	49.1900	1.6950	..	..	0.7505	0.6200	..	118.5780
19th November .. .	33.0200	46.8900	52.0700	4.0930	0.5433	0.7200	2.7780	1.1267	..	141.2410
3rd December .. .	36.7500	57.5500	55.8560	2.0806	0.2500	2.5500	3.8000	0.7500	1.1250	160.7116
17th December .. .	47.6250	58.1250	54.9750	2.8750	1.1250	5.5000	7.7500	2.0000	2.7500	182.7250
31st December .. .	61.8333	60.5000	72.4730	3.8333	0.5000	10.1666	14.4670	4.0000	4.6670	232.4403
14th January .. .	48.0000	45.3333	41.0160	1.1670	0.1833	33.3333	7.0000	2.0000	2.6670	180.6996
28th January .. .	74.5000	77.8333	48.7500	1.0000	0.8333	49.6667	10.0000	5.0000	5.0000	272.5833
11th February .. .	45.3300	73.3333	40.7300	..	..	43.3333	15.0000	5.0000	5.5000	228.2266
25th February .. .	54.0000	48.0000	20.7000	..	..	46.0000	18.6670	3.3330	5.5000	196.2003

TABLE No. 116.

Dry matter in grammes in the different organs of the cotton plant. (Unprotected.)

1929-30.

(Average of 4 to 6 plants.)

Date.	Roots.	Stem and branches.	Green leaves.	Flower-buds.	Flowers.	Bolls.	Shed leaves.	Shed buds.	Shed bolls.	Total dry weight of the whole plant.
2nd September ..	0.62	0.595	2.91	..	..	..	..	..	..	4.125
16th September ..	1.00	1.545	6.19	..	..	..	..	..	..	8.735
30th September ..	3.38	5.090	14.38	..	..	..	..	..	..	22.850
14th October ..	5.45	8.710	19.90	0.307	..	..	3.57	..	..	37.937
28th October ..	7.48	12.830	19.97	0.750	..	..	7.50	0.28	..	48.813
11th November ..	11.50	15.833	33.75	1.300	..	..	8.33	1.42	..	72.130
25th November ..	21.00	30.500	37.83	2.750	0.117	0.167	11.00	2.17	0.67	106.203
9th December ..	25.20	33.500	37.20	3.100	0.060	1.200	11.40	2.50	1.80	115.960
23rd December ..	38.50	39.400	43.70	4.600	..	7.600	12.00	3.10	3.30	152.200
6th January ..	41.63	41.800	43.50	2.700	0.300	27.200	16.00	3.50	7.75	184.380
20th January ..	41.50	44.167	34.83	0.410	0.033	29.167	22.50	3.00	9.00	184.609
3rd February ..	45.00	42.900	32.40	..	..	43.400	32.20	4.00	10.40	210.300
17th February ..	37.00	38.333	13.83	..	..	49.000	36.17	3.89	10.00	188.223
3rd March ..	31.75	35.000	11.00	..	..	42.750	34.99	1.50	5.83	162.820

TABLE No. 117.
Dry matter in grammes in the different organs of the cotton plant. (Unprotected.)
 1930-31.
 (Average of 4 to 6 plants.)

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Date.	Roots.	Stem and branches.	Green leaves.	Flower-buds.	Flowers.	Bolls.	Shed leaves.	Shed buds.	Shed bolls.	Total dry matter per plant.
3rd September	0.404	0.216	1.190	..	..	..	..	..	..	1.810
10th September .. .	0.550	0.275	1.275	..	..	..	..	..	..	2.100
17th September .. .				Fields unapproachable due to heavy rains.						
24th September .. .	1.400	1.244	4.800	..	..	..	..	..	..	7.444
1st October	2.084	3.252	8.920	..	..	..	..	..	..	14.256
15th October	4.900	6.100	13.000	0.291	..	..	1.400	0.058	..	25.749
29th October	6.800	12.200	17.400	0.408	..	..	3.000	0.200	..	39.808
12th November .. .	8.000	16.900	26.600	0.170	..	..	3.000	0.200	0.140	55.010
26th November .. .	16.000	23.400	31.600	1.200	..	0.180	4.400	0.200	0.200	77.180
10th December .. .	25.600	22.250	36.250	4.500	0.150	..	7.500	0.125	3.750	100.125
24th December .. .	24.000	20.400	35.000	4.400	0.400	4.000	9.500	0.200	4.000	101.900
7th January	24.250	32.800	39.400	2.200	0.160	13.440	9.000	1.200	4.800	127.250
21st January	30.000	41.200	34.400	..	..	25.400	16.000	1.200	10.000	158.200
4th February	24.000	33.250	29.500	..	..	75.500	26.250	1.500	14.250	204.250
18th February	28.250	29.500	23.250	..	..	72.500	25.500	0.500	11.750	191.250
4th March	28.750	36.667	13.666	..	..	72.833	35.333	0.667	13.000	200.917
18th March	26.250	41.250	11.500	..	..	66.250	28.000	1.000	12.000	186.250

TABLE No. 118.

Dry matter in grammes in the different organs of the cotton plant. (Unprotected.)

1931-32.

Date.	Roots.	Stem and branches.	Green leaves.	Flower-buds.	Flowers.	Bolls.	Shed leaves.	Shed buds.	Shed bolls.	Total weight per plant.
18th September ..	0.667	0.452	2.284	..	..	..	..	..	..	3.403
25th September ..	1.000	0.722	3.445	..	..	..	..	..	..	5.167
1st October	1.058	1.039	4.046	..	..	..	..	..	..	6.143
8th October	2.487	2.867	9.000	..	..	..	..	..	..	14.354
29th October	4.750	7.333	15.000	..	..	..	2.500	..	..	29.583
12th November ..	7.500	10.666	21.166	0.286	..	..	3.000	..	..	42.618
26th November ..	14.600	22.800	33.900	1.000	0.035	0.200	5.200	0.600	..	78.335
10th December ..	19.000	26.800	45.600	3.200	0.440	0.600	6.800	0.400	0.160	103.000
23rd December ..	21.250	27.750	42.250	4.750	1.250	2.500	6.750	0.750	1.750	109.000
6th January	26.750	27.500	48.250	5.500	1.000	12.125	11.750	1.000	3.500	137.375
20th January	25.125	26.750	42.250	2.750	1.250	25.000	12.500	1.000	6.750	143.375
3rd February	26.000	35.500	38.000	0.500	0.200	50.000	13.500	..	15.000	178.700
17th February	28.000	32.500	31.000	..	..	47.250	17.500	..	10.000	166.250
2nd March	29.750	28.000	20.333	..	..	85.000	27.000	1.000	9.000	200.083
16th March	27.667	40.000	15.000	..	..	72.500	35.000	..	12.000	202.167

TABLE NO. 119.

Ash percentage in the different organs of the cotton plant. (Unprotected.)

1929-30.

Date.	Roots.	Stem and branches.	Green leaves.	Flower-buds.	Flowers.	Bolls.	Shed leaves.	Shed buds.	Shed bolls.
2nd September	..	..	..	..	..	..	..	..	..
16th September	..	..	..	..	..	..	..	..	..
30th September	7.610	7.960	9.195	..	..	..	..	..	..
14th October	7.050	7.150	12.600	..	..	..	16.05	..	..
28th October	6.870	7.110	15.370	..	..	..	14.50	..	..
11th November	5.601	6.151	16.440	11.75	..	..	15.90	12.78	..
25th November	5.150	6.650	17.400	11.65	..	..	17.20	13.00	11.65
9th December	4.900	6.050	17.750	11.26	..	12.40	17.75	12.75	11.15
23rd December	4.240	4.625	16.200	11.55	..	7.40	17.60	12.57	11.12
6th January	4.550	6.800	18.650	12.15	..	7.40	17.50	12.65	10.65
20th January	4.100	5.400	18.240	11.50	..	5.75	18.95	12.40	10.45
3rd February	4.170	6.250	19.100	..	..	5.45	19.55	13.30	11.00
17th February	5.350	6.800	20.300	..	..	5.28	20.15	12.65	10.35
3rd March	..	..	..	..	..	..	..	..	..

TABLE No. 120.
Ash percentage in the different organs of the cotton plant. (Unprotected.)
 1930-31.

Date.	Roots.	Stem and branches.	Green leaves.	Flower-buds.	Flowers.	Bolls.	Shed leaves.	Shed buds.	Shed bolls.
3rd September .. ..	..	..	..	..	..	..	..	..	..
10th September .. ..	..	..	11.45	..	..	..	..	..	..
17th September .. ..	..	..	..	Fields unapproachable due to heavy rains.					
24th September	10.50	9.80	12.40	..	..	..	..	..	..
1st October	8.30	10.35	16.65	..	..	..	..	..	..
15th October	5.64	7.77	18.13	..	..	..	19.20	..	..
29th October	6.33	7.55	18.55	11.90	..	..	19.30	..	..
12th November	6.25	7.71	16.00	..	..	..	22.15	..	..
26th November	7.07	6.64	17.25	12.25	..	..	18.72	..	..
10th December	5.89	6.90	17.85	13.05	..	..	20.57	13.96	10.60
24th December	5.51	5.97	17.90	12.41	12.10	14.45	21.73	..	12.45
7th January	6.15	6.70	19.72	12.60	..	11.40	20.75	13.05	10.11
21st January	5.50	5.80	20.65	..	..	7.40	20.70	12.87	12.15
4th February	5.30	5.65	20.50	..	..	7.50	21.40	12.95	13.00
18th February	5.20	6.80	22.30	..	..	8.45	21.60	13.30	13.45
4th March	5.95	6.35	22.75	..	..	7.15	21.70	12.73	13.00
11th March	6.05	6.45	22.50	..	..	7.30	22.50	12.40	12.85

TABLE NO. 121.

Ash percentage in the different organs of the cotton plant. (Unprotected.)

1931-32.

Date.	Roots.	Stem and branches.	Green leaves.	Flower-buds.	Flowers.	Bolls.	Shed leaves.	Shed buds.	Shed bolls.
18th September	8.50	9.86	16.40	..	..	..	..	..	..
25th September	7.80	10.40	17.00	..	..	..	..	..	..
1st October	9.00	12.15	18.80	..	..	..	..	..	..
8th October	7.60	9.95	15.45	..	..	..	..	..	..
29th October	7.95	10.00	15.55	..	..	..	25.75	..	..
12th November	7.40	8.55	16.60	12.80	..	..	20.75	..	..
26th November	6.55	6.60	17.95	13.80	..	..	21.60	13.40	..
10th December	6.60	7.55	17.35	13.60	..	..	20.50	..	..
23rd December	6.00	7.05	18.30	14.50	13.45	13.05	20.65	..	10.90
6th January	6.45	6.60	19.30	13.30	13.20	9.55	21.30	13.70	10.30
20th January	6.20	7.45	21.40	13.10	..	9.00	22.20	..	12.70
3rd February	6.30	5.75	21.15	12.40	..	5.60	22.05	..	12.15
17th February	6.55	6.25	21.45	..	..	8.25	21.30	..	13.15
2nd March	5.80	7.15	22.70	..	..	6.75	22.20	..	11.20
16th March	6.75	6.50	22.35	..	..	7.40	22.60	..	14.30

TABLE NO. 122.
Total ash in grammes in the different organs of the cotton plant. (Unprotected.)
 1929-30.

Date.	Roots.	Stem and branches.	Green leaves.	Flower-buds.	Flowers.	Bolls.	Shed leaves.	Shed buds.	Shed bolls.	Total in the whole plant.
30th September ..	0·1928	0·6227	1·3222	..	..	..	..	..	..	2·4104
14th October	0·3842	0·6228	2·5074	..	..	..	0·5729	..	..	3·0873
28th October	0·5141	0·9122	3·0694	..	..	..	1·0875	..	..	5·5832
11th November	0·6440	0·9736	5·5500	0·1528	..	..	1·3240	0·1815	..	8·8259
25th November	1·0810	2·0280	6·5820	0·3204	..	..	1·8920	0·2821	0·0781	12·2636
9th December	1·2350	2·0270	6·6030	0·3490	..	0·1488	2·0230	0·3187	0·2004	12·9049
23rd December	1·6320	1·821	7·079	0·5314	..	0·5623	2·1120	0·3896	0·3669	14·4942
6th January	1·8940	2·843	8·114	0·3280	..	1·992	2·800	0·4426	0·8254	19·2390
20th January	1·7010	2·385	6·353	0·0459	..	1·677	4·265	0·3720	0·9405	17·7394
3rd February	1·878	2·681	6·187	..	..	2·365	6·295	0·5321	1·1440	21·0821
17th February	1·980	2·606	2·808	..	..	..	7·285	0·4920	1·0350	..

TABLE No. 123.

Total ash in grammes in the different organs of the cotton plant. (Unprotected.)
1930-31.

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Date.	Roots.	Stem and branches.	Green leaves.	Flower-buds.	Flowers.	Bolls.	Shed leaves.	Shed buds.	Shed bolls.	Total ash in the whole plant.	Rate of mineral intake.
15th October	0.2767	0.4740	2.3570	..	..	..	0.2687	..	..	3.3761	..
29th October	0.4178	0.9212	3.2280	0.0486	..	..	0.5790	..	..	5.1946	1.8185
12th November	0.5000	1.3020	4.2560	..	..	..	0.6645	..	..	6.7225	1.5279
26th November	1.1310	1.5530	5.4500	0.1470	..	..	0.8237	..	..	9.1047	2.3822
10th December	1.5080	1.5360	6.4710	0.5870	..	..	1.5430	0.0175	0.3975	12.0600	2.9553
24th December	1.3220	1.2180	6.2660	0.5461	0.0484	0.5776	2.0640	..	0.4979	12.5400	0.4800
7th January	1.4910	2.1980	7.7690	0.2772	..	1.5320	1.8670	0.1566	0.4852	15.7760	3.2360
21st January	1.6500	2.3900	8.0060	..	..	1.8790	3.3120	0.1545	1.2140	18.6055	2.8295
4th February	1.2720	1.8780	6.0470	..	..	5.6620	5.6160	0.1943	1.8520	22.5213	3.9158
18th February	1.4690	2.0050	5.1840	..	..	6.1280	5.5080	0.0665	1.5810	21.9415	..
4th March	1.7160	2.3290	3.1110	..	..	5.2070	7.6680	0.0849	1.6900	21.8009	..
11th March	1.5880	2.1180	2.5870	..	..	4.8370	6.3018	0.1240	1.5420	19.0970	..

TABLE No. 124.

Total ash in grammes in the different organs of the cotton plant. (Unprotected.)

1931-32.

Date.	Roots.	Stem and branches.	Green leaves.	Flower-buds.	Flowers.	Bolls.	Shed leaves.	Shed buds.	Shed bolls.	Total.
18th September ..	0·0567	0·0446	0·3746	..	..	..	..	..	..	0·4759
25th September ..	0·0780	0·0750	0·5856	..	..	..	..	..	..	0·7386
1st October	0·0952	0·1252	0·7606	..	..	..	..	..	..	0·9810
8th October	0·1890	0·2853	1·3885	..	..	..	..	..	..	1·8628
29th October	0·3776	0·7333	2·3325	..	..	..	0·6437	..	..	4·0871
12th November ..	0·5550	0·9120	3·5137	0·3661	..	..	0·6215	..	..	5·9683
26th November ..	0·9563	1·5048	6·0850	0·1380	..	..	1·1232	0·0804	..	9·8877
10th December ..	1·2540	2·0234	7·9116	0·4352	..	..	1·3940	..	..	13·0182
23rd December ..	1·2750	1·9564	7·7317	0·6887	0·1681	0·3262	1·3939	..	0·1907	13·7307
6th January	1·7254	1·8150	9·3122	0·7315	0·0130	1·1579	2·5027	0·1370	0·3605	17·7552
20th January	1·5577	1·9929	9·0415	0·3602	..	2·5500	2·7750	..	0·7572	19·0345
3rd February	1·6380	2·0412	8·0370	0·0620	..	2·8000	2·9767	..	1·8225	19·3774
17th February	1·8340	2·0312	6·6495	..	..	3·8981	3·7275	..	1·3150	19·4553
2nd March	1·7255	2·0020	4·6156	..	..	5·7375	5·9940	..	1·0080	21·0826
16th March	1·8675	2·6000	3·3525	..	..	5·3650	7·9100	..	1·7160	22·8110

TABLE No. 125.

Percentage mineral composition of dry matter in the different organs of the cotton plant grown under spotted boll-worm conditions.

1930-31.

Components.	Phase of growth.	
	Appearance of flower buds.	Maturation of bolls.
Roots.		
Ash	7.21	4.63
P ₂ O ₅	0.8292	.....
Lime	0.5550	1.2250
K ₂ O	3.3742	0.4921
STEM AND BRANCHES.		
Ash	10.23	6.15
P ₂ O ₅	0.8611	.....
Lime	1.3100	2.0100
K ₂ O	3.7112	1.2930
LEAVES.		
Ash	15.33	22.05
P ₂ O ₅	1.026	.....
Lime	4.3700	7.4500
K ₂ O	4.1258	4.7457
BOLLS.		
Ash .. .. .	.....	6.25
P ₂ O ₅ .. .. .	.....	.....
Lime .. .. .	.....	0.9600
K ₂ O .. .. .	.....	1.5730
SHED LEAVES.		
Ash .. .. .	.....	17.5000
P ₂ O ₅ .. .. .	.....	.....
Lime .. .. .	.....	6.4550
K ₂ O .. .. .	.....	5.0362
SHED BUDS.		
Ash .. .. .	.....	15.5750
P ₂ O ₅ .. .. .	.....	.....
Lime .. .. .	.....	.....
K ₂ O .. .. .	.....	.....
SHED BOLLS.		
Ash .. .. .	.....	17.2550
P ₂ O ₅ .. .. .	.....	.....
Lime .. .. .	.....	2.8600
K ₂ O .. .. .	.....	1.2740

TABLE No. 126.

Percentage mineral composition of dry matter in the different organs of the cotton plant grown under spotted boll-worm conditions.

1931-32.

Components.	Phase of plant growth.			
	Appearance of flower-buds.	Appearance of flowers.	End of flowering.	Maturation of bolls.
ROOTS.				
Ash	8.56	6.61	5.50	5.50
P ₂ O ₅	0.9792	0.7176	0.4338	0.4976
Lime	0.5100	2.0777	1.8000	2.1600
K ₂ O	3.1767	5.0909	..	1.7046
STEM AND BRANCHES.				
Ash	12.2000	7.65	7.10	6.00
P ₂ O ₅	0.8197	0.9409	0.6379	0.4018
Lime	1.2500	2.1000	2.8800	1.9200
K ₂ O	3.5199	3.8934	..	2.3244
LEAVES.				
Ash	17.59	17.90	21.05	22.79
P ₂ O ₅	1.1036	1.4799	1.2185	0.6251
Lime	3.8900	11.3000	8.4000	8.5600
K ₂ O	3.2348	3.2542	..	5.1137
FLOWER BUDS.				
Ash .. .. .	..	14.04	13.08	..
P ₂ O ₅ .. .. .	..	1.6713	1.4225	..
Lime .. .. .	..	1.8000	5.0000	..
K ₂ O .. .. .	..	2.6149	..	..

TABLE No. 128—(contd.)

Percentage mineral composition of dry matter in different organs of the cotton plant grown under spotted boll-worm conditions.

1931-32.

Components.	Phase of plant growth.			
	Appearance of flower-buds	Appearance of flowers.	End of flowering.	Maturation of bolls.
FLOWERS.				
Ash	13.90	12.20	..
P ₂ O ₅	1.8509	1.9720	..
Lime	4.5778	4.5333	..
K ₂ O	4.7355	..	..
BOLLS.				
Ash	14.80	9.05	7.70
P ₂ O ₅	1.8381	1.2694	0.9122
Lime	2.6000	3.0000	1.4800
K ₂ O	3.5835	..	4.0908
SHED LEAVES.				
Ash	20.82	21.90	22.46
P ₂ O ₅	1.1929	1.3332	1.1865
Lime	2.8000	10.3000	9.1000
K ₂ O	2.3244	..	4.8036
SHED BOLLS.				
Ash	11.10	14.18
P ₂ O ₅	1.1036	1.0398
Lime	3.0000	3.4800
K ₂ O	3.2500	..

TABLE NO. 127.

Percentage nitrogen in the different organs of the cotton plant. (Unprotected.)

1928-29.

Date.	Roots.	Stem and branches.	Green leaves.	Flower-buds.	Flowers.	Bolls.	Shed leaves.	Shed buds.	Shed bolls.
27th August	1.2000	1.7500	3.3900	..	..	..	..	..	..
10th September	1.0700	1.7580	3.4000	..	..	..	..	..	..
24th September	0.8736	1.3940	3.0180	..	..	..	..	..	..
8th October	0.5843	0.7759	2.8600	..	..	..	..	..	..
22nd October	0.5461	0.6993	2.5430	3.1720	..	..	..	..	..
5th November	0.4742	0.6275	2.4710	2.7870	..	..	1.3857	0.5806	..
19th November	0.3783	0.5127	2.1550	2.6150	2.2620	2.2710	1.2635	2.0236	..
3rd December	0.3877	0.4627	2.0260	2.5860	2.1170	2.1260	1.1211	1.6267	2.0089
17th December	0.3263	0.4024	1.9590	2.4960	2.0650	1.5160	1.1394	2.1450	1.5745
31st December	0.3309	0.3980	1.7040	2.3610	2.0650	1.4620	1.2615	2.1475	1.7720
14th January	0.3355	0.3936	1.6500	2.3200	2.0520	1.4350	1.2614	2.0100	1.5298
28th January	0.2773	0.3667	1.5430	2.1870	2.1190	1.2470	1.1000	1.8920	1.5160
11th February	0.3242	0.3774	1.5100	..	..	1.2420	1.2727	2.1340	1.8490
25th February	0.2936	0.3271	1.6230	..	..	1.4030	1.0441	2.0762	1.5345

TABLE No. 128.

Percentage nitrogen in the different organs of the cotton plant. (Unprotected.)
1929-30.

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Date.	Roots.	Stem and branches.	Green leaves.	Flower-buds.	Flowers.	Bolls.	Shed leaves.	Shed buds.	Shed bolls.
2nd September	1.1490	1.7080	3.932	..	..	..	..	..	..
16th September	1.3170	1.5030	3.840	..	..	..	..	..	..
30th September	0.9069	1.2580	3.297	..	..	..	..	..	..
14th October	0.5895	0.8872	3.522	3.416	..	..	2.370	..	..
28th October	0.7018	0.7877	2.922	3.380	..	..	2.556	2.591	..
11th November	0.5892	0.6553	2.806	3.641	..	..	2.582	2.980	..
25th November	0.4850	0.5590	2.465	3.031	2.551	2.291	2.384	2.789	1.913
9th December	0.5052	0.7679	2.533	2.977	2.522	2.755	2.169	2.735	2.020
23rd December	0.4445	0.5389	2.020	3.772	..	2.748	2.034	2.640	1.926
6th January	0.4581	0.4917	1.954	2.748	2.572	1.733	1.980	2.775	1.926
20th January	0.4054	0.4380	1.726	2.406	..	1.707	1.582	2.564	1.922
3rd February	0.3596	0.4250	1.805	..	..	1.381	1.608	2.745	1.792
17th February	0.2806	0.4119	1.635	..	..	1.495	1.464	2.602	1.740
3rd March	0.3922	0.446	1.478	..	..	1.229	1.438	2.328	1.740

TABLE NO. 129.
Percentage nitrogen in the different organs of the unprotected plants.
 1930-31.

Date.	Roots.	Stem and branches.	Green leaves.	Flower-buds.	Flowers.	Bolls.	Shed leaves.	Shed buds.	Shed bolls.
3rd September .. ..	..	..	..	..	..	..	..	..	..
10th September	1.255	1.355	3.186	..	..	..	..	..	..
17th September .. ..	..	..	Field inaccessible.		..	..	..	..	..
24th September	1.069	1.412	3.565	..	..	..	..	..	..
1st October	0.687	1.086	3.354	..	..	..	..	..	..
15th October	0.795	0.872	3.292	3.463	..	..	1.908	3.034	..
29th October	0.569	0.701	3.470	3.489	..	..	1.972	2.943	..
12th November	0.632	0.667	3.082	3.505	..	..	2.291	2.679	1.933
26th November	0.631	0.646	2.966	3.540	..	2.077	1.869	2.872	2.322
10th December	0.491	0.669	2.765	3.132	2.713	..	1.932	2.918	1.977
24th December	0.434	0.562	2.560	3.334	2.662	2.865	1.885	..	1.855
7th January	0.510	0.479	2.220	2.968	..	2.628	1.628	2.451	1.840
21st January	0.402	0.432	1.912	..	..	1.472	1.533	2.408	1.730
4th February	0.325	0.400	1.396	..	..	1.155	1.359	2.307	1.820
18th February	0.395	0.470	1.850	..	..	1.153	1.289	2.488	1.689
4th March	0.371	0.378	1.595	..	..	1.275	1.214	..	1.601
18th March	0.448	0.418	1.564	..	..	1.220	1.191	2.201	1.641

TABLE No. 130.

Percentage nitrogen in the different organs of the cotton plant in grammes. (Unprotected.)

1931-32.

Date.	Roots.	Stem and branches.	Green leaves.	Flower-buds.	Flowers.	Bolls.	Shed leaves.	Shed buds.	Shed bolls.
18th September	0.9286	1.1819	3.0926	..	..	..	..	..	..
25th September	0.9694	1.2480	2.9503	..	..	..	..	..	..
1st October	0.6641	1.1284	2.8942	..	..	..	..	..	..
8th October	0.6374	1.2072	3.1995	..	..	..	..	..	..
29th October	0.6776	0.9600	2.9745	..	..	..	1.6757	..	..
12th November	0.7150	0.8173	2.8691	3.3694	..	..	1.5329	..	..
26th November	0.5999	0.6629	2.9334	2.8305	..	2.8742	1.7116	3.2536	..
10th December	0.5279	0.6237	2.7417	3.3179	..	..	1.6216	..	2.1270
23rd December	0.5022	0.5761	2.8819	3.2150	2.6903	2.6498	1.5445	2.7803	2.0749
6th January	0.4672	0.5456	2.4592	3.1770	2.7666	2.1011	1.5631	2.5360	2.0872
20th January	0.4588	0.5187	2.2932	2.5867	2.5924	1.9466	1.4478	..	2.0642
3rd February	0.4035	0.4165	2.1902	2.2056	2.4085	1.4924	1.2419	..	1.8321
17th February	0.4257	0.4419	1.9474	..	..	1.2550	1.1266	..	1.6907
2nd March	0.4457	0.5303	1.9274	..	..	1.9720	1.0867	..	1.6982
16th March	0.4327	0.4849	1.8890	..	..	1.2627	1.0667	..	1.6876

TABLE NO. 131.

Dry matter and nitrogen content of developing bolls in grammes. (Without bracts.)

(From the flower stage to maturity.)

1928-29.

Date.	Average of bolls.	Per cent moisture.	Dry matter per boll.	Total nitrogen per boll.	Per cent. nitrogen.
15th December ..	24	75.23	0.0217	0.0007	3.178
17th December ..	11	79.40	0.0273	0.0012	4.407
19th December ..	12	81.96	0.0383	0.0015	3.967
21st December ..	12	80.86	0.0633	0.0021	3.252
23rd December ..	10	81.78	0.0900	0.0028	3.113
25th December ..	12	80.24	0.1383	0.0033	2.389
27th December ..	8	83.88	0.1441	0.0037	2.595
29th December ..	9	81.30	0.2900	0.0051	1.776
31st December ..	5	81.21	0.4080	0.0071	1.716
2nd January ..	5	81.55	0.4740	0.0081	1.715
4th January ..	6	77.97	0.9517	0.0143	1.503
6th January ..	5	81.65	0.7840	0.0113	1.409
8th January ..	7	84.45	0.8890	0.0151	1.696
10th January ..	6	83.99	1.1407	0.0185	1.624
12th January ..	6	79.92	1.7290	0.0247	1.429
14th January ..	5	..	1.7600	..	..
16th January ..	5	84.82	1.5200	..	..
19th January ..	5	79.01	2.0400	..	..
21st January ..	5	79.00	2.1000	..	..
23rd January ..	5	78.35	2.0000	..	..
25th January ..	6	80.92	2.2000	0.0292	1.327
28th January ..	7	76.31	2.2571	..	..
1st February ..	8	..	..	..	..
4th February ..	10	69.27	2.7200	0.0349	1.283
6th February ..	9	..	..	..	..
9th February ..	9	..	..	..	..
11th February ..	8	..	..	..	..
14th February ..	7	65.07	3.428	0.0444	1.295
16th February ..	7	67.26	2.900	0.0392	..

TABLE No. 132.

Total nitrogen in grammes in the different organs of the cotton plant. (Unprotected.)

1928-29.

Date.	Roots.	Stem and branches.	Green leaves.	Flower-buds.	Flowers.	Bolls.	Shed leaves.	Shed buds.	Shed bolls.	Total.
27th August	0.0069	0.0055	0.0644	..	..	..	..	..	..	0.0768
10th September ..	0.0118	0.0142	0.1229	..	..	..	..	..	..	0.1489
24th September ..	0.0349	0.0509	0.4204	..	..	..	..	..	..	0.5062
8th October	0.0474	0.0878	0.6992	..	..	..	..	..	..	0.8344
22nd October	0.0654	0.1137	0.7971	0.0130	..	..	..	..	..	0.9892
5th November	0.1219	0.2548	1.2150	0.0471	..	..	0.0104	0.0036	..	1.6528
19th November ..	0.1249	0.2402	1.1220	0.1070	0.0125	0.0164	0.0351	0.0228	..	1.6809
3rd December	0.1426	0.2678	1.1320	0.0538	0.0053	0.0543	0.0426	0.0122	0.0226	1.7332
17th December	0.1554	0.2340	1.0760	0.0719	0.0232	0.0834	0.0883	0.0429	0.0453	1.8174
31st December	0.2046	0.2408	1.2340	0.0904	0.0103	0.1487	0.1825	0.0859	0.0827	2.2779
14th January	0.1610	0.1784	0.6769	0.0271	0.0038	0.4785	0.0883	0.0402	0.0408	1.6950
28th January	0.2067	0.2854	0.7519	0.0219	0.0176	0.6197	0.1100	0.0946	0.0758	2.0836
11th February	0.1446	0.2768	0.6149	..	..	0.5406	0.1909	0.1067	0.1017	1.9762
25th February	0.1585	0.1570	0.3359	..	..	0.6454	0.1949	0.0692	0.0844	1.6453

TABLE NO. 133.

Total nitrogen in grammes in the different organs of the cotton plant. (Unprotected.)

1929-30.

Date.	Roots.	Stem and branches.	Green leaves.	Flower-buds.	Flowers.	Bolls.	Shed leaves.	Shed buds.	Shed bolls.	Total nitrogen in the whole plant.
2nd September ..	0.0071	0.0102	0.1144	..	..	..	..	..	..	0.1317
16th September ..	0.0482	0.0232	0.2377	..	..	..	..	..	..	0.3091
30th September ..	0.0307	0.0640	0.4747	..	..	..	..	..	..	0.5694
14th October ..	0.0321	0.0773	0.7001	0.0105	..	..	0.0846	0.0015	..	0.9016
28th October ..	0.0525	0.1010	0.5977	0.0254	..	..	0.1917	0.0059	..	0.9742
11th November ..	0.0678	0.1069	0.9471	0.0473	..	..	0.2143	0.0423	..	1.4256
25th November ..	0.1018	0.1705	0.9226	0.0834	0.0033	0.0038	0.2323	0.0605	0.0128	1.6010
9th December ..	0.1273	0.2572	0.9421	0.0923	0.0015	0.0331	0.2473	0.0684	0.0364	1.8056
23rd December ..	0.1712	0.2123	0.8790	0.1736	..	0.2088	0.2441	0.0819	0.0636	2.0345
6th January ..	0.1907	0.2055	0.8116	0.0742	0.0077	0.4709	0.3168	0.0972	0.1493	2.3209
20th January ..	0.1682	0.1935	0.6013	0.0099	..	0.4958	0.3560	0.0769	0.1730	2.1036
3rd February ..	0.1618	0.1824	0.5846	..	..	0.5994	0.5180	0.1098	0.1863	2.3423
17th February ..	0.1040	0.1579	0.2190	..	..	0.7323	0.5295	0.1013	0.2404	2.0844
3rd March ..	0.1246	0.1556	0.1622	..	..	0.5255	0.5032	0.0349	0.1014	1.6074

TABLE NO. 134.
Total nitrogen in grammes in the different organs of the cotton plant. (Unprotected.)
 1930-31.

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Date.	Roots.	Stem and branches.	Green leaves.	Flower-buds.	Flowers.	Bolls.	Shed leaves.	Shed buds.	Shed bolls.	Total per plant.
3rd September ..	..	..	..	..	..	..	..	..	..	..
10th September ..	0-0069	0-0037	0-0406	..	..	..	..	..	..	0-0512
17th September ..			Fields unapproachable due to heavy rains.							
24th September ..	0-0150	0-0176	0-0171	..	..	..	..	..	..	0-0497
1st October ..	0-0143	0-0353	0-2991	..	..	..	..	..	..	0-3487
15th October ..	0-0390	0-0532	0-4279	0-0101	..	..	0-0267	0-0018	..	0-5587
29th October ..	0-0376	0-0855	0-5900	0-0142	..	..	0-0591	0-0589	..	0-8453
12th November ..	0-0505	0-1161	0-8198	0-0059	..	..	0-0687	0-0536	0-0271	1-1417
28th November ..	0-1010	0-1511	0-9371	0-0425	..	0-0037	0-0828	0-0057	0-0046	1-3285
10th December ..	0-1257	0-1489	0-0290	0-1409	0-0041	..	0-1449	0-0036	0-0741	1-6712
24th December ..	0-1040	0-1148	0-8969	0-1467	0-0106	0-1147	0-1791	0-0048	0-0742	1-6458
7th January ..	0-1236	0-1571	0-8748	0-0653	0-0044	0-3532	0-1464	0-0294	0-0883	1-8425
21st January ..	0-1205	0-1781	0-6579	..	..	0-3741	0-2453	0-0289	0-1730	1-7778
4th February ..	0-0779	0-1331	0-4119	..	..	0-8720	0-3568	0-0346	0-2599	2-1462
18th February ..	0-1114	0-1387	0-4302	..	..	0-8360	0-3287	0-0124	0-1985	2-0559
4th March ..	0-1065	0-1385	0-2180	..	..	0-8922	0-4288	0-0163	0-2082	2-0085
11th March ..	0-1175	0-1723	0-1799	..	..	0-8117	0-3335	0-0220	0-1970	1-8339

The figures italicised are calculated on the percentage of the figures of the previous fortnight.

TABLE NO. 135.

Total nitrogen in grammes in the different organs of the cotton plant. (Unprotected.)

1931-32.

Date.	Roots.	Stem and branches.	Green leaves.	Flower-buds.	Flowers.	Bolls.	Shed leaves.	Shed buds.	Shed bolls.	Total.
18th September	0.0062	0.0053	0.0706	..	..	..	..	..	..	0.0821
25th September	0.0097	0.0090	0.1016	..	..	..	..	..	..	0.1203
1st October	0.0070	0.0117	0.1171	..	..	..	..	..	..	0.1358
8th October	0.0159	0.0346	0.2880	..	..	..	..	..	..	0.3385
29th October	0.0322	0.0704	0.4462	..	..	..	0.0419	..	..	0.5907
12th November	0.0536	0.0872	0.6073	0.0096	..	..	0.0460	..	..	0.8037
26th November	0.0876	0.1511	0.9945	0.0283	0.0009	0.0057	0.0890	0.0195	..	1.3766
10th December	0.1003	0.1672	1.2502	0.1062	0.0118	0.0159	0.1103	0.0111	0.0034	1.7764
23rd December	0.1067	0.1599	1.2176	0.1527	0.0336	0.0662	0.1043	0.0209	0.0363	1.8982
6th January	0.1250	0.1500	1.1866	0.1747	0.0277	0.2548	0.1837	0.0254	0.0731	2.2010
20th January	0.1153	0.1388	0.9689	0.0711	0.0324	0.4866	0.1810	0.0254	0.1393	2.1588
3rd February	0.1049	0.1479	0.8323	0.0110	0.0048	0.7462	0.1677	..	0.2748	2.2896
17th February	0.1192	0.1436	0.6037	..	..	0.6130	0.1972	..	0.1691	1.8458
2nd March	0.1326	0.1485	0.3919	..	..	1.6762	0.2934	0.0254	0.1528	2.8208
16th March	0.1197	0.1940	0.2833	..	..	0.9155	0.3733	..	0.2025	2.0883

TABLE No. 136.

*Percentage of the different forms of nitrogen in various organs of the plant.
(Unprotected.)*

1926-27.

YOUNG LEAVES.

Date.	Ammoniacal nitrogen.	Soluble albuminoid nitrogen.	Amid nitrogen.	Insoluble albuminoid nitrogen.	Total nitrogen.
11th October	0.050	1.526	0.293	2.394	4.263
21st October	0.043	0.093	0.390	3.085	3.611
1st November	0.053	0.342	0.063	2.857	3.315
11th November	0.031	0.157	0.273	2.848	3.309
25th November	0.034	0.115	0.348	2.825	3.322
11th December	0.054	0.398	0.294	2.656	3.402
25th December	0.041	0.107	0.521	2.973	3.642
10th January	0.055	0.181	0.135	2.213	2.584
25th January	0.040	0.138	0.235	1.953	2.366
9th February	0.025	0.128	0.455	2.025	2.633
24th February	0.026	0.082	0.208	1.760	2.076
11th March	0.203	0.141	0.191	1.550	2.085

ADULT LEAVES.

11th October	0.0342	..	0.4037	..	3.423
21st October	0.045	0.194	0.240	2.672	3.151
1st November	0.029	0.142	0.250	2.582	3.010
11th November	0.024	0.249	0.319	2.116	2.708
25th November	0.025	0.181	0.438	1.688	2.332
11th December	0.007	0.155	0.260	1.859	2.281
25th December	0.024	1.128	0.053	1.013	2.218
10th January	0.023	0.081	0.722	0.931	1.777
25th January	0.034	0.142	0.171	1.363	1.710
9th February	0.020	0.117	0.273	1.161	1.571
24th February	0.007	0.032	0.250	1.093	1.382
11th March	0.019	0.166	0.118	0.910	1.243

TABLE NO. 136—(contd.)
Percentage of the different forms of nitrogen in various organs of the plant.
(Unprotected.)
 1926-27.

Date.	Ammoniacal nitrogen.	Soluble albuminoid nitrogen.	Amid nitrogen.	Insoluble albuminoid nitrogen.	Total nitrogen.
YOUNG BUDS.					
11th October .. ..	..	..	..	..	..
21st October	0.088	0.333	0.374	2.565	3.360
1st November	0.052	1.216	0.618	2.254	3.994
11th November	0.068	0.337	0.562	2.195	3.162
25th November	0.079	0.276	0.551	2.293	3.199
11th December	0.042	0.483	0.373	2.128	3.026
25th December	0.029	0.293	0.388	2.336	3.046
10th January	0.078	0.033	0.600	2.131	2.842
25th January	0.047	0.451	0.377	1.782	2.657
9th February .. ..	..	..	..	..	..
24th February .. ..	..	..	..	..	..
11th March .. ..	..	..	..	..	..
FLOWERS.					
11th October .. ..	..	..	..	..	..
21st October .. ..	..	..	..	..	..
1st November .. ..	..	..	..	..	..
11th November	0.036	0.304	0.323	1.769	2.432
25th November	0.086	0.275	0.238	1.857	2.456
11th December	0.035	0.321	0.345	1.796	2.497
25th December	0.043	0.224	0.436	1.916	2.619
10th January	0.091	0.067	0.450	1.861	2.469
25th January	0.041	0.155	0.306	1.908	2.410
9th February	0.057	0.067	0.659	1.627	2.410
24th February	0.059	0.112	0.010	1.508	1.689
11th March	0.087	0.025	0.302	1.977	2.391
YOUNG BOLLS.					
11th October .. ..	..	..	..	..	..
21st October .. ..	..	..	..	..	..
1st November .. ..	..	..	..	..	..
11th November .. ..	..	..	..	..	..
25th November .. ..	..	..	..	..	..

TABLE No. 136—(contd.)

Percentage of the different forms of nitrogen in various organs of the plant.
(Unprotected.)
1926-27.

Date.	Ammoniacal nitrogen.	Soluble albuminoid nitrogen.	Amid nitrogen.	Insoluble albuminoid nitrogen.	Total nitrogen.
YOUNG BOLLS—(contd.)					
11th December	0.123	0.358	0.323	1.688	2.492
25th December	0.077	0.927	0.117	1.307	2.428
10th January	0.038	0.028	0.417	2.086	2.569
25th January	0.067	0.285	0.290	1.864	2.506
9th February	0.038	0.181	0.409	1.741	2.369
24th February	0.033	0.200	0.455	1.952	2.640
11th March	0.067	0.045	0.314	1.803	2.229
SHED BOLLS.					
11th October .. ..	..	..	..	..	..
21st October .. ..	..	..	..	..	..
1st November .. ..	..	..	..	..	..
11th November .. ..	..	..	..	..	..
25th November .. ..	..	..	..	..	..
11th December	0.252	0.206	0.343	1.609	2.410
25th December	0.123	0.045	0.163	1.294	1.625
10th January	0.037	0.016	0.305	2.200	2.558
25th January	0.335	0.190	0.331	1.856	2.412
9th February	0.008	0.154	0.578	1.239	1.979
24th February	0.118	0.067	0.366	1.404	1.943
11th March	0.081	0.083	0.232	1.352	1.748
MATURE BOLLS.					
11th October .. ..	..	..	..	..	..
21st October .. ..	..	..	..	..	..
1st November .. ..	..	..	..	..	..
11th November .. ..	..	..	..	..	..
25th November .. ..	..	..	..	..	..
11th December .. ..	..	..	..	..	..
25th December .. ..	..	..	..	..	..
10th January .. ..	..	..	..	..	..
25th January .. ..	..	..	..	..	..
9th February	0.039	0.046	0.701	0.866	1.652
24th February	0.032	0.281	0.817	0.722	1.852
11th March	0.035	0.075	0.567	0.920	1.599

TABLE NO. 137.

Percentage of the different forms of nitrogen in various organs of the plant.
(Unprotected.)

1927-28.

YOUNG LEAVES.

Date.	Ammoniacal nitrogen.	Soluble albuminoid nitrogen.	Amid nitrogen.	Insoluble albuminoid nitrogen.	Total nitrogen.
5th September	..	..	..	..	3.508
15th September	..	..	..	..	3.613
27th September	0.076	0.162	0.439	3.148	3.825
13th October	0.088	0.625	0.407	2.986	4.100
28th October	0.085	0.179	0.541	3.002	3.807
14th November	0.073	0.323	0.120	3.190	3.705
28th November	0.050	0.123	0.238	2.675	3.086
12th December	0.051	0.059	0.095	2.628	2.833
26th December	0.030	0.250	0.458	2.607	3.345
9th January	0.041	0.111	0.295	2.358	2.805
23rd January	0.050	0.212	0.300	2.152	2.718
6th February	0.036	0.033	0.281	2.203	2.553

ADULT LEAVES.

5th September	..	..	..	..	..
15th September	..	..	..	..	3.184
27th September	0.042	0.293	0.188	2.453	2.976
13th October	0.050	0.027	0.271	2.638	2.986
23th October	0.065	0.167	0.408	2.896	3.535
14th November	0.071	0.252	0.275	2.885	3.483
28th November	0.038	0.062	0.337	2.561	2.997
12th December	0.023	0.107	0.232	2.532	2.894
26th Dceember	0.034	0.040	0.292	2.696	3.063
9th January	0.035	0.291	0.294	1.624	2.244
23rd January	0.041	0.038	0.235	1.847	2.161
6th February	0.031	0.052	0.182	1.630	1.906

YOUNG BUDS.

5th September	..	..	..	..	..
15th September	..	..	..	..	..
27th September	..	..	..	..	..
13th October	..	..	..	..	..
28th October	0.564	0.300	0.157	2.638	3.158
14th November	0.065	0.418	0.089	2.222	2.794
28th November	0.076	0.230	1.361	3.504	4.171
12th December	0.065	0.280	1.054	2.331	3.730
26th December	0.088	0.109	0.706	2.262	3.163
9th January	0.081	0.191	0.540	2.250	3.062
23rd January	0.049	0.184	0.391	2.106	2.730
6th February	0.063	0.224	0.435	2.150	2.872

TABLE NO. 137—(contd.)
 Percentage of the different forms of nitrogen in various organs of the plant.
 (Unprotected.)
 1927-28

Date.	Ammoniacal nitrogen.	Soluble albuminoid nitrogen.	Amid nitrogen.	Insoluble albuminoid nitrogen.	Total nitrogen.
FLOWERS.					
12th December	0.0602	0.3130	0.8868	1.8330	3.0990
26th December	0.0651	0.1290	0.5089	1.8950	2.6080
9th January	0.0764	0.0420	0.3286	1.9560	2.4030
23rd January	0.0467	0.2030	0.3273	1.9320	2.5090
6th February	0.0586	0.0498	0.4985	2.0722	2.6790
YOUNG BOLLS.					
12th December .. ..	..	..	..	..	..
26th December	0.0435	0.1740	0.2615	2.1960	2.6750
9th January	0.0680	0.3310	0.3160	1.9160	2.6320
23rd January	0.0606	0.1750	0.2624	1.9820	2.4800
6th February	0.0955	0.0500	0.7585	1.9870	2.8910
SHED BUDS.					
28th November	0.1232	0.1700	0.0008	1.9960	2.2900
12th December	0.0478	0.0210	0.4623	1.8250	2.3560
SHED BOLLS.					
12th December .. ..	..	..	..	..	..
26th December	0.2118	0.0840	0.1912	1.9860	2.4730
9th January	0.1056	0.1190	0.3494	1.3000	1.8740
23rd January	0.0836	0.1160	0.2974	1.2340	1.7310
6th February	0.0631	0.2180	0.1549	1.2770	1.7130

TABLE No. 138.
Percentage of ether extract in different organs of the cotton plant. (Unprotected.)
 1930-31.

Date.	Roots.	Stem and branches.	Green leaves.	Flower-buds.	Flowers.	Bolls.	Shed leaves.	Shed buds.	Shed bolls.
24th September	2.60	1.47	3.75	..	..	..	..	..	..
1st October	2.00	1.55	4.85	..	..	..	..	..	..
15th October	2.55	1.41	3.85	..	..	..	2.67	..	..
29th October	1.64	0.70	4.67	..	..	..	1.83	..	..
12th November	2.09	0.83	3.40	..	..	..	3.00	..	..
26th November	2.57	0.87	4.60	2.05	..	..	2.38	..	..
10th December	1.64	0.82	4.63	1.75	..	..	3.34	1.47	2.58
24th December	1.80	0.85	5.37	2.27	3.00	2.08	3.70	..	2.25
7th January	1.90	1.15	6.30	1.80	..	1.80	3.20	1.35	2.40
21st January	1.80	0.90	6.50	..	..	2.20	3.70	1.66	1.85
4th February	8.10	0.70	6.05	..	..	5.70	6.65	2.40	2.25
18th February .. ..	..	0.85	4.90	..	..	5.10	5.25	..	2.35
4th March	2.55	0.80	7.05	..	..	7.45	6.00	..	2.30
11th March	2.95	1.15	5.45	..	..	6.25	7.20	..	2.05

TABLE NO. 139.

Percentage of ether extract in the different organs of the cotton plant. (Unprotected.)

1931-32.

Date.	Roots.	Stem and branches.	Green leaves.	Flower-buds.	Flowers.	Bolls.	Shed leaves.	Shed flower-buds.	Shed bolls.
18th September .. ..	..	..	..	..	..	..	..	..	..
25th September	1.80	1.88	3.67	..	..	..	..	..	..
1st October	1.00	1.30	2.50	..	..	..	..	..	..
8th October	1.60	1.10	4.20	..	..	..	..	..	..
29th October	1.60	1.15	2.85	..	..	..	2.60	..	..
12th November	1.70	1.10	3.45	..	..	..	3.45	..	..
26th November	1.50	1.10	3.40	2.70	..	..	3.05	2.70	..
10th December	1.30	0.90	3.55	1.85	..	..	3.10	..	..
23rd December	2.05	1.15	3.75	2.55	2.20	1.85	2.55	..	1.85
6th January	2.30	0.95	4.80	1.95	..	2.00	2.80	..	3.00
20th January	1.85	1.15	5.70	2.30	..	2.60	3.35	..	1.90
3rd February	3.50	0.95	6.10	..	..	2.55	3.70	..	2.45
17th February	2.35	0.80	7.25	..	..	5.60	5.25	..	2.50
2nd March	2.55	1.30	6.80	..	..	6.35	5.80	..	2.65
16th March	3.00	1.30	7.30	..	..	6.25	5.15	..	2.85

TABLE No. 140.

Total ether extract, in grammes, of the different organs of the cotton plant. (Unprotected.)

1930-31.

Date.	Roots.	Stem and branches.	Green leaves.	Flower-buds.	Flowers.	Bolls.	Shed leaves.	Shed buds.	Shed bolls.	Total in the whole plant.
24th September	0·0364	0·0183	0·1800	..	..	..	..	..	..	0·2347
1st October	0·0417	0·0504	0·4326	..	..	..	..	..	..	0·5247
15th October	0·1103	0·0860	0·5005	..	..	..	0·0374	..	..	0·7342
29th October	0·1082	0·0854	0·8126	..	..	..	0·0549	..	..	1·0611
12th November	0·1672	0·1403	0·9044	..	..	..	0·0900	..	..	1·3019
26th November	0·4112	0·2036	1·4536	0·0246	..	..	0·1047	..	..	2·1977
10th December	0·4198	0·1825	1·6784	0·0788	..	..	0·2505	0·0018	0·0968	2·7086
24th December	0·4320	0·1734	1·8795	0·0999	0·0120	0·0832	0·3515	..	0·0900	3·1215
7th January	0·4608	0·3772	2·4822	0·0396	..	0·2419	0·2880	0·0162	0·1152	4·0211
21st January	0·5400	0·3708	2·2360	..	..	0·5588	0·5920	0·0199	0·1850	4·5025
4th February	0·5040	0·2328	1·7848	..	..	4·1035	1·7456	0·0360	0·3186	8·7253
18th February	0·5791	0·2508	1·1393	..	..	3·6975	1·3388	..	0·2761	7·2816
4th March	0·6756	0·2933	0·9635	..	..	5·4261	2·1200	..	0·2990	9·7775
11th March	0·7744	0·4744	0·6268	..	..	4·1406	2·0160	..	0·2460	8·2782

TABLE No. 141.

Total ether extract, in grammes, of the different organs of the cotton plant. (Unprotected.)

1931-32.

Date.	Roots.	Stem and branches.	Green leaves.	Flower-buds.	Flowers.	Bolls.	Shed leaves.	Shed buds.	Shed bolls.	Total.
25th September	0·0180	0·0136	0·1264	..	..	..	..	..	..	0·1580
1st October	0·0106	0·0135	0·1011	..	..	..	..	..	..	0·1252
8th October	0·0398	0·0315	0·3780	..	..	..	..	..	..	0·4493
29th October	0·0760	0·0843	0·4275	..	..	..	0·0650	..	..	0·6528
12th November	0·1275	0·1173	0·7303	..	..	..	0·1035	..	..	1·0786
26th November	0·2190	0·2508	1·1526	0·0270	..	..	0·1586	0·0162	..	1·8242
10th December	0·2470	0·2412	1·6188	0·0592	..	..	0·2108	..	..	2·3770
23rd December	0·4356	0·3191	1·5844	0·1211	0·0275	0·0463	0·1721	..	0·0324	2·7385
6th January	0·6153	0·2613	2·3160	0·1073	..	0·2425	0·3290	..	0·1050	3·9764
20th January	0·4648	0·3076	2·4083	0·0633	..	0·6500	0·4188	..	0·1283	4·4411
3rd February	0·9100	0·3373	2·3180	..	..	1·2750	0·4995	..	0·3675	5·7073
17th February	0·6580	0·2600	2·2475	..	..	2·6460	0·9188	..	0·2500	6·9803
2nd March	0·7686	0·3640	1·3827	..	..	5·3975	1·5660	..	0·2385	9·7073
16th March	0·8300	0·5200	1·0950	..	..	4·5313	1·8025	..	0·3420	9·1208

TABLE No. 142.
Fibre percentage in the different organs of the cotton plant. (Unprotected.)
 1930-31.

Date.	Roots.	Stem and branches.	Green leaves.	Flower-buds.	Flowers.	Bolls.	Shed leaves.	Shed buds.	Shed bolls.
10th September .. ..	..	..	..	..	..	..	..	..	..
17th September .. ..	..	..	..	..	..	..	..	..	..
24th September	55.45	44.33	13.85	..	..	..	..	..	..
1st October	49.40	56.85	16.30	..	..	..	..	..	..
15th October	61.25	56.05	15.45	..	..	..	12.00	..	..
29th October	61.00	58.90	14.30	..	..	..	11.10	..	..
12th November	53.60	49.55	10.35	..	..	..	10.00	..	..
26th November	49.87	53.03	10.38	11.64	..	..	9.65	..	..
10th December	52.10	49.40	14.80	13.85	..	..	13.30	16.40	17.50
24th December	50.85	52.90	13.30	19.70	23.57	20.35	15.10	..	17.30
7th January	41.50	49.60	14.00	15.00	..	17.40	13.40	14.90	13.30
21st January	47.00	55.65	11.05	..	..	31.05	12.40	13.60	14.55
4th February	46.45	53.65	14.50	..	..	39.70	11.30	16.10	15.20
18th February	54.95	48.30	10.70	..	..	40.20	13.00	..	16.05
4th March	51.75	56.10	10.70	..	..	41.60	13.10	..	14.85
11th March	48.45	54.45	9.30	..	..	43.65	14.25	..	16.10

TABLE No. 143.

Fibre percentage in the different organs of the cotton plant. (Unprotected.)

1931-32.

Date.	Roots.	Stem and branches.	Green leaves.	Flower-buds.	Flowers.	Bolls.	Shed leaves.	Shed buds.	Shed bolls.
18th September	51.60	..	12.35	..	..	..	..	..	..
25th September	48.85	42.70	..	..	..	..	..	..	..
1st October	47.70	44.40	13.80	..	..	..	..	..	..
8th October	53.80	42.70	11.40	..	..	..	..	..	..
29th October	55.50	47.95	13.80	..	..	..	13.85	..	..
12th November	57.25	62.70	14.15	..	..	..	17.10	..	..
26th November	58.95	57.25	13.60	14.90	..	..	15.20	16.00	..
10th December	56.00	51.10	12.40	14.40	..	..	14.85	..	..
23rd December	58.10	54.00	12.80	14.85	14.20	14.70	14.10	..	15.65
6th January	52.05	52.20	12.95	16.35	..	18.95	12.85	..	16.85
20th January	52.35	51.10	12.15	14.20	..	20.05	14.05	..	15.25
3rd February	45.25	56.10	13.10	..	..	27.85	13.85	..	15.45
17th February	42.85	56.95	13.10	..	..	32.50	14.95	..	16.05
2nd March	53.05	51.35	10.75	..	..	37.50	14.25	..	13.25
16th March	42.60	52.10	9.35	..	..	33.75	11.75	..	15.30

TABLE No. 144.

Total fibre, in grammes, in the different organs of the cotton plant. (Unprotected.)

1930-31.

Date.	Roots.	Stem and branches.	Green leaves.	Flower-buds.	Flowers.	Bolls.	Shed leaves.	Shed buds.	Shed bolls.	Total in the whole plant.
24th September ..	0·7763	0·5515	0·6648	..	..	..	..	..	..	1·9926
1st October	1·0295	1·8488	1·4540	..	..	..	..	..	..	4·3323
15th October	3·0013	3·4191	2·0085	..	..	..	0·1680	..	..	8·5969
29th October	4·0260	7·1858	2·4882	..	..	..	0·3330	..	..	14·0330
12th November ..	4·2480	8·3740	2·7531	..	..	..	0·3000	..	..	15·6751
26th November ..	7·9792	12·4090	3·2801	0·1397	..	..	0·4246	..	..	24·2326
10th December ..	13·3376	10·9915	5·3650	0·6233	..	..	0·9975	0·0205	0·6563	31·9917
24th December ..	12·2040	10·7916	4·6550	0·8668	0·0943	0·8140	1·4345	..	0·6920	31·5522
7th January	10·0838	16·2688	5·5160	0·3300	..	2·3386	1·2060	0·1788	0·6384	36·5404
21st January	14·1000	22·9278	3·8012	..	..	7·8867	1·9840	0·1632	1·4550	52·3179
4th February	11·1420	17·8386	4·2776	..	..	29·9735	2·9663	0·2415	2·1660	68·6055
18th February ..	15·5234	14·2485	2·4878	..	..	29·1450	3·3150	..	1·8859	66·6056
4th March	14·8781	20·5700	1·4623	..	..	30·2987	4·6287	..	1·9305	73·7683
11th March	12·7181	22·4606	1·0695	..	..	28·9181	2·9900	..	1·9320	71·0883

TABLE No. 145.

Total fibre, in grammes, in the different organs of the cotton plant. (Unprotected.)

1931-32.

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Date.	Roots.	Stem and branches.	Green leaves.	Flower-buds.	Flowers.	Bolls.	Shed leaves.	Shed buds.	Shed bolls.	Total.
18th September ..	0.2440	0.1931	0.2821	..	..	..	..	..	..	0.8192
25th September ..	0.4885	0.3081	0.4754	..	..	..	..	..	..	1.2720
1st October	0.5048	0.4614	0.5583	..	..	..	..	..	..	1.5245
8th October	1.3383	1.2244	1.0260	..	..	..	..	..	..	3.5887
29th October	2.6362	3.5163	2.970	..	..	..	0.3462	..	..	8.4687
12th November ..	4.2937	6.6880	2.9951	..	..	..	0.5130	..	..	14.4898
26th November ..	8.6067	13.0530	4.6104	0.1490	..	..	0.7904	0.0960	..	27.3055
10th December ..	10.6400	13.6984	5.6544	0.4608	..	..	1.0098	..	..	31.4598
23rd December ..	12.3462	14.9850	5.4080	0.7054	0.1775	0.3675	0.9517	..	0.2739	35.2152
6th January	13.9234	14.3550	6.2484	0.8992	..	2.2977	1.5099	..	0.5897	39.8233
20th January	13.1529	13.6692	5.1334	0.3905	..	5.0125	1.7562	..	0.8269	39.9416
3rd February	11.7650	21.9155	4.9780	..	..	13.9250	1.8697	..	2.3175	56.7707
17th February	11.9980	18.5087	4.0610	..	..	15.3562	2.6162	..	1.6050	54.1451
2nd March	15.7824	14.3780	2.1858	..	..	31.8750	3.8475	..	1.1925	69.2612
16th March	11.7861	20.8400	1.4025	..	..	24.4687	4.1125	..	1.8360	64.4458

TABLE No. 146.

Percentage of total hydrolysable carbohydrates in the different organs of the cotton plant. (Unprotected.)

1930-31.

Date.	Roots.	Stem and branches.	Green leaves.	Flower-buds.	Flowers.	Bolls.	Shed leaves.	Shed buds.	Shed bolls.	Total in the whole plant.
24th September .. ..	..	..	..	..	..	..	..	..	..	..
1st October .. ..	..	..	..	..	..	..	..	..	..	..
15th October	25·8755	29·3180	41·9969	..	..	..	54·2142	..	..	36·7203
29th October	27·4697	28·4689	41·2839	..	..	..	55·4590	..	..	36·2887
12th November	34·6150	37·6219	50·9950	..	..	..	50·5370	..	..	44·4909
26th November	36·5456	35·0000	49·2386	51·9250	..	..	57·4886	..	..	42·9631
10th December	37·3008	38·6939	47·7360	51·7400	..	..	50·7120	50·1600	56·9680	43·8079
24th December	39·1333	36·7623	47·4111	44·7795	44·8750	45·2075	47·6905	..	56·4075	43·5034
7th January	47·2656	39·5552	46·1048	52·0500	..	52·9762	52·4889	55·3833	62·6937	46·5274
21st January	43·1897	35·1900	47·2235	..	..	50·1063	53·6108	56·8150	60·6470	45·3621
4th February	44·1463	37·4998	50·2237	..	..	40·1470	52·1603	54·1267	56·7649	44·4475
18th February	35·3352	41·1146	50·5381	..	..	39·0407	52·0929	..	57·5863	42·9732
4th March	36·9381	34·3876	49·5175	..	..	36·1444	51·6131	..	59·8400	41·1602
11th March	39·7528	36·6548	52·9680	..	..	35·2923	48·5993	..	58·7400	40·8727

TABLE No. 147.

Percentage of total hydrolysable carbohydrates in the different organs of the cotton plant. (Unprotected.)

1931-32.

Date.	Roots.	Stem and branches.	Green leaves.	Flower-buds.	Flowers.	Bolls.	Shed leaves.	Shed buds.	Shed bolls.
25th September	35.490	37.222	47.100	..	..	..	..	..	..
1st October	38.165	35.212	46.811	..	..	..	..	..	..
8th October	33.005	38.710	48.972	..	..	..	..	..	..
29th October	30.716	34.902	49.875	..	..	..	47.327	..	..
12th November	29.184	22.541	47.869	50.909	..	..	49.150	..	..
26th November	29.251	30.908	46.684	50.910	53.429	53.850	53.298	47.585	..
10th December	32.802	36.550	49.565	49.406	53.341	53.834	51.411	47.576	..
23rd December	30.712	34.198	47.138	48.009	53.353	53.848	53.044	47.574	59.320
6th January	36.279	36.840	47.579	48.547	53.340	56.365	53.157	47.570	56.797
20th January	36.733	37.057	46.416	54.240	53.346	54.986	51.349	47.570	61.733
3rd February	42.428	28.963	45.960	54.240	53.350	54.673	52.639	..	58.500
17th February	45.589	33.240	46.029	..	..	45.541	51.456	..	57.731
2nd March	35.815	36.886	47.706	..	..	37.076	50.960	47.570	62.288
16th March	44.948	37.070	49.196	..	..	44.708	53.836	..	57.004

TABLE No. 148.

Total hydrolysable carbohydrates in grammes in the different organs of the cotton plant. (Unprotected.)

1930-31.

Date.	Roots.	Stem and branches.	Green leaves.	Flower-buds.	Flowers.	Bolls.	Shed leaves.	Shed buds.	Shed bolls.	Total in the whole plant.
24th September	..	..	..	..	..	..	..	..	..	..
1st October	..	..	..	..	..	..	..	..	..	..
15th October	1·2679	1·7884	5·4596	0·1511	..	..	0·7590	0·0291	..	9·4551
29th October	1·8130	3·4732	7·1837	0·2120	..	..	1·6637	0·1003	..	14·4459
11th November	2·7692	6·3581	13·5627	0·880	..	..	1·5161	0·1003	0·0798	24·4742
26th November	5·8473	8·2900	15·5594	0·6231	..	0·0954	2·5295	0·1003	0·1139	33·1589
10th December	9·5490	8·6094	17·3043	2·3303	0·0673	..	3·8034	0·0627	2·1363	43·8627
24th December	9·3920	7·4995	16·5939	1·9703	0·1795	1·8083	4·5306	0·1003	2·2563	44·3307
7th January	11·4619	12·9741	18·1653	1·1451	0·0718	6·9900	4·7240	0·6646	3·0093	59·2061
21st January	12·9569	14·4983	16·2449	..	..	12·7374	8·5789	0·6818	6·0647	71·7629
4th February	10·5951	12·4687	14·8164	..	..	30·3110	13·6921	0·8119	8·0890	90·7842
18th February	9·9822	12·1288	11·7501	..	..	28·3045	13·2837	0·2706	6·7664	82·4863
4th March	10·6197	12·6088	6·7674	..	..	26·3252	18·2366	0·3609	7·7792	82·6978
11th March	10·4351	15·1201	6·0913	..	..	23·2812	13·6078	0·5413	7·0487	76·1255

TABLE No. 149.

Total hydrolysable carbohydrates in grammes in the different organs of the cotton plant. (Unprotected.)

1931-32.

Date.	Roots.	Stem and branches.	Green leaves.	Flower-buds.	Flowers.	Bolls.	Shed leaves.	Shed buds.	Shed bolls.	Total.
25th September	0.3549	0.2686	1.6226	..	..	..	..	..	..	2.2461
1st October	0.4039	0.3659	1.8939	..	..	..	..	..	..	2.6637
8th October	0.8210	1.1100	4.4075	..	..	..	..	..	..	6.3385
29th October	1.4589	2.5594	7.4812	..	..	..	1.1832	..	..	12.6827
12th November	2.188	2.4044	10.1323	0.1456	..	..	1.4745	..	..	16.3456
26th November	4.2705	7.0470	15.8264	0.5091	0.0187	0.1077	2.7715	0.2855	..	30.8364
10th December	6.2321	9.7956	22.6014	1.5810	0.2347	0.3230	3.4960	0.1903	..	44.4541
23rd December	6.5263	9.4901	19.9159	2.2804	0.6699	1.3462	3.5804	0.3568	1.0381	45.2011
6th January	9.7046	10.1312	22.9571	2.6701	0.5334	6.8344	6.2603	0.4757	1.9879	61.5547
20th January	9.2290	9.9128	19.6112	1.4916	0.6668	13.7462	6.4187	0.4757	4.1670	65.7190
3rd February	11.0314	10.2816	17.4651	0.2712	0.1067	27.3362	7.1060	..	8.7750	82.3732
17th February	12.7650	10.8026	14.2689	..	..	21.5184	9.0050	..	5.7731	74.1330
2nd March	10.6547	10.3279	9.6998	..	..	31.5137	13.7587	0.4757	5.6060	82.0365
16th March	12.4353	14.8275	7.3794	..	..	32.4131	18.8419	..	6.8404	92.7376

TABLE No. 150.
Dry matter of the different organs of the cotton plant in grammes. (Unprotected and Manured.)
 1928-29.

(Average of 3 to 4 plants.)

Date.	Roots.	Stem and branches.	Green leaves.	Flower-buds.	Flowers.	Bolls.	Shed leaves.	Shed buds.	Shed bolls.	Total weight.
8th August	0·0930	0·0295	0·2566	..	..	..	..	..	..	0·3791
15th August	0·2925	0·2125	1·1620	..	..	..	..	..	..	1·6670
3rd September	0·7110	0·3525	1·9415	..	..	..	..	..	..	3·0050
17th September				R	A	I	N			
1st October	5·1925	8·0120	19·7300	..	..	..	..	..	..	32·9345
15th October	8·5710	14·1880	30·3360	..	..	..	..	..	..	53·0950
29th October	14·4250	25·2325	40·2750	0·7145	..	..	..	..	..	80·6470
12th November	28·3200	50·3600	54·2530	2·3533	..	..	5·0266	1·0266	..	141·3395
26th November	47·6670	85·5000	86·6800	7·2670	0·8670	2·3333	5·8900	2·0000	..	238·2043
10th December	58·1671	89·5000	101·5870	6·3333	1·9600	12·1133	8·6670	1·6670	1·3333	281·3279
24th December	60·6667	112·0000	109·3333	7·5000	2·7333	20·0000	8·9000	2·6000	1·6667	325·4000
7th January	62·5000	114·1000	96·7500	3·1000	1·0400	60·9800	14·0000	2·3333	6·0000	360·8033
21st January	59·3333	97·0000	82·5000	1·0670	..	89·0000	15·0000	4·6667	9·3333	357·9003
4th February	92·3333	122·6670	73·4600	..	..	93·6667	15·0000	3·0000	3·3333	403·4600
18th February	70·0000	128·0000	47·6670	..	..	170·3333	15·0000	3·0000	10·6670	444·6670
2nd March .. ..	..	..	..	..	..	..	..	..	..	..

TABLE No. 151.

Per cent. moisture in different organs of manured unprotected plants.

1928-29.

(Average of 3 to 4 plants.)

Date.	Stem and branches.	Leaves.	Flower- buds.	Flowers.	Bolls.
9th August	83·71	85·51	..	..	..
15th August	79·93	80·93	..	..	..
3rd September	78·68	79·77	..	..	..
17th September .. .. .	..	..	..	..	..
1st October	79·09	79·38	..	..	..
15th October	73·81	75·54	..	..	..
29th October	71·14	76·79	78·30	..	..
12th November	66·62	78·73	80·91	..	..
26th November	62·24	68·63	76·80	76·63	81·37
10th December	62·56	72·09	78·79	77·10	80·00
24th December	60·19	70·61	75·81	76·90	82·22
7th January	60·00	64·62	75·00	74·07	82·05
21st January	64·33	70·75	78·00	..	80·65
4th February	56·20	67·36	..	..	81·00
18th February	57·38	63·58	..	..	80·00

TABLE No. 152.

Per cent, nitrogen in the different organs of the cotton plant. (Unprotected and Manured.)

1928-29.

Date.	Roots.	Stem and branches	Green leaves.	Flower-buds.	Flowers.	Bolls.	Shed leaves.	Shed buds.	Shed bolls.
9th August	1.282	1.8430	2.886	..	..	..	..	..	..
15th August	1.705	1.388	3.755	..	..	..	..	..	..
3rd September	1.066	1.670	3.593	..	..	..	..	..	..
17th September	..	..	R	A	I	N	..	..	..
1st October	0.8764	1.307	3.247	..	..	..	..	..	..
15th October	0.7137	1.077	2.945	..	..	..	..	..	..
29th October	0.7548	0.7663	2.643	2.960	..	..	..	..	..
12th November	0.4836	0.6417	2.831	3.139	..	..	1.2792	2.2988	..
26th November	0.5460	0.7806	2.299	2.661	2.457	2.429	1.2469	2.1550	..
10th December	0.4645	0.5590	2.191	2.615	2.213	2.011	1.4803	2.2255	1.2225
24th December	0.3432	0.4991	2.005	2.502	2.059	1.873	1.4809	2.0577	1.8960
7th January	0.3578	0.5367	1.758	2.415	2.160	1.429	1.2071	2.0605	1.6100
21st January	0.3220	0.4159	1.865	2.334	..	1.482	1.5027	1.8792	1.6103
4th February	0.3443	0.4353	1.637	..	..	1.273	1.2073	2.0133	1.6110
18th February	0.3941	0.4193	1.585	..	..	1.163	1.3840	2.2633	2.1647

TABLE No. 153.

Total nitrogen in grammes in the different organs of the cotton plant. (Unprotected and Manured.)

1928-29.

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Date.	Roots.	Stem and branches.	Green leaves.	Flower-buds.	Flowers.	Bolls.	Shed leaves.	Shed buds.	Shed bolls.	Total.
9th August	0·0012	0·0005	0·0074	..	..	..	..	..	..	0·0091
15th August	0·0050	0·0029	0·0436	..	..	..	..	..	..	0·0515
2nd September	0·0076	0·0059	0·0697	..	..	..	..	..	..	0·0832
17th September		R		A		I		N		
1st October	0·0455	0·1047	0·6407	..	..	..	..	..	..	0·7909
15th October	0·0612	0·1606	0·8937	..	..	..	..	..	..	1·1155
29th October	0·0829	0·1933	1·0900	0·0212	..	..	..	..	..	1·3874
12th November	0·1370	0·3232	1·5361	0·0738	..	..	0·0643	0·0236	..	2·1580
26th November	0·2602	0·6678	1·9930	0·1952	0·0213	0·0081	0·0736	0·0431	..	3·2623
10th December	0·2702	0·5002	2·2330	0·1656	0·0434	0·2435	0·1283	0·0371	0·0263	3·6276
24th December	0·2082	0·5590	2·1930	0·1877	0·0563	0·3747	0·1318	0·0534	0·0316	3·7947
7th January	0·2237	0·6124	1·7000	0·0727	0·0225	0·8715	0·1690	0·0482	0·0966	3·8566
21st January	0·1910	0·4034	1·5380	0·0249	..	1·3190	0·2254	0·0877	0·1503	3·9397
4th February	0·3179	0·5340	1·2020	..	..	1·0520	0·1811	0·0604	0·0537	3·4011
18th February	0·2758	0·5374	0·7566	..	..	1·9810	0·2076	0·0679	0·2309	4·0562

TABLE No. 154.

Dry matter of the different organs of the cotton plant in grammes. (Protected.)
1929-30.

(Average of 4 to 6 plants.)

Date.	Roots.	Stem and branches.	Green leaves.	Flower-buds.	Flowers.	Bolls.	Shed leaves.	Shed buds.	Shed bolls.	Total.
9th September ..	0·810	0·89	2·29	..	..	..	..	..	..	3·990
23rd September ..	2·533	2·89	9·20	..	..	..	..	..	..	14·623
7th October	3·742	6·50	15·67	0·088	..	..	3·133	..	..	29·133
21st October	7·791	17·78	26·40	1·275	0·0903	0·2717	4·4100	0·140	0·280	58·438
4th November	13·550	23·18	31·90	3·333	0·0860	1·1160	5·388	0·367	0·434	79·354
18th November	12·916	27·81	37·50	6·216	1·0000	10·000	7·167	0·667	3·250	106·526
2nd December	13·600	36·00	44·33	1·633	0·3333	41·2500	9·500	1·000	14·333	161·9793
16th December	15·800	44·54	45·70	..	..	75·300	13·000	1·2000	22·4000	217·9400
30th December	19·500	44·17	35·87	..	..	99·8333	17·3333	1·3333	20·000	238·0399
14th January	19·000	43·60	26·94	..	..	94·2000	30·5000	1·3000	21·800	237·3400
28th January	20·000	44·40	17·60	..	..	116·000	37·000	1·3300	20·633	256·963
11th February	21·400	40·50	12·67	..	..	137·6700	44·00	1·0000	22·000	279·24

TABLE No. 155.

Dry matter of the different organs of the cotton plant in grammes. (Protected.)

1930-31.

(Average of 4 to 6 plants.)

Date.	Roots.	Stem and branches.	Green leaves.	Flower-buds.	Flowers.	Bolls.	Shed leaves.	Shed buds.	Shed bolls.	Total.
8th October	3.4400	4.2000	8.1000	0.0394	..	..	1.1000	..	..	16.8794
22nd October	4.6000	11.2000	15.8000	1.8400	0.2000	..	2.6000	0.2400	..	36.4800
5th November	7.0400	13.6000	19.4400	0.3866	0.1546	0.5146	2.8000	0.8000	0.8000	45.5358
19th November	9.6000	24.8000	28.7000	1.9600	..	1.8000	5.8000	0.8000	1.8000	75.2600
2nd December	13.0000	29.1667	29.6667	5.1667	0.1500	6.0000	8.3333	0.3667	1.5000	93.3501
17th December	16.2000	23.8000	32.2000	4.8000	0.6000	14.2000	7.0000	0.5000	2.000	101.3000
31st December	18.0000	29.8000	27.2000	0.4000	0.0685	37.8000	16.0000	0.8000	16.000	146.0685
14th January	17.6000	29.2000	22.4000	..	..	43.4000	25.0000	0.8000	14.4000	152.8000
28th January	20.0000	29.5000	21.7500	..	..	53.7500	27.5000	1.0000	14.250	167.7500
11th February	19.8000	20.6667	14.5000	..	..	50.3333	23.5000	0.8333	12.5000	142.1333
25th February	19.4000	22.0000	11.2500	..	..	57.2500	26.500	0.7500	14.2500	151.4000

TABLE No. 156.

Dry matter of the different organs of the cotton plant in grammes. (Protected.)

1931-32.

(Average of 4 to 6 plants.)

Date.	Roots.	Stem and branches.	Green leaves.	Flower-buds.	Flowers.	Bolls.	Shed leaves.	Shed buds.	Shed bolls.	Total.
22nd October	2·6667	5·0050	11·2000	..	..	..	0·5000	..	..	19·3717
5th November	4·6667	10·1667	18·7500	0·2467	..	..	2·3333	..	..	36·1634
19th November	12·6667	26·1667	32·0000	1·8333	0·0533	..	4·3333	0·0833	..	77·1366
3rd December	18·000	27·6000	46·0000	6·4000	0·8000	0·6900	6·8000	0·2000	..	106·4900
16th December	18·7500	30·0000	51·5000	8·3750	1·7000	5·750	9·000	0·5000	2·5000	128·0750
30th December	17·5000	30·2500	48·5000	4·7500	2·0000	27·500	9·000	0·5000	7·000	147·0000
13th January	19·5000	29·7500	40·7500	0·7500	1·0000	50·0000	13·000	1·0000	19·5000	175·2500
27th January	20·0000	30·5000	41·5000	..	..	45·7500	15·7500	..	17·5000	171·0000
10th February	21·5000	46·000	27·000	..	..	46·5000	27·7780	..	21·5000	190·278
24th February	20·000	47·500	25·5000	..	..	95·7500	34·5000	..	19·0000	245·250
	22/10	5/11	19/11	3/12	16/12	30/12	13/1	27/1	10/2	24/2
Total leaves	11·7000	21·0833	36·3333	52·8000	60·5000	57·5000	53·7500	57·2500	54·7780	60·0000

TABLE No. 157.

Moisture percentage in the different organs of the cotton plant. (Protected.)
1929-30.

Date.	Stem and branches.	Leaves.	Flower-buds.	Flowers.	Bolls.
9th September ..	75·21	78·82	..	..	..
23rd September ..	74·88	77·21	..	..	..
7th October ..	76·60	78·23	77·52	..	..
21st October ..	71·81	78·78	77·16	80·20	82·84
4th November ..	65·66	74·51	77·27	81·40	84·02
18th November ..	67·52	74·01	80·63	83·91	85·38
2nd December ..	65·08	72·08	78·93	84·00	84·06
16th December ..	60·82	72·15	..	..	79·47
30th December ..	57·61	72·40	..	..	74·13
14th January ..	63·24	66·19	..	..	76·33
28th January ..	53·45	67·89	..	..	65·39

TABLE No. 158.

Moisture percentage in the different organs of the cotton plant. (Protected.)
1930-31.

Date.	Stem and branches.	Green leaves on plant.	Flower-buds.	Flowers.	Bolls.
8th October ..	80·93	85·40	96·05	..	..
22nd October ..	74·54	81·45	79·56	89·77	..
5th November ..	71·87	79·25	78·82	80·46	81·05
19th November ..	66·85	76·17	74·45	..	86·73
3rd December ..	63·36	75·78	77·76	81·01	88·02
17th December ..	73·96	73·50	78·63	84·55	80·37
31st December ..	63·66	71·58	83·12	82·33	84·97
14th January ..	65·72	71·32	..	..	85·77
28th January ..	67·44	69·74	..	..	81·65
11th February ..	69·39	66·72	..	..	66·56
25th February ..	65·35	67·27	..	..	..

TABLE No. 159.

Moisture percentage in the different organs of the cotton plant. (Protected.)

1931-32.

Date.	Stem and branches.	Green leaves on the plant.	Flower-buds.	Flowers.	Bolls.
22nd October	77.40	78.89	..	..	..
5th November	75.77	79.37	74.71	..	..
19th November	71.41	79.81	75.00	75.00	..
3rd December	75.16	76.93	78.78	80.53	79.07
17th December	78.36	77.63	81.38	81.42	87.74
31st December	73.66	75.49	78.40	79.96	84.82
14th January	78.39	81.37	79.38	77.84	89.68
28th January	72.19	76.44	..	..	89.49
11th February	59.08	74.54	..	..	87.05
25th February	55.83	69.28	..	..	78.26

TABLE NO. 160.

Ash percentage in the different organs of the cotton plant. (Protected.)

1929-30.

Date.	Roots.	Stem and branches.	Green leaves.	Flower-buds.	Flowers.	Bolls.	Shed leaves.	Shed buds.	Shed bolls.
9th September .. ..	..	..	..	..	..	..	..	..	..
23rd September .. ..	..	..	..	..	..	..	..	..	..
7th October	5.950	6.750	13.900	..	..	..	17.850	..	..
21st October	6.716	6.551	15.380	12.450	..	11.960	18.600	..	12.830
4th November	6.220	5.851	15.750	13.050	..	10.050	18.900	13.850	9.750
18th November	5.550	5.351	17.900	13.950	12.750	12.250	20.200	13.800	10.330
2nd December	5.300	4.900	18.850	12.250	4.400	7.900	20.400	14.000	11.100
16th December	5.4000	5.450	18.900	..	..	5.850	20.600	13.500	11.650
30th December	4.650	5.550	18.950	..	..	5.500	20.950	13.500	11.800
13th January	5.450	6.250	19.350	..	..	5.070	20.200	13.500	11.750
27th January	5.130	4.960	19.500	..	..	6.520	19.250	13.500	12.280
10th February	5.000	5.08	18.540	..	..	6.451	21.350	13.760	12.590

TABLE No. 161.

Ash percentage in the different organs of the cotton plant. (Protected.)

1930-31.

Date.	Roots.	Stem and branches.	Green leaves.	Flower- buds.	Flowers.	Bolls.	Shed leaves.	Shed buds.	Shed bolls.
8th October	6.430	8.660	19.465	..	..	..	19.730	..	..
22nd October	6.200	7.550	19.350	15.900	..	..	22.150	..	..
5th November	6.120	7.490	17.330	11.200	..	14.620	21.280	..	..
19th November	6.170	7.730	16.710	12.320	..	10.020	21.150	14.080	13.730
3rd December	6.060	5.500	18.770	13.610	..	8.920	20.640	..	11.600
17th December	5.920	6.030	17.150	12.820	12.500	9.270	20.100	13.500	10.000
31st December	5.850	5.550	17.800	14.100	..	16.000	21.550	14.300	11.800
14th January	5.650	5.900	19.800	..	..	7.150	21.750	13.800	12.150
28th January	5.450	5.900	20.650	..	..	7.900	21.000	14.200	12.300
11th February	5.550	5.950	20.850	..	..	8.300	21.500	13.430	12.950
25th February	4.500	5.950	19.700	..	..	8.700	21.100	13.270	13.550

TABLE No. 162.

Ash percentage in the different organs of the cotton plant. (Protected.)

1931-32.

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Date.	Roots.	Stem and branches.	Green leaves.	Flower- buds.	Flowers.	Bolls.	Shed leaves.	Shed buds.	Shed bolls.
22nd October	7.25	9.45	15.50	..	..	..	22.10	..	..
5th November	7.50	8.75	16.65	..	..	..	22.10	..	..
19th November	7.20	7.95	19.20	14.55	..	..	21.95	..	..
3rd December	6.70	7.10	18.65	14.50	..	..	21.50	..	..
16th December	6.20	7.20	19.16	14.88	14.80	14.88	23.60	14.30	9.80
30th December	7.05	6.10	19.10	14.05	13.65	9.65	21.25	13.40	10.70
13th January	6.25	6.40	21.40	..	..	7.60	22.25	..	11.65
27th January	5.60	6.30	22.75	..	..	7.95	23.05	..	13.15
10th February	5.15	6.70	21.55	..	..	6.90	22.40	..	11.75
24th February	5.35	5.35	23.15	..	..	6.60	22.85	..	14.35

TABLE No. 163.

Total ash in the different organs of the cotton plant in grammes. (Protected.)

1929-30.

Date.	Roots.	Stem and branches.	Green leaves.	Flower-buds.	Flowers.	Bolls.	Shed leaves.	Shed buds.	Shed bolls.	Total in the whole plant.
7th October	0·2227	0·4388	2·1781	..	..	..	0·5592	..	..	3·4288
21st October	0·5232	1·0390	4·0610	0·1587	..	0·0325	0·8202	..	0·0359	6·6705
4th November	0·8428	1·3530	5·0240	0·4348	..	0·1121	1·0180	0·0508	0·0424	8·8779
18th November	0·7171	1·4880	6·7130	0·8672	0·2550	1·2250	1·4460	0·0920	0·3357	13·1390
2nd December	0·7207	1·7640	8·3520	0·2164	0·0147	3·2580	1·9370	0·1400	1·5910	17·9938
16th December	0·8533	2·4280	8·6380	..	..	4·4060	2·6780	0·1620	2·6100	21·8753
30th December	0·9300	2·4510	6·8000	..	..	5·4910	3·6290	0·1610	2·3600	21·8220
13th January	1·0350	2·7250	5·2130	..	..	4·776	6·3050	0·1610	2·563	22·7780
27th January	1·0260	2·2030	3·432	..	..	7·563	7·1220	0·1610	2·533	24·040
10th February	1·0700	2·0580	2·349	..	..	8·877	9·394	0·1376	2·2662	26·1518

TABLE NO. 164.

Total ash in the different organs of the cotton plant in grammes. (Protected.)

1930-31.

Date.	Roots.	Stem and branches.	Green leaves.	Flower-buds.	Flowers.	Bolls.	Shed leaves.	Shed buds.	Shed bolls.	Total.
8th October	0·2212	0·3637	1·5770	..	..	..	0·2171	..	..	2·3790
22nd October	0·2852	0·8455	3·0650	0·2931	..	..	0·5755	0·0060	..	5·0643
5th November	0·4309	1·0190	3·3680	0·0433	..	0·0753	0·5958	0·0221	0·0170	5·5714
19th November	0·5924	1·9170	4·7960	0·2415	..	0·1803	1·2270	0·0235	0·0407	9·0184
3rd December	0·7877	1·6040	5·5680	0·7031	..	0·5353	1·7200	0·0083	0·0303	10·9567
17th December	0·9590	1·4350	5·5220	0·6167	0·0750	1·3160	1·4070	0·0110	0·0368	12·3785
31st December	1·0530	1·6540	4·8420	0·5640	..	3·0240	3·4470	0·0181	0·2922	14·8943
14th January	0·9902	1·7230	4·4330	..	..	3·1030	5·8380	0·0198	0·2738	16·3808
28th January	1·0900	1·7410	4·4920	..	..	4·2460	5·7750	0·0262	0·2616	17·6318
11th February	1·0990	1·2300	3·0240	..	..	4·1780	5·0530	0·0221	0·2256	14·8217
25th February	0·8730	1·3090	2·2660	..	..	4·9800	5·5910	0·0235	0·1721	15·3761

TABLE NO. 165.

Total ash in the different organs of the cotton plant in grammes. (Protected.)

1931-32.

Date.	Roots.	Stem and branches.	Green leaves.	Flower-buds.	Flowers.	Bolls.	Shed leaves.	Shed buds.	Shed bolls.	Total.
22nd October	0·1933	0·4730	1·7360	..	..	..	0·1165	..	..	2·5128
5th November	0·3500	0·8896	3·1219	..	..	..	0·5157	..	..	4·8772
19th November	0·9120	2·0802	6·1440	0·1667	..	..	0·9512	..	..	10·3541
3rd December	1·2060	1·9596	8·5790	0·9280	..	..	1·4620	..	..	14·1346
16th December	1·1625	2·1600	9·8674	1·2462	0·2516	0·8556	2·1240	0·0715	0·2450	17·9838
30th December	1·2337	1·8452	9·2635	0·6674	0·2730	2·6537	1·9125	0·0670	0·7490	18·6650
13th January	1·2181	1·9040	8·7205	..	..	3·8000	2·8925	..	2·2717	20·8074
27th January	1·1200	1·9215	9·4412	..	..	3·6371	3·6304	..	2·3012	22·0514
10th February	1·1072	3·0820	5·8185	..	..	3·2085	6·2223	..	2·5262	21·9647
24th February	1·0700	2·5412	5·9032	..	..	6·3195	7·8832	..	2·7265	26·4436
Date	22/10	5/11	19/11	3/12	16/12	30/12	13/1	27/1	10/2	24/2
Total leaves	1·8465	3·6376	7·0952	10·0410	11·9914	11·1760	11·6130	13·0716	12·0408	13·7864

TABLE No. 166.

Percentage mineral composition of dry matter in the different organs of the cotton plant. (Protected.)

1930-31.

Constituents.	Appearance of flower-buds. 8/10.	End of flowering. 31/12.	Maturation of bolls. 25/2.
ROOTS.			
Ash	7.21	5.85	4.63
P ₂ O ₅	0.8292	0.4523	0.4353
Lime	0.5550	1.7912	1.1850
K ₂ O	3.3742	2.3391	1.9300
STEM AND BRANCHES.			
Ash	10.23	5.55	5.90
P ₂ O ₅	0.8611	0.5129	0.3060
Lime	1.3100	2.1192	1.9050
K ₂ O	3.7112	2.4312	1.4500
LEAVES.			
Ash	15.33	17.800	21.85
P ₂ O ₅	1.026	1.1524	0.9232
Lime	4.37	8.1132	7.4550
K ₂ O	4.1258	4.3009	5.8110
FLOWER-BUDS.			
Ash .. .. .	..	14.10	..
P ₂ O ₅ .. .. .	..	1.4306	..
Lime .. .. .	..	..	..
K ₂ O .. .. .	..	..	..
FLOWERS.			
Ash .. .. .	..	..	..
P ₂ O ₅ .. .. .	..	1.4691	..
Lime .. .. .	..	..	..
K ₂ O .. .. .	..	..	..

TABLE No. 166—(contd.)

Percentage mineral composition of dry matter in the different organs of the cotton plant. (Protected.)

1930-31.

Constituents.	Appearance of flower-buds. 8/10.	End of flowering. 31/12.	Maturation of bolls. 25/2.
BOLLS.			
Ash	8.000	6.90
P ₂ O ₅	1.1911	0.8210
Lime	2.2191	1.85
K ₂ O	2.2901	1.8350
SHED LEAVES.			
Ash	21.55	18.45
P ₂ O ₅	1.0927	0.9325
Lime	9.7815	8.7333
K ₂ O	3.8217	6.7790
SHED BUDS.			
Ash	14.30	13.47
P ₂ O ₅	1.3320
Lime
K ₂ O
SHED BOLLS.			
Ash	11.80	17.82
P ₂ O ₅	1.0031	0.7940
Lime	3.1134	3.4550
K ₂ O	3.7117	2.9055

TABLE No. 167.

Percentage mineral composition of dry matter at different stages of growth in the cotton plant. (Protected.)

1931-32.

Constituents.	Appearance of flower-buds. 1/10.	Appearance of flowers 3/12.	End of flowering. 13/1.	Maturity of bolls. 25/2.
ROOTS.				
Ash	8.56	6.30	6.53	6.12
P ₂ O ₅	0.9792	0.7336	0.6898	0.6251
Lime	0.5100	0.6400	2.3500	1.8000
K ₂ O	3.1767	2.2973	2.2802	1.8595
STEM AND BRANCHES.				
Ash	12.20	6.55	6.07	5.32
P ₂ O ₅	0.8197	0.8293	0.7336	0.4784
Lime	1.2500	0.8000	1.6000	1.4000
K ₂ O	3.5199	2.3438	2.6343	2.4019
LEAVES.				
Ash	17.59	18.70	21.30	22.28
P ₂ O ₅	1.1036	1.5629	1.2565	0.9760
Lime	3.8900	5.1900	6.1200	8.0800
K ₂ O	3.2348	3.5408	4.8890	5.6250
FLOWER-BUDS.				
Ash .. .. .	..	14.25	13.44	..
P ₂ O ₅ .. .. .	..	1.5948	1.3779	..
Lime .. .. .	..	2.8500	1.6800	..
K ₂ O .. .. .	..	3.7423	3.5408	..
FLOWERS.				
Ash .. .. .	..	13.85	14.20	..
P ₂ O ₅ .. .. .	..	1.5756	1.4672	..
Lime .. .. .	..	2.2300	0.6200	..
K ₂ O .. .. .	..	3.3083	3.5114	..

TABLE No. 167—(contd.)

Percentage mineral composition of dry matter at different stages of growth in the cotton plant. (Protected.)

1931-32.

Constituents.	Appearance of flower-buds 1/10.	Appearance of flowers. 3/12.	End of flowering. 13/1.	Maturity of bolls. 25/2.
BOLLS.				
Ash	18.10	7.50	6.85
P ₂ O ₅	2.1179	0.9815	0.9887
Lime	4.5000	2.2000	1.6000
K ₂ O	2.0920	2.6343	3.7035
SHED LEAVES.				
Ash	21.86	21.90	21.27
P ₂ O ₅	1.4129	1.5948	1.1992
Lime	7.3600	8.9400	8.6000
K ₂ O ₅	3.2154	3.5951	4.4164
SHED BUDS.				
Ash
P ₂ O ₅	1.6841	1.6841	..
Lime	1.2000	..
K ₂ O ₅
SHED BOLLS.				
Ash	14.38
P ₂ O ₅	0.4889	1.0971	..
Lime	4.5600
K ₂ O	4.1064	3.6803

TABLE NO. 168.

Percentage of nitrogen in the different organs of the cotton plant. (Protected.)

1929-30.

Date.	Roots.	Stem and branches.	Green leaves.	Flower-buds.	Flowers.	Bolls.	Shed leaves.	Shed buds.	Shed bolls.
9th September.. .. .	1.1170	1.5490	3.9320	..	..	..	..	..	..
23rd September	0.8937	1.3900	3.4690	..	..	..	..	..	..
7th October	0.6621	1.0920	3.4690	3.7180	..	..	2.4500	..	..
21st October	0.5627	0.7877	3.1370	3.7800	2.9300	2.6220	2.3440	2.6960	..
4th November.. .. .	0.6354	0.6158	2.8200	3.5620	3.0900	2.1310	2.0650	2.5950	1.8930
18th November.. .. .	0.5426	0.5958	2.7540	3.1390	2.7080	2.2230	2.0650	2.4650	1.7780
2nd December	0.5524	0.5657	2.2770	3.0840	2.6680	1.7580	1.8190	2.4520	1.7240
16th December	0.4177	0.7610	2.1280	..	..	1.5380	1.7380	2.3300	1.7510
30th December	0.3906	0.4984	2.0470	..	..	1.5630	1.6160	2.3300	1.7820
13th January	0.4177	0.4310	1.8860	..	..	1.3950	1.4550	2.3300	1.7380
27th January	0.4315	0.4641	1.8960	..	..	1.3990	1.3080	2.3300	1.9090
11th February	0.4250	0.4969	1.9230	..	..	1.1330	1.3730	2.4590	1.7520

TABLE No. 169.

Percentage of nitrogen in the different organs of the cotton plant. (Protected.)

1930-31.

Date.	Roots.	Stem and branches.	Green leaves.	Flower-buds.	Flowers.	Bolls.	Shed leaves.	Shed buds.	Shed bolls.
8th October	0.7615	0.9465	3.3920	..	..	..	2.2572	..	..
22nd October	0.6350	0.7730	3.5130	3.4990	2.9160	..	2.0280	2.5010	..
5th November	0.6390	0.7370	3.4300	3.5130	3.0160	2.7350	2.0820	2.7610	2.1240
19th November	0.6015	0.6280	3.2320	3.4910	..	2.3750	2.0720	2.9370	2.2600
3rd December	0.4180	0.5060	2.9870	3.1020	2.8120	1.8250	2.0520	2.2500	2.0220
17th December	0.4410	0.5170	2.4630	2.9780	2.7060	2.0320	1.9010	2.2060	1.8400
31st December	0.4650	0.5105	2.4570	2.7650	2.9210	1.825	1.9350	2.2610	1.8270
14th January	0.4260	0.4260	2.2590	..	..	1.6270	1.7360	2.4730	1.9010
28th January	0.4250	0.4700	2.0210	..	..	1.3660	1.6150	2.6160	1.8360
11th February	0.3801	0.4630	1.9450	..	..	1.2740	1.5620	2.6550	1.8050
25th February	0.529	0.4718	1.881	..	..	1.1840	1.4760	3.136	1.2080

TABLE No. 170.

Percentage of nitrogen in the different organs of the cotton plant. (Protected.)

1931-32.

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Date.	Roots.	Stem and branches.	Green leaves.	Flower-buds.	Flowers.	Bolls.	Shed leaves.	Shed buds.	Shed bolls.	Total.
22nd October	0.7851	1.2035	3.0234	..	..	..	1.8043	..	..	2.213
5th November	0.7980	0.8635	2.8691	3.3063	..	..	1.5625	..	..	1.957
19th November	0.6063	0.6764	3.2536	3.3436	..	..	1.6731	..	..	1.854
3rd December	0.5742	0.6321	3.0105	3.2150	..	..	1.5445	..	..	2.068
16th December	0.5163	0.6080	3.1901	3.1396	2.2428	2.7872	1.5702	2.8189	1.9740	2.028
30th December	0.4288	0.5572	2.7282	3.0863	2.8696	2.2286	1.5631	2.5022	1.9597	1.820
13th January	0.4357	0.4803	2.4853	..	..	1.8121	1.4217	..	1.8014	1.557
27th January	0.4357	0.4419	2.2548	..	..	1.6523	1.1789	..	1.7030	1.400
10th February	0.4357	0.4288	1.8183	..	..	1.4348	1.1912	..	1.780	1.137
24th February	0.4465	0.4911	2.1749	..	..	1.7184	1.0867	..	1.7015	1.329
Date	22/10	5/11	19/11	3/12	16/12	30/12	13/1	27/1	10/2	24/2
Average total leaves ..	4.8277	4.4316	4.9267	4.5550	4.7603	4.2913	3.9070	3.4337	3.0095	3.2616

TABLE No. 171.

Nitrogen content of the growing leaf on the cotton plant. (Protected.)

Leaves incepted on 3rd October.

(Average of six leaves.)

1930-31.

Age in days.	Area in square cms.	Dry matter in grams.	Percentage moisture.	Percentage nitrogen.	Total nitrogen in gms. per leaf.	Remarks.
8 ..	32.20	0.1400	76.3905	3.888	0.0054	
12 ..	43.17	0.2468	76.3948	3.533	0.0087	
16 ..	56.17	0.2481	77.8704	3.595	0.0102	
20 ..	54.13	0.3087	76.9846	3.449	0.0107	
24 ..	54.45	0.3111	77.4317	3.313	0.0103	
28 ..	52.88	0.3183	76.4314	3.238	0.0103	
32 ..	54.93	0.3205	77.3871	3.055	0.0098	
36 ..	55.93	0.3495	75.6446	2.973	0.0104	
43 ..	56.25	0.3523	74.8573	2.802	0.0099	
50 ..	55.80	0.3650	72.0800	2.759	0.0101	
57 ..	55.81	0.3846	73.8700	2.602	0.0100	
78 ..	64.10	0.4745	75.4100	2.273	0.0108	
85 ..	55.50	0.3792	75.2900	1.799	0.0068	Commencement of yellowing.
	..	0.3976	..	1.707	0.0066	Do.
100 ..	..	0.3776	..	1.091	0.0041	Completely detached.
107 ..	..	0.3876	..	1.280	0.0050	Do.

TABLE No. 172.

Nitrogen content of the growing leaf on the cotton plant. (Protected.)

Leaves incepted on 1st September.

(Average of six leaves.)

1931-32.

Date.	Average area in sq. cms.	Dry matter in grams.	Percentage moisture.	Percentage nitrogen.	Total quantity of nitrogen in gms. per leaf.	Remarks.
7th September	36.50	0.1392	80.5618	4.111	0.0057	
12th September	48.27	0.2383	78.7100	3.221	0.0077	
17th September	51.98	0.2802	78.5264	3.246	0.0091	
22nd September	55.08	0.2758	81.0836	3.464	0.0096	Over 3" rain on 19th, 20th and 21st September.
29th September	68.56	0.4192	78.2160	3.026	0.0126	
3rd October ..	71.48	0.4333	78.0443	2.800	0.0121	
8th October ..	82.68	0.4958	79.4303	2.681	0.0133	
15th October ..	72.35	0.4417	78.9131	2.537	0.0112	
22nd October ..	..	0.4438	78.1000	2.349	0.0104	Leaves about to yellow.
24th October ..	..	0.4483	..	1.716	0.0077	Leaves yellow and turned dry towards the periphery.
26th October ..	..	0.4082	..	1.646	0.0067	Leaves fallen.
30th October ..	..	0.4421	..	1.529	0.0068	Do.
31st October ..	..	0.4421	..	1.286	0.0057	

TABLE No. 173.

Nitrogen content of the growing leaf on the cotton plant. (Protected.)

Leaves incepted on 2nd October 1931.

(Average of six leaves.)

1931-32.

Date.	Area in square cms.	Dry matter in grams.	Percentage moisture.	Percentage nitrogen.	Total quantity of nitrogen in gms. per leaf.	Remarks.
8th October ..	33.98	0.1367	79.7381	3.832	0.0053	
15th October ..	66.45	0.3614	76.7542	3.3990	0.0123	
20th October ..	53.30	0.3525	75.0626	2.673	0.0094	
24th October ..	66.98	0.4373	73.5717	2.588	0.0113	
29th October ..	70.90	0.4244	74.8900	2.469	0.0106	
3rd November	70.00	0.4167	74.89	2.623	0.0109	
11th November	65.100	0.4778	72.89	2.508	0.0120	
18th November	67.20	0.4450	74.50	2.438	0.0109	
21st November	60.43	0.3911	74.39	2.384	0.0093	
28th November	76.60	0.4726	74.08	2.315	0.0109	
5th December	70.00	0.5009	75.76	2.263	0.0113	
19th December	70.00	0.4708	73.88	1.865	0.0088	Yellow.
25th December	..	0.4801	..	1.104	0.0053	Detached.
30th December	..	0.4778	..	1.238	0.0059	Do.

TABLE No. 174.

Nitrogen content of the growing leaf on the cotton plant. (Protected.)

Leaves incepted on 3rd November.

(Average of six leaves.)

1931-32.

Date.	Area in square cms.	Dry matter in grams.	Percentage moisture.	Percentage nitrogen.	Total quantity of nitrogen in gms. per leaf.	REMARKS.
11th November	24.90	0.1556	73.09	3.748	0.0058	
16th November	28.31	0.1839	74.00	3.343	0.0061	
23rd November	36.55	0.2377	..	3.206	0.0076	
28th November	34.40	0.2070	75.82	3.366	0.0069	
5th December	35.28	0.2116	75.05	3.109	0.0066	
12th December	34.66	0.2133	76.81	3.152	0.0067	
19th December	34.89	0.2160	75.79	1.801	0.0039	Slight yellowish.
26th December	35.00	0.2143	75.21	1.930	0.0041	Do.
2nd January	..	0.2200	..	1.775	0.0039	Dried at the periphery.
17th January	..	0.2199	..	1.672	0.0036	

TABLE NO. 175.

Total nitrogen in grammes in the different organs of the cotton plant. (Protected.)

1929-30.

Date.	Roots.	Stem and branches.	Green leaves.	Flower-buds.	Flowers.	Bolls.	Shed leaves.	Shed buds.	Shed bolls.	Total.
9th September ..	0·0091	0·0138	0·0900	..	..	..	..	..	..	0·1129
23rd September ..	0·0113	0·0209	0·3191	..	..	..	..	..	..	0·3513
7th October ..	0·0248	0·0710	0·5437	0·0033	..	..	0·0767	0·0019	..	0·7214
21st October ..	0·0438	0·1401	0·8283	0·0620	0·0027	0·0071	0·1034	0·0037	..	1·1911
4th November ..	0·0861	0·1428	0·8997	0·1187	0·0027	0·0238	0·1113	0·0953	0·0083	1·4887
18th November ..	0·0702	0·1657	1·0330	0·1951	0·0278	0·2223	0·1480	0·0164	0·0578	1·9363
2nd December ..	0·0751	0·2036	1·0090	0·0504	0·0089	0·7250	0·1728	0·0245	0·2471	2·5164
16th December ..	0·0666	0·3390	0·9727	..	..	1·1600	0·2259	0·0280	0·3922	3·1838
30th December ..	0·0778	0·2202	0·7345	..	..	1·5600	0·2801	0·0309	0·3564	3·2599
13th January ..	0·0794	0·1879	0·5082	..	..	1·3140	0·4437	0·0309	0·3788	2·9429
27th January ..	0·0863	0·2061	0·3337	..	..	1·6240	0·4839	0·0309	0·3940	3·1589
11th February ..	0·09095	0·2013	0·2435	..	..	2·0130	0·6042	0·0246	0·3154	3·5735

TABLE No. 176.

Total nitrogen in grammes in the different organs of the cotton plant. (Protected.)

1930-31.

Date.	Roots.	Stem and branches.	Green leaves.	Flower-buds.	Flowers.	Bolls.	Shed leaves.	Shed buds.	Shed bolls.	Total.
8th October	0·0262	0·0435	0·2748	0·0432	..	..	0·0248	..	..	0·4125
22nd October	0·0292	0·0866	0·5550	0·0644	0·0058	..	0·0527	0·0060	..	0·7997
5th November	0·0450	0·1002	0·6667	0·0136	0·0047	0·0141	0·0583	0·0221	0·0170	0·9417
19th November	0·0582	0·1558	0·9276	0·0684	..	0·0428	0·1201	0·0235	0·0407	1·4371
3rd December	0·0543	0·1475	0·8863	0·1603	0·0042	0·1095	0·1710	0·0082	0·0303	1·5716
17th December	0·0714	0·1230	0·7932	0·1429	0·0162	0·2886	0·1331	0·0110	0·0368	1·6162
31st December	0·0837	0·1521	0·6683	0·0111	0·0020	0·6900	0·3095	0·0181	0·2922	2·2270
14th January	0·0750	0·1244	0·5059	..	..	0·7065	0·4340	0·0198	0·2738	2·1394
28th January	0·0850	0·1387	0·4397	..	..	0·7345	0·4443	0·0262	0·2616	2·1300
11th February	0·0752	0·0959	0·2821	..	..	0·6410	0·3671	0·0221	0·2257	1·7091
25th February	0·1026	0·1038	0·2116	..	..	0·6680	0·3910	0·0235	0·1721	1·6726

TABLE No. 177.

Total nitrogen in grammes in the different organs of the cotton plant. (Protected.)

1931-32.

Date.	Roots.	Stem and branches.	Green leaves.	Flower-buds.	Flowers.	Bolls.	Shed leaves.	Shed buds.	Shed bolls.	Total.
22nd October	0.0209	0.0602	0.3386	..	..	..	0.0090	..	..	0.4287
5th November	0.0372	0.0878	0.5380	0.0082	..	..	0.0365	..	..	0.7077
19th November	0.0768	0.1770	1.9412	0.0613	0.0015	..	0.0725	..	..	1.4303
3rd December	0.1034	0.1745	1.3848	0.2058	0.2226	..	0.1050	..	..	2.2031
16th December	0.0968	0.1824	1.6429	0.2694	0.0381	0.1603	0.1413	0.0141	0.0520	2.5972
30th December	0.0750	0.1686	1.3232	0.1466	0.0574	0.6129	0.1407	0.0125	0.1372	2.6741
13th January	0.0849	0.1429	1.0128	0.0231	0.0224	0.9060	0.1848	..	0.3513	2.7282
27th January	0.0871	0.1348	0.9357	..	..	0.7559	0.1857	..	0.2980	2.3972
10th February	0.0937	0.1972	0.4909	..	..	0.6672	0.3309	..	0.3827	2.1626
24th February	0.0893	0.2333	0.5546	..	..	1.6454	0.3749	..	0.3233	3.2208
Dates	22/10	5/11	19/11	3/12	16/12	30/12	13/1	27/1	10/2	24/2
Total leaves	0.3476	0.5745	1.1137	1.4898	1.7842	1.4639	1.1976	1.1214	0.8218	0.9295

TABLE No. 178.

Percentage of ether extract in the different organs of the cotton plant. (Protected.)

1929-30.

Date.	Roots.	Stem and branches.	Green leaves.	Flower-buds.	Flowers.	Bolls.	Shed leaves.	Shed buds.	Shed bolls.
7th October	3.3485	0.9892	4.2495	..	..	..	2.2502	..	..
21st October	2.6004	1.5613	4.3977	2.4717	..	..	2.3696	..	..
4th November	1.8000	0.8516	4.7994	2.6492	..	1.8638	3.7490	..	..
18th November	1.7505	2.4998	4.8000	2.4983	1.9000	3.0000	2.9482	..	3.0500
2nd December	1.8500	0.8000	5.0999	2.1004	..	2.5001	3.1000	1.4700	2.0993
16th December	2.6500	1.1001	5.8840	..	..	4.3001	2.9492	2.1083	2.1495
30th December	3.1641	1.0700	6.2531	..	..	9.9475	4.6730	1.8975	2.1995
13th January	2.5200	1.6447	7.9733	..	..	6.8874	7.2000	1.9461	1.9885
27th January	2.3995	1.3601	6.4756	..	..	5.4905	7.2000	1.9022	1.5194
11th February	1.6748	1.6198	6.0103	..	..	7.9039	5.4611	1.8500	1.4977

TABLE No. 179.

Percentage of ether extract in the different organs of the cotton plant. (Protected.)

1930-31.

Date.	Roots.	Stem and branches.	Green leaves.	Flower-buds.	Flowers.	Bolls.	Shed leaves.	Shed buds.	Shed bolls.
8th October	2.010	1.520	3.780	..	..	..	3.080	..	..
22nd October	1.710	0.950	4.700	1.900	..	..	3.450	..	..
5th November	1.580	0.700	4.180	..	..	..	3.50	..	..
19th November	1.630	0.870	4.270	1.570	..	1.810	2.750	..	1.900
3rd December	2.050	0.550	5.340	1.990	..	2.070	2.180	..	2.560
17th December	2.400	1.000	3.950	1.450	2.160	1.750	2.550	1.550	2.350
31st December	2.350	0.580	6.000	..	..	4.550	3.500	1.600	2.320
14th January	2.050	0.950	6.400	..	..	5.800	3.650	3.000	2.150
28th January	2.850	1.500	5.600	..	..	5.050	5.550	2.600	2.250
11th February	1.700	0.650	6.700	..	..	6.200	8.150	3.000	2.350
25th February	2.800	1.250	5.35	..	..	5.650	6.150	..	4.500

TABLE NO. 180.

Percentage of ether extract in the different organs of the cotton plant. (Protected.)

1931-32.

Date.	Roots.	Stem and branches.	Green leaves.	Flower-buds.	Flowers.	Bolls.	Shed leaves.	Shed buds.	Shed bolls.	Total leaves.
22nd October	1.95	1.35	2.95	..	..	..	..	..	..	2.95
5th November	1.30	1.15	2.90	..	..	..	2.90	..	..	5.80
19th November	2.05	1.20	4.05	2.10	..	..	2.60	..	..	6.65
3rd December	1.75	1.05	4.10	2.15	..	..	2.80	..	..	6.90
16th December	1.65	0.85	3.25	1.95	1.50	2.65	3.80	..	2.75	7.05
30th December	2.55	0.95	4.30	2.20	..	2.30	3.35	..	..	7.65
13th January	2.45	0.90	5.55	..	..	3.10	2.30	..	2.50	7.85
27th January	2.10	1.05	4.95	..	..	3.05	3.70	..	2.40	8.65
10th February	2.40	1.00	6.20	..	..	2.80	4.10	Buds inclusive.	2.25	10.30
24th February	2.45	1.15	6.65	..	..	6.45	5.50		2.35	12.15

TABLE NO. 181.

Total ether extract, in grammes, of the different organs of the cotton plant. (Protected.)

1929-30.

Date. . .	Roots.	Stem and branches.	Green leaves.	Flower- buds.	Flowers.	Bolls.	Shed leaves.	Shed buds.	Shed bolls.
7th October	0.1253	0.0643	0.6659	..	..	..	0.0705	..	..
21st October	0.2026	0.2776	1.1610	0.0315	..	..	0.1045	..	..
4th November	0.2439	0.1974	1.5310	0.0883	..	0.0208	0.2020	..	..
18th November	0.2261	0.6952	1.8000	0.1553	0.0190	0.3000	0.2113	..	0.0991
2nd December	0.2516	0.2880	2.2608	0.0343	..	1.0313	0.3135	0.0147	3.009
16th December	0.4187	0.4900	2.6890	..	..	3.2380	0.3834	0.0253	0.4815
30th December	0.6170	0.4726	2.2430	..	..	9.9310	0.8100	0.0253	0.4399
13th January	0.4788	0.7171	2.1480	..	..	6.4880	2.1960	0.0253	0.4335
27th January	0.4799	0.6039	1.1397	..	..	6.3690	2.6640	0.0253	0.3135
10th February	0.3584	0.6560	0.7615	..	..	10.8814	2.4030	0.01850	0.3295

TABLE NO. 102.

Total ether extract, in grammes, of the different organs of the cotton plant. (Protected.)

1930-31.

Date.	Roots.	Stem and branches.	Green leaves.	Flower-buds.	Flowers.	Bolls.	Shed leaves.	Shed buds.	Shed bolls.	Total.
8th October	0·0691	0·0638	0·3062	..	..	..	0·0339	..	..	0·4730
22nd October	0·0787	0·1064	0·7426	0·0350	..	..	0·0897	..	..	1·0524
5th November	0·1112	0·0952	0·8126	..	..	..	0·0980	..	..	1·1170
19th November	0·1565	0·2158	1·2255	0·0308	..	0·0326	0·2175	..	0·0342	1·9129
3rd December	0·2665	0·1604	1·5842	0·1028	..	0·1242	0·1817	..	0·0384	2·4582
17th December	0·3888	0·2380	1·2719	0·0696	0·0130	0·2465	0·1785	0·0078	0·0470	2·4631
31st December	0·4230	0·1728	1·6320	..	..	1·7199	0·5600	0·0128	0·3712	4·8917
14th January	0·3608	0·2774	1·4336	..	..	2·5172	0·9125	0·0240	0·3096	5·8351
28th January	0·5700	0·4425	1·2180	..	..	2·7144	1·5263	0·0250	0·3206	6·8168
11th February	0·3366	0·1343	0·9715	..	..	3·1207	1·9153	0·0250	0·2938	6·7972
25th February	0·5432	0·2750	0·6019	..	..	3·2346	1·6298	..	0·6413	6·9258

TABLE No. 183.

Total ether extract, in grammes, of the different organs of the cotton plant. (Protected.)

1931-32.

Date.	Roots.	Stem and branches.	Green leaves.	Flower-buds.	Flowers.	Bolls.	Shed leaves.	Shed buds.	Shed bolls.	Total.
22nd October	0·0520	0·0676	0·3304	..	..	..	..	..	..	0·4500
5th November	0·0607	0·1169	0·0544	..	..	..	0·0677	..	..	0·2997
19th November	0·2597	0·3140	1·2960	0·0385	..	..	0·1127	..	..	2·0209
3rd December	0·3150	0·2898	1·8860	0·1376	..	..	0·1904	..	..	2·8188
16th December	0·3094	0·2550	1·6738	0·1633	0·0255	0·1524	0·3420	..	0·0688	2·9902
30th December	0·4463	0·2874	2·0855	0·1045	0·0300	0·6325	0·3015	..	..	3·8877
13th January	0·4778	0·2678	2·2616	..	0·0150	1·5500	0·2990	..	0·4875	5·3587
27th January	0·4200	0·3203	2·0543	..	..	1·3954	0·5828	} Buds inclusive.	0·4200	5·1928
10th February	0·5160	0·4600	1·6740	..	..	1·3020	1·1389		0·4838	5·5747
24th February	0·4900	0·5463	1·6958	..	..	6·1759	1·8975		0·4405	11·2520
Dates	22/10	5/11	19/11	3/12	16/12	30/12	13/1	27/1	10·2	24/2
Total leaves	0·3304	0·1221	1·4087	2·0764	2·158	2·3870	2·5606	2·6371	2·8129	3·5933

TABLE No. 184.

Fibre percentage in the different organs of the cotton plant. (Protected.)

1929-30.

Date.	Roots.	Stem and branches.	Green leaves.	Flower-buds.	Flowers.	Bolls.	Shed leaves.	Shed buds.	Shed bolls.
7th October	54·8546	41·0615	10·8998	..	..	..	8·9371	..	..
21st October	58·7999	51·2559	11·2500	13·7019	..	..	8·9387	..	..
4th November	51·5424	47·1959	14·4514	14·9685	..	7·6344	11·0857	..	..
18th November	51·8000	49·7501	9·9501	11·6007	14·8000	16·6000	8·3005	..	14·8000
2nd December	49·2279	49·5500	9·2001	11·2002	..	17·8000	10·5000	10·9000	14·0093
16th December	48·1456	51·4145	10·4814	..	..	33·2005	11·0000	12·6250	12·2321
30th December	47·6615	52·5923	8·5531	..	..	42·0400	8·7057	11·3627	13·9500
13th January	50·0526	51·4450	6·8003	..	..	46·1995	9·3205	11·6538	13·7064
27th January	47·7500	52·8378	8·0511	..	..	42·6551	10·8000	11·3627	14·0551

TABLE NO. 185.

Fibre percentage in the different organs of the cotton plant. (Protected.)

1930-31.

Date.	Roots.	Stem and branches.	Green leaves.	Flower- buds.	Flowers.	Bolls.	Shed leaves.	Shed buds.	Shed bolls.
8th October	59.05	51.85	17.05	..	..	..	11.45	..	..
22nd October	59.85	59.25	18.85	22.15	..	..	11.90	..	..
5th November	54.90	51.75	12.85	..	..	..	13.75	..	..
19th November	57.45	54.90	12.20	11.44	..	13.80	13.80	..	13.95
3rd December	48.62	53.42	8.99	11.75	..	27.65	10.28	..	14.15
17th December	51.25	54.40	15.45	16.65	21.00	29.05	14.20	18.55	18.35
31st December	39.50	57.75	12.15	..	..	33.00	14.75	17.90	18.30
14th January	44.40	54.90	11.90	..	..	36.95	11.25	12.90	13.55
28th January	48.65	54.55	10.65	..	..	39.80	11.45	13.70	13.15
11th February	51.45	58.30	18.30	..	..	40.15	12.35	13.30	15.20
25th February	44.90	57.70	13.10	..	..	42.15	13.75	..	16.90

TABLE No. 186.

Fibre percentage in the different organs of the cotton plant. (Protected.)

1931-32.

Date.	Roots.	Stem and branches.	Green leaves.	Flower-buds.	Flowers.	Bolls.	Shed leaves.	Shed buds.	Shed bolls.
22nd October	53.65	48.40	14.65	..	..	..	..	..	..
5th November	56.75	52.00	15.40	..	..	..	17.85	..	..
19th November	52.70	56.40	15.70	15.95	..	..	14.90	..	..
3rd December	62.65	60.35	13.40	15.65	..	..	13.75	..	..
16th December	58.55	57.70	12.80	14.60	15.50	15.15	14.95	..	18.10
30th December	55.40	57.90	12.15	13.50	..	18.40	13.20	..	..
13th January	46.00	56.55	12.30	..	..	21.60	15.55	..	17.30
27th January	46.05	53.30	11.70	..	..	29.55	13.20		15.40
10th February	51.95	53.65	11.00	..	..	27.90	12.00	Buds inclusive	14.05
24th February	51.90	52.60	10.55	..	..	36.90	13.00		16.40

TABLE No. 187.

Total fibre in the different organs of the cotton plant in grammes. (Protected.)

1929-30.

Date.	Roots.	Stem and branches.	Green leaves.	Flower-buds.	Flowers.	Bolls.	Shed leaves.	Shed buds.	Shed bolls.	Total in the whole plant.
7th October	2.0526	2.6690	1.7080	..	..	..	0.2800	..	..	6.7096
21st October	4.5811	9.1133	2.9700	0.1747	..	..	0.3942	..	..	17.2333
4th November	6.9840	10.9400	4.6100	0.4999	..	0.0852	0.5973	..	..	23.7164
18th November	6.6905	13.8355	3.7313	0.7211	0.1480	1.6600	0.5949	..	0.4810	27.8623
2nd December	6.6950	17.8380	4.0784	0.1829	..	7.3425	0.9975	0.1090	2.0080	39.2513
16th December	7.6070	22.9000	4.7900	..	..	25.0000	1.4300	0.1515	2.7400	64.6185
30th December	9.2940	23.230	3.068	..	..	41.9700	1.509	0.1515	2.7900	82.0125
13th January	9.5010	22.4300	1.832	..	..	43.5200	2.8470	0.1515	2.988	83.2695
27th January	9.5500	23.460	1.417	..	..	49.4800	3.996	0.1515	2.9000	..

TABLE No. 188.

Total fibre in the different organs of the cotton plant in grammes. (Protected.)
1930-31.

Date.	Roots.	Stem and branches.	Green leaves.	Flower-buds.	Flowers.	Bolls.	Shed leaves.	Shed buds.	Shed bolls.	Total.
8th October	2·0313	2·2284	1·3811	..	..	..	0·1260	..	..	5·7668
22nd October	2·7531	6·6360	2·5043	0·4076	..	..	0·3094	..	..	12·6104
5th November	3·8649	7·0380	2·4981	..	..	..	0·3850	..	..	13·7860
19th November	5·5151	13·6150	3·5014	0·2242	..	0·2484	0·8004	..	0·2511	24·1556
3rd December	6·3205	15·5810	2·6671	0·6071	..	1·6590	0·8566	..	0·2123	27·9036
17th December	8·3026	12·9470	4·9750	0·7992	0·1260	4·1252	0·9986	0·0928	0·3626	32·7290
31st December	7·1100	17·2090	3·3048	..	..	12·4740	2·3600	0·1432	2·9280	45·5290
14th January	7·8144	16·0310	2·6656	..	..	16·0360	2·8125	0·0872	1·9512	47·3979
28th January	9·7300	16·0920	2·2946	..	..	21·3920	3·1488	0·1370	1·8739	54·6683
11th February	10·4250	12·0480	2·6535	..	..	20·2090	2·9023	0·1108	1·9000	50·2486
25th February	8·7106	12·6940	1·4737	..	..	24·1310	3·6437	..	2·4082	53·0612

TABLE No. 189.

Total fibre in the different organs of the cotton plant in grammes. (Protected.)

1931-32.

Date.	Roots.	Stem and branches.	Green leaves.	Flower-buds.	Flowers.	Bolls.	Shed leaves.	Shed buds.	Shed bolls.	Total in the whole plant.	Total leaves.
22nd October ..	1·4307	2·4224	1·6408	..	..	..	..	..	..	15·4939	1·6408
5th November ..	2·6484	5·2867	2·8875	..	..	..	0·4165	..	..	1·2391	3·3040
19th November ..	6·6753	14·7580	5·0240	2·9241	..	..	0·6457	..	..	30·0271	5·6697
3rd December ..	11·2775	16·8566	6·1640	1·0016	..	..	0·9350	..	..	36·0347	7·0990
16th December ..	10·9781	17·3100	6·5920	1·2227	0·2635	0·8711	1·3455	..	0·4525	39·0354	7·9375
30th December ..	9·6950	17·5147	5·8927	0·6412	..	5·0600	1·1880	..	..	39·9916	7·0807
13th January ..	8·9700	16·8236	5·0122	..	..	10·8000	2·0215	..	3·3735	47·0008	7·0337
27th January ..	9·2100	16·2565	4·8555	..	..	13·5191	2·0790	..	2·6950	48·6151	6·9345
10th February ..	11·1692	24·6790	2·9700	..	..	12·9735	3·3334	Buds inclusive	3·0207	58·1458	6·3034
24th February ..	10·3800	24·9850	2·6902	..	..	35·3317	4·4850	..	3·1160	80·9879	7·1752

TABLE No. 190.

Percentage of total hydrolysable carbohydrates in different organs of the cotton plant. (Protected.)

1929-30.

Date.	Roots.	Stem and branches	Green leaves.	Flower- Buds.	Flowers.	Bolls.	Shed leaves.	Shed buds.	Shed bolls.
7th October	31·7050	44·3707	49·3128	..	..	..	50·2028	..	..
21st October	28·3699	36·4145	49·3602	40·9882	..	..	55·4376	..	..
4th November	36·4664	42·2653	47·6574	47·0507	..	67·1237	53·3612	..	..
18th November	37·5000	38·6757	50·1317	51·8501	40·4200	54·2560	55·8690	..	60·7046
2nd December	40·1713	41·2152	52·6336	54·2498	..	60·8167	54·4421	58·7200	62·0156
16th December	41·1930	37·2770	51·4288	..	..	47·0199	54·5900	57·1833	63·0236
30th December	41·9118	37·6728	53·4384	..	..	32·7459	55·5849	60·6015	60·9130
13th January	39·4152	37·9667	54·5033	..	..	33·1247	53·7013	59·5923	61·2247
27th January	42·0835	37·9394	54·1193	..	..	36·5845	54·5757	60·5037	60·7958

TABLE No. 191.

Percentage of total hydrolysable carbohydrates in different organs of the cotton plant. (Protected.)

1930-31.

Date.	Roots.	Stem and branches.	Green leaves.	Flower-buds.	Flowers.	Bolls.	Shed leaves.	Shed buds.	Shed bolls.
8th October	27.7500	30.2905	38.4963	..	..	..	51.6364	..	..
22nd October	28.2717	27.4179	38.0968	38.1413	..	..	49.8462	..	..
5th November	33.4048	35.4522	44.2098	..	..	..	48.4571	..	..
19th November	30.9604	32.5742	46.6188	52.3468	..	59.5111	48.3534	..	67.7556
3rd December	40.6608	37.3693	48.2291	53.2603	..	49.9516	54.0746	..	68.6400
17th December	37.6747	35.3412	48.0528	50.4458	47.4500	47.2288	51.2000	63.9200	66.1800
31st December	49.3939	32.9315	48.6922	..	..	43.3057	48.1163	64.1000	66.1394
14th January	45.2602	35.5860	47.7942	..	..	39.9267	50.8980	68.1500	70.5146
28th January	40.3935	37.1444	50.5623	..	..	38.7107	51.9018	64.8000	71.2905
11th February	37.7242	32.2015	41.9855	..	..	37.3889	48.2340	64.4786	69.3600
25th February	44.4943	32.1509	49.6524	..	..	36.2086	49.7800	..	69.8421

TABLE NO. 192.

Percentage of total hydrolysable carbohydrates in different organs of the cotton plant. (Protected.)

1931-32.

Date.	Roots.	Stem and branches.	Green leaves.	Flower-buds.	Flowers.	Bolls.	Shed leaves.	Shed buds.	Shed bolls.	Percentage in the whole plant.
22nd October	32.441	33.271	48.006	..	..	..	..	..	..	40.820
5th November	29.465	32.701	49.729	..	..	..	47.371	..	..	41.839
19th November	34.260	30.223	40.718	..	..	..	50.091	..	..	35.584
3rd December	25.417	27.529	45.028	47.606	..	..	52.299	..	..	37.063
17th December	30.373	29.853	44.848	48.452	54.194	49.893	47.838	..	56.346	40.200
31st December	32.319	31.565	47.400	50.958	..	55.720	52.431	..	..	41.262
14th January	42.579	33.147	46.244	..	..	56.375	51.015	..	65.487	48.036
28th January	42.467	36.586	46.508	..	..	49.124	52.679	..	58.576	46.827
11th February	37.776	35.971	49.890	..	..	53.433	54.051	..	61.869	47.984
25th February	37.506	37.831	46.059	..	..	39.313	51.858	..	57.321	42.783

TABLE No. 193.

Total hydrolysable carbohydrates in grammes in the different organs of the cotton plant. (Protected.)

1929-30.

Date.	Roots.	Stem and branches.	Green leaves.	Flower-buds.	Flowers.	Bolls.	Shed leaves.	Shed buds.	Shed bolls.	Total.
7th October	1·1864	2·8841	7·7280	0·0361	..	..	1·5729	..	..	13·4075
21st October	2·2103	6·4745	13·0311	0·5226	0·0365	0·1824	2·4448	0·0822	0·1700	25·1544
4th November	4·0412	9·7971	15·2027	1·5682	0·0348	0·7491	2·8751	0·2214	0·2635	35·6531
18th November	4·8435	10·7557	18·7994	3·2230	0·4042	5·4256	3·9898	0·3917	1·9729	49·8058
2nd December	5·4633	14·8375	23·3325	0·8859	0·1347	25·0869	5·1720	0·5872	8·8887	84·3887
16th December	6·5085	16·6032	23·5036	..	..	35·4060	7·0967	0·6862	14·1173	103·9215
30th December	8·1728	16·6401	19·1684	..	..	32·6913	9·6347	0·8080	12·1826	99·2979
13th January	7·4889	16·5535	14·6832	..	..	31·2035	16·3789	0·7747	13·4478	100·5305
27th January	8·4167	16·8451	9·5257	..	..	42·4380	20·1936	0·8047	12·4240	110·6478

TABLE No. 194.

Total hydrolysable carbohydrates in the different organs of the cotton plant in grammes. (Protected.)

1930-31.

Date.	Roots.	Stem and branches.	Green leaves.	Flower-buds.	Flowers.	Bolls.	Shed leaves.	Shed buds.	Shed bolls.	Total.
8th October	0.9546	1.2722	3.1182	0.0150	..	..	0.5680	..	..	5.9280
22nd October	1.3005	3.0708	6.0193	0.7018	0.0949	..	1.2960	0.1534	..	12.6367
5th November	2.3517	4.8215	8.5944	0.2024	0.0734	0.3062	1.3568	0.5114	0.5420	18.7598
19th November	2.9722	8.0784	13.3796	1.0260	..	1.0712	2.8045	0.5114	1.2196	31.0629
3rd December	5.2859	10.8994	14.3080	2.7518	0.0712	2.9971	4.5062	0.2344	1.0296	42.0836
17th December	6.1033	8.4112	15.4736	2.4214	0.2847	6.7065	3.5840	0.3196	1.3236	44.6279
31st December	8.8909	9.8136	13.2443	0.2018	0.0325	16.2696	7.6986	0.5128	10.5823	67.2464
14th January	7.9658	10.3911	10.7059	..	..	17.3282	12.7245	0.5452	10.1541	69.8148
28th January	8.0787	10.9576	10.9973	..	..	20.8070	14.2730	0.6480	10.1589	75.9205
11th February	7.4694	6.6550	6.0879	..	..	18.8193	8.4327	0.5373	8.6700	56.6716
25th February	8.6319	7.0732	5.5859	..	..	20.7294	13.1917	0.4836	9.9528	65.6485

TABLE No. 195.

Total hydrolysable carbohydrates in the different organs of the cotton plant in grammes. (Protected.)

1931-32.

Date.	Roots.	Stem and branches	Green leaves.	Flower-buds.	Flowers.	Bolls.	Shed leaves.	Shed buds.	Shed bolls.	Total.	Total leaves.
22nd October	0·8651	1·6658	5·3768	..	..	..	..	..	..	7·9077	5·3768
5th November	1·3751	3·3247	9·3242	..	..	..	1·1053	..	..	15·1293	10·4295
19th November	4·3397	7·9085	13·0300	..	..	..	2·1706	..	..	27·4488	15·2006
3rd December	4·5552	7·5980	20·7130	3·0468	..	..	3·5563	..	..	39·4693	24·2693
16th December	5·6950	9·1350	23·0068	4·0578	0·9213	2·8689	4·3054	..	1·4087	51·4889	27·4022
30th December	5·6562	9·5487	22·9893	2·4205	..	15·3228	4·7188	..	..	60·6563	27·7081
13th January	8·3028	9·8614	18·4257	..	..	28·1880	6·6320	..	12·7704	84·1803	25·0577
27th January	8·7056	11·1591	19·3010	..	..	22·4744	8·2968	..	10·2513	80·1882	25·5978
10th February	8·1220	16·5470	13·4695	..	..	24·8460	15·0154	..	13·3023	91·3022	28·4949
24th February	7·5012	17·9695	11·7448	..	..	37·6429	17·8913	..	10·8913	103·6410	29·6361

TABLE No. 196.

Ratio of total hydrolysable carbohydrates to total nitrogen in different organs of the protected plants.

1929-30.

Date.	Roots.	Stem and branches.	Green leaves.	Flower-buds.	Flowers.	Bolls.
7th October	47.84	40.62	14.21	12.00	..	..
21st October	50.46	46.21	15.74	8.43	13.51	25.69
4th November	48.67	68.51	16.96	13.18	12.51	31.48
18th November	68.99	67.29	18.12	16.69	14.43	24.44
2nd December	72.84	72.73	23.12	17.60	15.13	34.63
16th December	98.62	38.82	22.91	..	..	30.54
30th December	104.78	75.64	26.26	..	..	20.95
13th January	94.79	88.09	28.90	..	..	23.74
27th January	97.87	81.77	28.88	..	..	26.13

TABLE No. 197.

Ratio of total hydrolysable carbohydrates to total nitrogen in different organs of the protected plants.

1930-31.

Date.	Roots.	Stem and branches.	Green leaves.	Flower-buds.	Flowers.	Bolls.
8th October	36.43	29.24	11.34	..	..	..
22nd October	44.53	35.46	10.84	10.89	16.36	..
5th November	52.27	48.21	12.89	14.89	15.61	21.43
19th November	59.17	51.78	14.42	14.95	16.95	25.03
3rd December	97.21	73.89	16.15	17.16	17.57	27.37
17th December	85.48	68.38	19.50	14.14	16.25	23.44
31st December	106.22	64.56	19.81	18.18	..	23.58
14th January	106.21	83.79	21.16	..	..	24.52
28th January	95.05	78.99	25.01	..	..	28.32
11th February	99.58	69.39	21.58	..	..	29.35
25th February	84.13	68.14	26.39	..	..	31.03

TABLE NO. 198.

Ratio of total hydrolysable carbohydrates to total nitrogen in different organs of the protected plants.

1931-32.

Date.	Roots.	Stem and branches.	Green leaves.	Flower-buds.	Flowers.	Bolls.
22nd October	41.19	27.76	15.88	..	..	..
5th November	37.16	37.79	17.33	..	..	..
19th November	56.50	44.68	12.53	..	..	..
3rd December	44.22	43.42	14.95	14.80	..	..
16th December	58.71	50.19	14.05	15.09	24.19	17.89
30th December	75.41	56.83	17.37	16.47	..	24.99
13th January	97.68	68.95	18.19	..	..	31.11
27th January	100.06	82.66	20.64	..	..	29.73
10th February	86.40	83.94	27.44	..	..	37.25
24th February	84.29	77.12	21.16	..	..	..

TABLE NO. 199.

Ratio of total ash to total nitrogen absorbed by the plant at different stages of growth. (Unprotected plants.)

Date.	1929-30.	1930-31.	1931-32.
18th September	..	..	5.79
25th September	..	..	6.14
30th September	4.22	..	..
1st October	..	..	7.22
8th October	..	..	5.60
14th October	3.41	6.06	..
29th October	5.73	6.07	6.92
12th November	6.19	5.88	7.42
26th November	7.66	6.85	7.11
10th December	7.15	7.21	7.04
24th December	7.17	7.62	7.23
7th January	8.29	8.56	8.06
21st January	8.43	10.46	8.81
4th February	9.00	10.49	8.42
18th February	..	10.67	10.54
4th March	..	10.85	7.47

TABLE No. 200.

*Ratio of total ash to total nitrogen absorbed by the plant at different stages of growth.
(Protected.)*

Date.	1929-30.	1930-31.	1931-32.
7th October	4·75	5·76	..
21st October	5·60	6·13	5·86
4th November	5·96	5·91	6·89
18th November	6·78	6·26	7·24
2nd December	7·11	6·97	6·49
16th December	6·87	7·04	6·92
30th December	6·69	6·68	6·98
13th January	7·74	7·66	7·62
27th January	7·61	8·27	9·19
10th February	7·31	8·67	10·15
24th February .. .. .	....	9·19	8·21

TABLE No. 201.

*Percentage of total nitrogen and of insoluble albuminoid nitrogen in growing and shed bolls of the same size.
1926-27.*

Date.	Organ.	Percentage total nitrogen.	Percentage insoluble albuminoid nitrogen.
11th December ..	Young bolls with bracts	2·492	1·688
	Shed " "	2·410	1·609
25th December ..	Young " "	2·428	1·307
	Shed " "	1·625	1·294
9th February ..	Young " "	2·369	1·741
	Shed " "	1·979	1·239
24th February ..	Young " "	2·640	1·952
	Shed " "	1·943	1·404
11th March ..	Young " "	2·229	1·803
	Shed " "	1·748	1·352
10th January ..	Young bolls without bracts ..	2·569	2·086
	Shed " "	2·558	2·200
25th January ..	Young " "	2·506	1·864
	Shed " "	2·412	1·856

TABLE No. 201—(contd.)

Percentage of total nitrogen and of insoluble albuminoid nitrogen in growing and shed bolls of the same size.

1927-28.

Date.	Organ.	Percentage total nitrogen.	Percentage insoluble albuminoid nitrogen.
28th November ..	Young buds with bracts	4.171	3.504
	Shed " " " "	2.290	1.996
12th December ..	Young " " " "	3.730	2.331
	Shed " " " "	2.356	1.825
26th December ..	Young bolls " " " "	2.675	2.196
	Shed " " " "	2.473	1.986
9th January ..	Young " " " "	2.632	1.916
	Shed " " " "	1.874	1.300
23rd January ..	Young " " " "	2.480	1.982
	Shed " " " "	1.731	1.234
6th February ..	Young " " " "	2.891	1.987
	Shed " " " "	1.713	1.277

TABLES FOR CHAPTER VI.

TABLE No. 202.

Plant performance with 3 acre-inches of water, given at various depths from the commencement of flowering.

Dates of watering :—30-10-26, 30-11-26 and 19-1-27.

1926-27.

(Average of 5 plants in each set.)

Organs.	At the depth of			
	Control.	30 cms.	60 cms.	90 cms.
BEFORE THE COMMENCEMENT OF THE TREATMENT.				
Vegetative buds	108·4	92·2	82·2	94·5
Flower-buds	46·8	38·2	29·6	45·75
FINAL PERFORMANCE.				
Vegetative buds	294·0	400·4	442·8	571·7
Flower-buds	299·2	376·4	381·2	533·0
Flowers	79·8	90·4	87·2	168·5
Bolls	27·4	37·2	35·00	68·2
Seed-cotton in gms.	56·74	74·88	70·78	130·81
Percentage success of :—				
Bud to flower	26·6	24·0	22·8	31·6
Flower to boll	34·3	41·1	40·0	40·5
Bud to boll	9·1	9·8	9·1	12·8

TABLE No. 203.

Plant performance with 2 acre-inches of water, given at various depths from the close of monsoon.

Dates of watering :—18-10, 7-11, 3-12, 28-12-27, 11-1, 31-1 & 21-2-28.

1927-28.

(Average of 5 plants in each set.)

Organs.	At the depth of			
	Control.	30 cms.	60 cms.	90 cms.
BEFORE THE COMMENCEMENT OF THE TREATMENT.				
Vegetative buds	359·3	321·6	276·9	321·3
Flower-buds	115·0	108·3	94·0	96·9
FINAL PERFORMANCE.				
Vegetative buds	688·2	911·4	777·2	815·0
Flower-buds	315·0	464·2	342·0	365·6
Flowers	76·8	153·8	120·2	123·6
Bolls	33·6	65·4	50·2	50·4
Seed-cotton in gms.	53·16	96·09	82·42	83·40
Percentage success of :—				
Bud to flower	24·3	33·1	35·1	33·8
Flower to boll	43·7	42·5	41·7	40·7
Bud to boll	10·6	14·0	14·8	13·6

TABLE No. 204.

Plant performance with 2 acre-inches of water, given at various depths from the commencement of flowering.

Dates of watering :—6-12-27, 26-12-27, 9-1-28, 30-1-28 and 20-2-28.

1927-28.

(Average of 5 plants in each set.)

Organs.	At the depth of			
	Control.	30 cms.	60 cms.	90 cms.
BEFORE THE COMMENCEMENT OF THE TREATMENT.				
Vegetative buds	523·6	696·7	503·4	792·8
Flower-buds	225·8	385·8	197·1	364·4
FINAL PERFORMANCE.				
Vegetative buds	556·8	774·6	575·0	921·8
Flower-buds	234·8	424·8	232·5	461·4
Flowers	64·6	108·0	63·0	128·4
Bolls	30·2	47·6	30·75	54·8
Seed-cotton in gms.	40·58	65·33	47·40	87·82
Percentage success of :—				
Buds to flower	27·5	25·4	27·1	27·8
Flower to boll	46·7	44·0	48·8	42·6
Bud to boll	12·9	11·2	13·2	11·8

TABLE No. 205.

Plant performance with 2 acre-inches of water, given at various depths from the midst of flowering.

Dates of watering :—26-12, 9-1, 30-1 and 20-2.

1927-28.

(Average of 5 plants in each set.)

Organs.	At the depth of			
	Control.	30 cms.	60 cms.	90 cms.
BEFORE THE COMMENCEMENT OF THE TREATMENT.				
Vegetative buds	538·6	712·2	827·0	947·2
Flower-buds	230·2	351·2	400·6	625·7
FINAL PERFORMANCE.				
Vegetative buds	556·8	794·8	880·0	999·5
Flower-buds	234·8	377·0	417·6	648·6
Flowers	64·6	92·0	111·2	170·6
Bolls	30·2	37·4	44·4	70·0
Seed-cotton in gms.	40·58	65·91	77·55	122·15
Percentage success of :—				
Buds to flower	27·5	24·4	26·6	26·3
Flower to boll	46·7	40·6	39·9	41·0
Bud to boll	12·9	9·9	10·6	10·7

TABLE No. 206.

Plant performance with one acre-inch of water, given at various depths from the close of the monsoon.

Dates of watering :—15-10, 5-11, 26-11, 17-12-28, 7-1, 28-1, & 18-2-29.
1928-29.

(Average of 5 plants in each set.)

Organs.	At the depth of			
	Control.	30 cms.	60 cms.	90 cms.
	BEFORE THE COMMENCEMENT OF THE TREATMENT.			
Vegetative buds	163.2	163.0	195.4	138.2
Flower-buds	67.4	67.8	83.8	58.8
	FINAL PERFORMANCE.			
Vegetative buds	402.8	429.2	539.2	362.4
Flower-buds	349.4	339.8	372.2	297.4
Flowers	62.8	71.4	92.4	65.4
Bolls	22.2	23.0	29.4	22.8
Seed-cotton in gms.	43.60	41.00	58.50	39.00
Percentage success of :—				
Bud to flower	18.0	21.0	24.8	22.0
Flower to boll	35.3	32.2	31.8	34.9
Bud to boll	6.4	6.8	7.9	7.7

TABLE No. 207.

Plant performance with one acre-inch of water, given at various depths from the commencement of flowering.

Dates of watering :—17-11-28, 8-12-28, 29-12-28, 19-1-29, 9-2-29 and 2-3-29.
1928-29.

(Average of 5 plants in each set.)

Organs.	At the depth of			
	Control.	30 cms.	60 cms.	90 cms.
BEFORE THE COMMENCEMENT OF THE TREATMENT.				
Vegetative buds	315.8	324.4	321.8	368.0
Flower-buds	229.4	245.6	263.6	269.6
FINAL PERFORMANCE.				
Vegetative buds	402.8	417.8	429.0	479.8
Flower-buds	349.4	322.6	360.0	342.2
Flowers	62.8	68.0	75.4	81.4
Bolls	22.2	20.6	24.6	28.6
Seed-cotton in gms.	43.6	37.10	45.00	54.10
Percentage success of :—				
Buds to flower	18.0	21.1	20.9	23.8
Flower to boll	35.3	30.0	32.6	35.1
Bud to boll	6.4	6.4	6.8	8.4

TABLE No. 208.

Plant performance with one acre-inch of water, given at various depths from the midst of flowering.

Dates of watering :—10-12, 31-12, 27-1, 11-2 and 4-3

1928-29.

(Average of 5 plants in each set.)

Organs.	At the depth of			
	Control.	30 cms.	60 cms.	90 cms.
BEFORE THE COMMENCEMENT OF THE TREATMENT.				
Vegetative buds	377·9	320·4	347·8	401·0
Flower-buds	300·9	243·8	306·8	328·4
FINAL PERFORMANCE.				
Vegetative buds	455·2	385·6	403·8	502·8
Flower-buds	386·7	288·0	354·2	401·0
Flowers	87·0	61·6	78·8	97·4
Bolls	27·7	17·2	26·4	33·0
Seed-cotton in gms.	46·87	27·50	55·10	66·20
Percentage success of:—				
Buds to flower	22·5	21·4	22·2	24·3
Flower to boll	31·8	27·9	33·5	83·9
Bud to boll	7·2	6·0	7·0	8·2

TABLE No. 209.
*Plant performance with 2 acre-inches of water, given at the depth of 45 cms.
 from mid-October.*
 Protected plants.
 1930-31.
 (Average of 9 plants.)

Organs produced.	Only tube as control.	2 acre-inches.	Increase or decrease over control.	
PLANT GROWTH AT THE COMMENCEMENT OF TREATMENT.				
Vegetative buds	201.9	199.9	-2.0	
Flower-buds	196.2	191.8	-4.4	
FINAL PLANT PERFORMANCE AT THE END OF THE SEASON.				
Vegetative buds	265.3	294.9	-429.6	
Flower-buds	311.6	308.1	-3.5	
Flowers	110.8	118.8	8.0	
Bolls	46.0	55.8	9.8	
Percentage success of:—				
Buds into flowers	35.5	38.6	3.6	
Flowers into bolls	41.5	47.0	5.5	
Buds into bolls	14.7	18.1	3.4	
Seed-cotton in grammes	62	79	16.7	
Ratio $\frac{\text{Seed-cotton}}{\text{Plant body}}$	0.92	1.03	..	
ANALYSIS OF VARIANCE FOR NUMBER OF BOLLS.				
Due to	Degrees of Freedom.	Sum of squares.	Mean Square.	$\frac{1}{2}$ log _e . mean square.
Between treatments	1	430.22	430.22	0.72954
Within treatments	16	1975.56	123.47	0.10538
Total	17	2405.75	..	0.62416

According to Fisher's table of Z for $n_1=1$ & $n_2=16$, $Z=0.7514$ when $P=0.05$
 There is therefore no significant difference between treatments.

TABLE No. 210.

Plant performance with 2 acre-inches of water, given bi-weekly in small and equal doses at the depth of 45 cms. from 26-10-31 to 31-12-31.

Protected plants.

1931-32.

(Average of 10 plants.)

Organs produced.	Only tubes.	2 acre-inches.	Increase or decrease over control.
PLANT GROWTH AT THE COMMENCEMENT OF TREATMENT.			
Vegetative buds	129	109	-20
Flower-buds	63	50	-13
FINAL PLANT PERFORMANCE AT THE END OF THE SEASON.			
Vegetative buds	292.2	296.2	4.0
Flower-buds	271.8	295.6	23.8
Flowers	113.0	127.7	14.7
Bolls	52.8	50.5	-2.3
Percentage success of—			
Buds into flowers	41.6	43.2	1.6
Flowers into bolls	46.7	39.5	-7.2
Buds into bolls	19.4	17.1	-2.3
Weight in grammes of —			
Seed-cotton	83.7	91.8	8.1
Dry plant body	49.1	52.2	3.1
Ratio $\frac{\text{Seed-cotton}}{\text{Plant body}}$	1.71	1.76	0.05

TABLE No. 211.

Average number of vegetative and flower-buds in treatments of application of water at the depth of 60 cms. from middle of October, in small and equal bi-weekly doses to make up the following quantities per month.

1929-30.

(Average of 10 plants in each set.)

Fortnight ending	$\frac{1}{2}$ acre-inch of water.		Control.		1 acre-inch of water.	
	Vegetative buds.	Flower-buds.	Vegetative buds.	Flower-buds.	Vegetative buds.	Flower-buds.
2nd September	32.5	4.7	24.6	1.7	32.8	3.9
16th September	59.8	22.9	41.8	13.2	63.9	20.5
30th September	93.5	65.9	70.0	41.4	106.4	67.6
14th October	110.3	98.3	84.6	72.5	118.3	108.5
28th October	54.1	98.8	40.8	76.3	51.1	106.5
11th November	36.1	116.5	34.3	85.0	53.0	138.5
25th November	40.4	86.8	35.1	85.0	53.1	199.8
9th December	20.0	62.4	19.7	52.7	27.0	60.8
23rd December	17.0	34.6	12.9	20.4	19.6	26.8
6th January	12.5	9.8	5.8	9.1	7.4	10.8
20th January	1.4	1.0	0.1	..	0.5	0.2
Total	477.6	601.7	369.7	457.3	533.1	663.9

Fortnight ending	$1\frac{1}{2}$ acre-inches of water.		Control.		2 acre-inches of water.	
	Vegetative buds.	Flower-buds.	Vegetative buds.	Flower-buds.	Vegetative buds.	Flower-buds.
3rd September	27.3	2.7	18.1	0.1	30.2	3.6
17th September	48.5	14.9	36.0	7.8	49.9	20.1
2nd October	86.5	50.7	77.2	31.7	100.1	61.9
16th October	96.3	78.8	74.1	59.6	100.2	88.9
30th October	53.6	103.9	39.4	78.3	49.7	108.6
14th November	68.7	144.2	50.4	124.9	64.1	134.5
28th November	67.9	122.2	31.3	72.3	64.6	117.1
12th December	41.2	69.2	17.6	45.0	31.1	71.6
26th December	20.2	33.9	12.1	18.3	15.9	26.7
9th January	9.4	6.8	4.0	2.8	7.3	6.3
23rd January	0.2	0.2	0.5	..	1.6	0.3
Total	519.8	627.5	360.7	440.8	514.7	639.6

TABLE NO. 212.

Average number of flowers opened in treatments of application of water at the depth of 60 cms. from middle of October, in small and equal doses to make up the following quantities of water per month.

1929-30.

Week ending	$\frac{1}{2}$ acre-inch of water.	Control.	1 acre-inch of water.	$1\frac{1}{2}$ acre-inches of water.	Control.	2 acre-inches of water.
6th October	0.5	..	0.2	0.1	..	0.1
13th October	4.5	0.6	2.3	1.0	0.1	1.9
20th October	3.5	1.0	2.7	1.3	..	1.4
27th October	2.2	1.1	3.0	0.9	0.6	1.0
3rd November	2.5	2.1	1.7	0.9	0.9	1.2
10th November	1.8	1.1	1.5	0.8	1.0	0.7
17th November	2.7	1.0	0.8	0.3	1.5	1.5
24th November	2.0	1.2	1.1	1.0	1.4	1.1
1st December	2.1	2.7	3.1	2.3	1.2	2.1
8th December	3.9	3.6	7.2	5.6	4.3	5.6
15th December	8.9	5.7	14.5	12.2	8.2	9.1
22nd December	11.2	10.3	18.0	18.3	14.6	12.5
29th December	7.6	7.5	10.9	10.9	8.4	11.8
5th January	12.1	12.3	19.9	20.2	14.3	20.9
12th January	14.4	12.3	15.0	18.1	14.0	19.3
19th January	11.2	8.3	7.7	13.2	7.3	12.0
26th January	5.7	5.1	3.8	5.9	3.0	7.5
2nd February	1.5	0.6	0.6	2.8	0.6	2.9
9th February	0.6	..	0.1	0.6	..	0.4
16th February	0.5	..	0.1	0.1	..	0.2
Total	99.4	76.5	114.2	116.5	81.4	113.2

TABLE No. 213.

Average number of vegetative and flower-buds in treatments of application of water at the depth of 60 cms. from middle of October, water given bi-weekly in small and equal doses to make up 1 and 2 acre-inches per month.

1930-31.

(Average of 10 plants in each set.)

Fortnight ending	1 acre-inch of water.		Control.		2 acre-inches of water.	
	Vegetative buds.	Flower-buds.	Vegetative buds.	Flower-buds.	Vegetative buds.	Flower-buds.
2nd September	37.7	5.6	30.8	2.4	33.7	3.5
16th September	63.8	27.1	51.1	20.2	50.4	16.5
30th September	60.4	57.8	67.1	39.0	61.1	43.5
14th October	51.6	52.1	59.6	71.5	58.6	74.2
28th October	61.0	105.5	56.4	89.4	49.0	55.4
11th November	60.6	92.3	43.0	44.3	51.1	41.1
25th November	41.4	69.6	24.7	59.6	60.4	112.7
9th December	23.8	48.0	14.3	23.7	23.6	44.2
23rd December	9.5	14.0	9.5	11.1	8.6	13.8
6th January .. ..	..	0.7	..	0.2	3.0	0.2
Total	409.8	472.7	356.5	361.4	399.5	405.1

TABLE No. 214.

Average number of flowers opened in treatments of application of water at the depth of 60 cms. from middle of October, water given bi-weekly in small and equal doses to make up 1 and 2 acre-inches per month.

1930-31.

Week ending	1 acre-inch of water.	Control.	2 acre-inches of water.
19th October	1.3	0.3	0.4
26th October	3.3	2.1	0.7
2nd November	1.6	2.5	2.1
9th November	0.3	1.3	0.7
16th November	0.5	0.7	0.9
23rd November	0.6	2.0	1.6
30th November	2.2	4.5	3.9
7th December	6.5	10.5	7.6
14th December	13.7	12.5	11.6
21st December	17.9	14.2	17.9
28th December	25.1	17.1	21.1
4th January	18.4	11.4	17.8
11th January	14.1	7.7	18.0
18th January	4.0	2.2	7.0
25th January	0.4	0.1	1.2
Total	109.9	89.1	112.5

TABLE No. 215.

Percentage of total moisture in several layers of the soil, expressed on oven-dry basis, in the plot serving as control to plots irrigated with $\frac{1}{2}$ and 1 acre-inch of water at a depth of 2 feet.

1929-30.

Date of sampling.	22.5 to 45 cms.	45 to 67.5 cms.	67.5 to 90 cms.	Average for 22.5 to 90 cms.
12th September	26.74	27.06	27.71	27.17
26th September	26.42	27.06	27.88	27.12
11th October	25.94	27.23	28.20	27.12
25th October	24.07	26.26	27.39	25.91
8th November	21.80	24.37	24.84	23.67
22nd November	21.65	22.85	23.30	22.60
6th December	21.07	22.10	23.15	22.10
24th December	21.36	22.40	22.70	22.15
3rd January	20.92	21.65	21.65	21.41
17th January	20.19	20.63	21.21	20.68
31st January	20.34	19.90	20.77	20.34

TABLE No. 216.

Percentage of total moisture in several layers of the soil, expressed on oven-dry basis, in the plot receiving water at the rate of 1 acre-inch per month at a depth of 2 feet.

1929-30.

Date of sampling.	22.5 to 45 cms.	45 to 67.5 cms.	67.5 to 90 cms.	Average for 22.5 to 90 cms.
12th September .. .. .	..	..	..	..
26th September .. .. .	..	..	..	..
11th October	25.62	28.37	28.53	27.50
25th October	23.30	25.62	28.04	25.65
8th November	22.10	23.30	25.16	23.52
22nd November	22.10	23.61	23.91	23.21
6th December	21.65	22.55	21.80	22.00
24th December	20.63	20.92	21.80	21.12
3rd January	21.65	24.07	22.70	22.81
17th January	20.05	21.65	22.10	21.27
31st January	22.10	25.16	23.00	23.42

TABLE No. 217.

Percentage of total moisture in several layers of the soil, expressed on oven-dry basis, in the plot receiving water at the rate of 2 acre-inches per month at a depth of 60 cms.

1929-30.

Date of sampling.	22.5 to 45 cms.	45 to 67.5 cms.	67.5 to 90 cms.	Average for 22.5 to 90 cms.
12th September .. .. .	..	..	..	..
26th September .. .. .	..	..	..	..
11th October	24.84	26.90	29.63	26.92
25th October	22.85	26.42	27.71	25.66
8th November	20.19	21.80	26.42	22.80
22nd November	26.58	23.91	28.56	26.45
6th December	22.85	27.55	26.90	25.80
24th December	21.65	27.88	29.03	26.19
3rd January	23.15	27.71	27.06	25.97
17th January	22.85	26.58	27.39	25.61
31st January	29.20	30.33	29.87	29.82

TABLE No. 218.

Percentage of total moisture in several layers of the soil, expressed on oven-dry basis, in plot serving as control to plots irrigated with 1 and 2 acre-inches of water per month.

1930-31.

Date of sampling.	22.5 to 45 cms.	45 to 67.5 cms.	67.5 to 90 cms.
5th September.. .. .	27.23	26.90	27.71
30th September	26.74	27.39	27.55
14th October	22.10	24.68	27.06
28th October	20.77	22.55	24.84
11th November	21.65	23.46	24.07
25th November	20.19	22.10	23.000
9th December	19.90	20.77	22.25
23rd December	20.05	20.63	22.25
6th January	19.62	19.76	20.19
20th January	18.76	19.90	19.47
3rd February	18.91	19.62	20.34
17th February	18.62	18.62	20.05

TABLE NO. 219.

Percentage of total moisture in several layers of the soil, expressed on oven-dry basis, in the plot receiving water at the rate of 1 acre-inch per month at a depth of 2 feet.

1930-31.

Date of sampling.	5 to 22½ cms.	22½ to 45 cms.	45 to 67½ cms.
5th September	27.39	27.39	27.06
30th September	26.90	28.37	28.37
14th October	25.16	24.68	25.94
15th October	Commencement of irrigation.		
25th October	23.00	24.84	25.31
11th November	22.40	24.68	25.78
25th November	21.07	22.40	23.61
9th December	20.34	21.07	22.55
23rd December	21.36	25.00	25.78
6th January	20.19	24.84	24.37
20th January	18.34	22.70	24.37
26th January	Irrigation stopped.		
3rd February	20.63	22.10	23.30
17th February	18.78	20.77	21.65

TABLE NO. 220.

Percentage of total moisture in several layers of the soil, expressed on oven-dry basis, in plot receiving irrigation at 2 acre-inches per month at a depth of 60 cms.

1930-31.

Date of sampling.	5 to 22½ cms.	22½ to 45 cms.	45 to 67½ cms.
5th September	27.55	27.23	27.23
30th September	26.90	27.23	27.23
14th October	23.91	25.04	26.58
15th October	Commencement of irrigation.		
28th October	21.21	26.42	26.90
11th November	25.78	28.20	28.37
25th November	25.31	29.20	29.37
9th December	27.39	28.04	28.86
23rd December	28.37	28.86	29.37
6th January	26.10	29.03	29.20
20th January	23.90	28.53	28.04
26th January	Irrigation stopped.		
3rd February	23.46	28.04	27.23
17th February	22.10	24.07	24.03

TABLE No. 221.

Percentage of total moisture in several layers of the soil, expressed on oven-dry matter, in the plot serving as control to plot receiving water at 2 acre-inches per month.

1931-32.

Date of sampling.	22½ to 45 cms.	45 to 67½ cms.	67½ to 90 cms.	Average for 22½ to 90 cms.
21st October	34.41	31.23	31.06	32.23
4th November	30.72	31.58	30.38	30.89
18th November	25.62	26.72	27.06	26.47
3rd December .. .. .	..	..	..	..
17th December	22.25	22.85	24.68	23.27
30th December	23.30	22.70	23.30	23.10
13th January	20.92	23.15	22.55	22.21
27th January	21.65	21.51	22.40	21.85
10th February	19.76	20.48	21.65	20.63
24th February	18.76	19.19	20.05	19.33
9th March	15.47	..	18.48	16.98

TABLE No. 222.

Percentage of total moisture in several layers of the soil, expressed on oven-dry matter, in the plot receiving water at 2 acre-inches per month.

1931-32.

Date of sampling.	22½ to 45 cms.	45 to 67½ cms.	67½ to 90 cms.	Average for 22½ to 90 cms.
21st October	31.58	31.06	30.72	31.12
4th November	30.38	30.55	31.06	30.66
18th November	29.87	29.70	29.87	29.81
3rd December .. .. .	..	..	..	..
17th December	29.37	29.70	30.04	29.70
30th December	29.53	31.58	29.87	30.33
13th January	28.37	29.37	28.70	28.81
27th January	29.20	29.70	30.38	29.76
10th February	27.23	26.58	27.23	27.01
24th February	25.00	26.26	26.74	26.00
9th March	25.00	24.84	24.53	24.79

TABLE NO. 223.

Effect of the application of nitrogen at 116 lbs. per acre as nitrate of soda with water at 3 acre-inches, from the commencement of flowering.

Dates of watering :—31-10-1926, 1-12-1926 and 27-1-1927.

1926-27.

(Average of 5 plants.)

Plant organs.	At the depth of 30 cms.		At the depth of 60 cms.		At the depth of 90 cms.	
	Water as control.	Water and nitrogen.	Water as control.	Water and nitrogen.	Water as control.	Water and nitrogen.
PERFORMANCE BEFORE COMMENCEMENT OF THE TREATMENT.						
Vegetative buds ..	71.4	90.4	61.0	73.4	73.5	68.2
Flower-buds	22.4	40.0	17.8	27.4	30.7	37.8
FINAL PERFORMANCE.						
Vegetative buds ..	400.4	531.6	442.8	521.0	571.7	651.4
Flower-buds	376.4	526.2	381.2	485.8	533.0	535.8
Flowers	90.4	141.4	87.2	134.4	168.5	166.8
Bolls	37.2	58.2	35.0	49.2	68.2	59.4
Seed-cotton in gms. ..	74.88	112.90	70.78	96.52	130.81	113.49
Percentage success of—						
Bud into flower ..	24.0	26.8	22.8	27.6	31.6	31.1
Flower into boll ..	41.1	41.1	40.0	36.6	40.5	35.6
Bud into boll ..	9.8	11.0	9.1	10.1	12.8	11.1

TABLE No. 224.

Effect of the application of 70 lbs. nitrogen as nitrate of soda per acre with water at 2 acre-inches from the midst of flowering.

Dates of flowering :—28-12, 11-1, 31-1 and 22-2-1928.

1927-28.

(Average of 5 plants.)

Plant organs.	At the depth of 30 cms.		At the depth of 60 cms.		At the depth of 90 cms.	
	Water as control.	Water and nitrogen.	Water as control.	Water and nitrogen.	Water as control.	Water and nitrogen.
PERFORMANCE BEFORE THE COMMENCEMENT OF THE TREATMENT.						
Vegetative buds ..	712.2	816.0	827.0	696.4		
Flower-buds	351.2	431.6	400.6	343.8	..	..
FINAL PERFORMANCE.						
Vegetative buds ..	794.8	903.4	880.0	835.8	..	..
Flower-buds	377.0	473.6	417.6	426.8	..	..
Flowers	92.0	145.8	111.2	151.6	..	..
Bolls	37.4	78.6	44.4	78.6	..	..
Seed-cotton in gms. ..	65.91	117.62	77.75	122.28	..	..
Percentage success of—						
Bud to flower ..	24.4	30.7	26.6	35.5	..	..
Flower to boll ..	40.6	53.9	39.9	51.8	..	..
Bud to boll ..	9.9	16.5	10.6	18.4	..	..

TABLE No. 225.

Effect of the application of 70 lbs. nitrogen per acre as nitrate of soda with water at 1 acre-inch.

Dates of watering :—10-12, 31-12, 21-1, 11-2 and 4-3.

1928-29.

(Average of 5 plants.)

Plant organs.	At the depth of 30 cms.		At the depth of 60 cms.		At the depth of 90 cms.	
	Water as control.	Water and nitrogen.	Water as control.	Water and nitrogen.	Water as control.	Water and nitrogen.
PERFORMANCE BEFORE THE COMMENCEMENT OF THE TREATMENT.						
Vegetative buds ..	320.4	232.2	347.8	217.4	401.0	267.2
Flower-buds	243.8	133.4	306.6	140.6	328.4	196.2
FINAL PERFORMANCE.						
Vegetative buds ..	385.6	636.0	403.8	622.8	502.8	623.2
Flower-buds	288.0	304.4	354.2	275.4	401.0	371.6
Flowers	61.6	50.2	78.8	45.4	97.4	93.0
Bolls	17.2	18.0	26.4	16.2	33.0	41.8
Seed-cotton in grammes.	27.50	16.90	55.10	20.80	66.30	71.10
Percentage success of—						
Bud to flower ..	21.4	16.5	22.2	16.5	24.3	25.0
Flower to boll ..	27.9	34.8	33.5	35.7	33.9	45.9
Bud to boll ..	6.0	5.9	7.5	5.9	8.2	11.4

TABLE No. 226.

Effect of the application of 40, 60, 80, and 100 lbs. of nitrogen per acre with 2 acre-inches of water per month at the depth of 60 cms. from the middle of October in small and equal doses, twice a week. (30 doses.)

1929-30.

(Average of 10 plants in each set.)

Plant organs.	2 acre-inches of water with				
	Control.	40 lbs. N.	60 lbs. N.	80 lbs. N.	100 lbs. N.
PERFORMANCE BEFORE THE COMMENCEMENT OF THE TREATMENT.					
Vegetative buds ..	180.2	206.9	206.2	228.6	298.0
Flower-buds	85.6	96.4	88.6	81.8	188.9
FINAL PERFORMANCE.					
Vegetative buds ..	514.7	813.5	872.9	906.1	1188.4
Flower-buds	693.6	1042.2	988.3	1011.5	1473.9
Flowers	113.2	233.5	235.0	269.7	344.3
Bolls	42.6	82.3	78.8	87.5	113.3
Seed-cotton in gms. . .	82.4	176.0	173.7	192.1	254.9
Dry plant body in gms.	87.6	158.9	159.7	168.3	254.8
Ratio $\frac{\text{Seed-cotton}}{\text{Plant body}}$..	0.94	1.11	1.09	1.14	1.00
Percentage success of—					
Bud to flower ..	17.7	22.5	23.8	26.7	23.4
Flower to boll ..	37.6	35.2	33.5	32.4	32.8
Bud to boll .. .	6.7	7.9	8.0	8.6	7.7

TABLE No. 227.

Effect of the application of 40, and 100 lbs. of nitrogen per acre with 2 acre-inches of water per month at the depth of 60 cms. from the middle of October in small and equal doses, twice a week. (30 doses.)

1930-31.

(Average of 10 plants in each set.)

Plant organs.	2 acre-inches of water with		
	Control.	40 lbs. N	100 lbs. N
PERFORMANCE BEFORE THE COMMENCEMENT OF THE TREATMENT.			
Vegetative buds	203.8	175.9	224.3
Flower-buds	137.7	97.8	153.0
FINAL PERFORMANCE.			
Vegetative buds	399.5	569.4	751.9
Flower-buds	405.1	598.8	701.0
Flowers	112.5	188.0	254.9
Bolls	42.3	63.0	82.6
Seed-cotton in gms.	83.4	142.8	197.1
Dry plant body in gms.	85.8	113.6	172.3
Ratio $\frac{\text{Seed-cotton}}{\text{Plant body}}$	0.97	1.26	1.14
Percentage success of—			
Bud to flower	27.8	31.4	36.4
Flower to boll	37.6	33.5	32.4
Bud to boll	10.4	10.5	11.8

TABLE No. 228.

Effect of the application of 40 and 100 lbs. of nitrogen per acre with 2 acre-inches of water per month at the depth of 60 cms. from 30th October, 1931, in 30 small and equal bi-weekly doses.

1931-32.

(Average performance of *Unprotected plants.*)

Plant organs.	Water as control.	Water and 40 lbs. nitrogen.	Water and 100 lbs. nitrogen.
PERFORMANCE BEFORE THE COMMENCEMENT OF THE TREATMENT.			
Vegetative buds	157.7	149.7	205.4
Flower-buds	57.4	53.9	109.8
FINAL PERFORMANCE.			
Vegetative buds	433.9	704.3	908.0
Flower-buds	284.2	505.7	725.4
Flowers	89.1	184.3	243.0
Bolls	40.8	77.2	95.9
Seed-cotton in gms.	81.0	160.3	199.5
Dry plant body	51.1	84.5	154.2
Ratio $\frac{\text{Seed-cotton}}{\text{Plant body}}$	1.59	1.87	1.29
Percentage success of—			
Bud to flower	31.4	36.4	33.5
Flower to boll	45.7	41.9	39.6
Bud to boll	14.4	15.3	13.2

TABLE No. 229.

Effect of the application of 40 lbs. of nitrogen per acre with 2 acre-inches of water per month at the depth of 45 cms. in 20 small and equal doses from middle of October in 1930-31 and from 26th October in 1931-32.

(Average performance of *Protected plants*; average of 9 plants in each set in 1930-31 and of 20 in 1931-32.)

Plant organs	1930-31.		1931-32.	
	Water as control.	Water with nitrogen.	Water as control.	Water with nitrogen.
PERFORMANCE BEFORE THE COMMENCEMENT OF THE TREATMENT.				
Vegetative buds	199.9	180.7	109.0	124.7
Flower-buds	191.8	187.2	50.4	65.1
FINAL PERFORMANCE.				
Vegetative buds	294.9	444.4	296.2	580.7
Flower-buds	303.1	510.6	295.6	704.5
Flowers	118.8	230.0	127.7	311.0
Bolls	55.8	96.3	50.5	109.7
Weight of seed-cotton in gms. ..	78.7	190.9	91.8	222.0
Dry plant body	76.6	108.2	52.2	418.2
Ratio $\frac{\text{Seed-cotton}}{\text{Dry plant body}}$	1.03	1.76	1.76	1.50
Percentage success of :—				
Bud to flower	38.6	45.0	43.2	44.1
Flower to boll	47.0	41.9	39.5	35.3
Bud to boll	18.1	18.9	17.1	15.6

TABLE No. 230.

Weekly total production in five plants of vegetative buds and flower-buds and the relative success of flower-buds into flowers in experiments of nitrogen application with 2 acre-inches of water per month.

(Protected plants. Spacing 3' × 9".)

1930-31.

Week ending	25 lbs. N. for one month.				Only tubes.				50 lbs. N. for 2 months.			
	Vegetative buds.	Flower buds.	Relative flowers	Relative success, %	Vegetative buds.	Flower buds.	Relative flowers	Relative success, %	Vegetative buds.	Flower buds.	Relative flowers	Relative success, %
5th September	66	..	..	..	67	1	..	..	75	3	..	..
12th September	16	7	..	..	24	9	3	33.3	41	16	1	6.2
19th September	24	14	9	64.3	19	10	9	90.0	36	21	13	61.9
26th September	25	19	18	94.7	25	25	23	92.0	27	35	26	74.3
3rd October	12	28	15	53.6	26	28	24	85.7	25	39	28	71.8
10th October	17	38	6	15.8	23	38	12	31.6	29	53	10	18.8
17th October	21	47	..	..	17	39	..	..	19	56	..	..
24th October	41	73	4	5.5	15	27	4	14.8	38	73	5	6.8
31st October	94	135	70	51.8	19	17	5	29.4	121	133	67	50.4
7th November	124	150	103	68.7	25	23	10	43.5	195	147	90	61.2
14th November	83	108	69	63.9	34	17	5	29.4	153	162	101	62.3
21st November	86	144	53	36.8	12	14	..	..	107	178	93	52.2
28th November	32	86	6	7.0	7	1	..	..	111	151	77	50.9
5th December	19	28	..	..	2	2	..	..	109	150	19	12.7
12th December	5	13	..	..	..	..	..	..	29	86	..	..
19th December	2	..	..	..	..	..	..	..	29	76	..	..
26th December .. ..	..	..	..	..	..	..	..	..	3	13	..	..
2nd January .. ..	..	..	..	..	..	..	..	..	..	1	..	..
9th January .. ..	..	..	..	..	..	..	..	..	..	..	..	..
Average per plant	133.4	178.0	70.6	39.6	63.0	50.2	19.0	37.8	229.4	278.6	106.0	38.0

TABLE NO. 230—*contd.*

Weekly total production in five plants of vegetative buds and flower-buds and the relative success of flower-buds into flowers in experiments of nitrogen application with 2 acre-inches of water per month.

(Protected plants. Spacing 3' × 9".)

1930-31.

Week ending	7½ lbs. N. for 3 months.				Only tubes.				100 lbs. N. for 4 months.			
	Vegetative buds.	Flower buds.	Relative flowers	Relative success. %	Vegetative buds.	Flower buds.	Relative flowers	Relative success. %	Vegetative buds.	Flower buds.	Relative flowers	Relative success. %
5th September ..	07	1	..	..	67	..	..	..	81	..	..	..
2th September ..	24	9	2	22.2	24	5	1	20.0	25	6	↓	10.0
19th September ..	26	8	6	75.0	23	9	6	66.6	19	7	6	85.7
26th September ..	38	29	19	65.5	32	22	15	68.2	32	26	17	65.4
3rd October ..	27	42	20	47.6	26	30	18	60.0	26	47	20	42.6
10th October ..	28	35	..	..	20	31	9	29.0	17	31	..	..
17th October ..	20	38	..	..	26	34	..	..	13	38	..	..
24th October ..	51	93	4	4.8	20	40	..	..	32	65	3	4.6
31st October ..	123	143	60	42.0	16	25	9	26.0	103	105	56	53.3
7th November ..	177	146	89	61.0	23	21	13	61.9	141	123	75	61.0
14th November ..	144	217	120	55.3	27	34	9	26.5	124	167	105	62.9
21st November ..	141	206	118	57.3	21	9	1	11.1	102	168	106	63.1
28th November ..	161	209	108	51.7	10	9	1	11.1	120	162	89	54.9
5th December ..	142	236	104	44.1	3	3	..	..	123	181	55	30.4
12th December ..	66	155	34	21.9	3	..	..	..	75	94	16	17.0
19th December ..	82	138	12	8.7	1	..	..	..	45	81	11	13.6
26th December ..	46	99	1	1.0	1	..	..	..	43	70	↓	1.4
2nd January ..	14	21	..	..	..	..	..	..	7	10	..	..
9th January ..	3	1	..	..	..	..	..	..	..	..	..	..
Average per plant ..	276.0	365.2	139.4	38.2	68.6	54.4	16.4	30.2	225.6	276.2	112.2	40.6

TABLE No. 231.

Weekly total flower-opening and its relative boll-success on five plants treated with nitrogen with 2 acre-inches of water per month.

(Protected plants. Spacing 3' x 9".)

1930-31.

Week ending	25 lbs. N. for 1 month.			Only tubes.			50 lbs. N. for 2 months.		
	Flowers.	Relative bolls.	Relative success. %	Flowers.	Relative bolls.	Relative success. %	Flowers.	Relative bolls.	Relative success. %
19th October ..	2	1	50.0	6	2	33.3	1	..	..
26th October ..	24	..	..	26	4	15.4	35	..	..
2nd November ..	18	..	..	30	7	23.3	38	3	7.9
9th November ..	3	2	66.7	9	6	66.7	4	1	25.0
16th November ..	..	..	..	..	..	..	..	..	..
23rd November ..	..	..	..	..	..	..	2	2	100.0
30th November ..	10	7	70.0	2	2	100.0	11	8	72.7
7th December ..	61	40	65.6	8	5	62.5	42	35	83.3
14th December ..	69	31	44.9	10	3	30.0	80	35	43.8
21st December ..	73	1	1.4	3	1	33.3	77	17	22.1
28th December ..	63	..	..	1	..	..	82	7	8.5
4th January ..	28	..	..	..	..	..	73	7	9.6
11th January ..	2	..	..	..	..	..	67	6	9.0
18th January ..	..	..	..	..	..	..	18	2	11.1
25th January ..	..	..	..	..	..	..	..	..	..
1st February ..	..	..	..	..	..	..	..	..	..
Average per plant.	70.6	16.4	23.2	19.0	6.0	31.6	106.0	24.6	23.2

TABLE No. 231—continued.

Weekly total flower-opening and its relative boll-success on five plants treated with nitrogen with 2 acre-inches of water per month.

(Protected plants. Spacing 3'×9'.)

1930-31.

Week ending	75 lbs. N. for 3 months.			Only tubes.			100 lbs. N. for 4 months.		
	Flowers.	Relative bolls.	Relative success. %	Flowers.	Relative bolls.	Relative success. %	Flowers.	Relative bolls.	Relative success. %
19th October ..	1	..	..	1	1	100.0	..	..	..
26th October ..	19	..	..	19	6	31.6	20	..	..
2nd November ..	25	..	..	19	4	21.1	23	..	..
9th November ..	1	..	..	10	9	90.0	..	..	..
16th November ..	..	..	..	..	..	..	..	..	..
23rd November ..	..	..	..	1	1	100.0	..	..	..
30th November ..	12	6	50.0	1	1	100.0	4	3	75.0
7th December ..	46	27	58.7	7	5	71.4	46	30	65.2
14th December ..	73	36	49.3	11	5	45.5	79	42	53.2
21st December ..	82	34	41.5	7	1	14.3	63	22	34.9
28th December ..	101	40	39.6	6	..	..	93	23	24.7
4th January ..	89	27	30.3	..	..	..	70	19	27.1
11th January ..	101	16	15.8	..	..	..	72	20	27.8
18th January ..	83	1	1.2	..	..	..	52	4	7.7
25th January ..	47	..	..	..	..	..	34	1	2.9
1st February ..	17	..	..	..	..	..	5	..	..
Average per plant.	139.4	37.6	27.0	16.4	6.6	40.2	112.2	32.8	29.2

TABLE No. 232.

Percentage moisture in several layers of the soil in the plot manured with 40 lbs. of nitrogen and irrigated with 2 acre-inches of water at the depth of 60 cms.

1929-30.

(Expressed on oven-dry basis.)

Date of sampling.	22.5 to 45 cms.	45 to 67.5 cms.	67.5 to 90 cms.	Average for 22.5 to 90 cms.
12th September	26.10	28.04	29.87	28.00
26th September	24.68	28.20	28.37	27.08
11th October	24.22	26.58	26.74	25.85
25th October	22.70	26.58	27.88	25.72
8th November	21.36	23.61	24.22	23.06
22nd November	22.25	25.31	25.00	24.19
6th December	21.51	23.00	24.22	22.91
24th December	20.92	21.95	21.80	21.56
3rd January	21.52	22.10	22.85	22.15
17th January	20.92	22.10	21.51	21.51
31st January	21.36	21.36	22.55	21.76

TABLE No. 233.

Percentage moisture in several layers of the soil in the plot serving as control to those manured with 40 and 60 lbs. of nitrogen and irrigated with 2 acre-inches of water per month at the depth of 60 cms.

1929-30.

(Expressed on oven-dry basis.)

Date of sampling.	22.5 to 45 cms.	45 to 67.5 cms.	67.5 to 90 cms.	Average for 22.5 to 90 cms.
12th September .. .. .	..	..	..	..
26th September .. .. .	..	..	..	..
11th October	24.84	26.74	26.58	26.05
25th October	24.84	27.39	26.10	26.11
8th November	21.07	23.00	24.07	22.71
22nd November	22.25	23.76	24.07	23.36
6th December	20.48	21.65	22.55	21.56
24th December	20.34	21.36	22.70	21.47
3rd January	20.92	21.07	21.80	21.26
17th January	21.07	20.92	21.36	21.12
31st January	21.07	21.65	22.25	21.66

TABLE No. 234.

Percentage moisture in several layers of the soil in the plot manured with 60 lbs. of nitrogen and irrigated with 2 acre-inches of water at the depth of 60 cms.

1929-30.

(Expressed on oven-dry basis.)

Date of sampling.	22.5 to 45 cms.	45 to 67.5 cms.	67.5 to 90 cms.	Average for 22.5 to 90 cms.
12th September .. .. .	..	..	..	..
26th September .. .. .	..	..	..	..
11th October	24.84	27.06	27.71	26.54
25th October	25.53	25.94	27.55	26.34
8th November	21.36	23.00	24.07	22.81
22nd November	22.70	25.16	24.84	24.23
6th December	22.10	23.76	23.76	23.21
24th December	21.07	21.36	23.61	22.01
3rd January	21.95	23.00	23.46	22.80
17th January	20.77	20.93	21.51	21.07
31st January	21.80	22.55	23.61	22.65

TABLE No. 235.

Percentage moisture in several layers of the soil in the plot manured with 80 lbs. of nitrogen and irrigated with 2 acre-inches of water per month at the depth of 60 cms.

1929-30.

(Expressed on oven-dry basis.)

Date of sampling.	22.5 to 45 cms.	45 to 67.5 cms.	67.5 to 90 cms.	Average for 22.5 to 90 cms.
12th September	28.30	28.53	28.87	28.60
26th September	26.26	27.06	28.20	27.14
11th October	26.26	26.90	28.04	27.07
25th October	23.61	26.26	26.26	25.38
8th November	25.53	27.55	25.78	26.29
22nd November	25.00	25.94	27.55	26.16
6th December	24.68	27.55	25.46	25.90
24th December	22.10	23.15	23.91	23.05
3rd January	22.55	25.62	25.62	24.60
17th January	22.40	24.37	24.07	23.61
31st January	20.63	21.65	22.70	21.66

TABLE NO. 236.

Percentage moisture in several layers of the soil in the plot control to plots manured with 80 and 100 lbs. of nitrogen per acre and irrigated with 2 acre-inches of water per month at the depth of 60 cms.

1929-30.

(Expressed on oven-dry basis.)

Date of sampling.	22.5 to 45 cms.	45 to 67.5 cms.	67.5 to 90 cms.	Average of 22.5 to 90 cms.
12th September	29.53	28.53	29.37	29.14
26th September	26.58	27.06	27.39	27.01
11th October	27.55	27.71	27.71	27.66
25th October	23.91	25.62	28.20	25.91
8th November	22.10	24.07	25.53	23.90
22nd November	23.15	23.76	25.00	23.97
6th December	21.80	22.10	22.55	22.15
24th December	22.40	22.85	25.53	23.59
3rd January	22.25	22.85	24.07	23.06
17th January	22.10	22.25	23.61	22.65
31st January	20.92	22.25	22.55	21.91

TABLE NO. 237.

Percentage moisture in several layers of the soil in the plot manured with 100 lbs. of nitrogen per acre and irrigated with 2 acre-inches of water per month at the depth of 60 cms.

1929-30.

(Expressed on oven-dry basis.)

Date of sampling.	22.5 to 45 cms.	45 to 67.5 cms.	67.5 to 90 cms.	Average of 22.5 to 90 cms.
12th September .. .. .	..	..	..	..
26th September .. .. .	..	..	..	..
11th October	23.91	25.94	27.55	25.80
25th October	23.91	25.94	27.71	25.85
8th November	22.10	23.61	24.07	23.26
22nd November	23.15	25.00	24.37	24.17
6th December	23.15	23.15	24.07	23.46
24th December	27.23	23.15	24.07	24.82
3rd January	22.17	23.46	25.78	23.80
17th January	22.40	23.15	23.30	22.95
31st January	22.10	23.00	23.00	22.70

TABLE No. 238.

Percentage moisture in several layers of the soil, expressed on oven-dry basis, in plot receiving *40 lbs. of nitrogen plus water at 2 acre-inches per month at a depth of 60 cms.

1930-31.

Date of sampling.	22.5 to 45 cms.	45 to 67.5 cms.	67.5 to 90 cms.	Average of 22.5 to 90 cms.
4th September	29.03	28.04	28.66	28.64
1st October	28.70	27.55	29.70	28.65
15th October .. .. .	..	..	..	..
29th October	21.51	25.46	27.06	24.67
12th November	23.91	27.39	28.70	26.66
26th November	22.40	28.70	27.55	26.21
10th December	23.91	28.04	27.71	26.55
24th December	22.25	27.88	27.55	25.56
7th January	23.46	26.10	26.26	25.27
21st January	21.51	21.65	22.25	21.80
4th February	20.63	21.36	22.10	21.36
18th February	19.19,	20.63	21.21	20.34

* The manure (sulphate of ammonia) was given with water in 30 equal doses, twice every week from 15th October to 26th January.

TABLE No. 239.

Percentage moisture in several layers of the soil, expressed on oven-dry basis, in plot serving as control to plots receiving 40 and 100 lbs. of nitrogen with water.

1930-31.

Date of sampling.	22.5 to 45 cms.	45 to 67.5 cms.	67.5 to 90 cms.	Average of 22.5 to 90 cms.
4th September	28.20	27.88	28.53	28.20
1st October	30.38	29.27	29.70	29.82
15th October .. .. .	..	..	..	..
29th October	20.92	22.85	23.91	22.56
12th November	22.40	23.15	25.00	23.51
26th November	21.80	21.95	22.40	22.05
10th December	21.21	21.07	22.55	21.61
24th December	20.63	21.80	22.40	21.61
7th January	20.77	21.07	21.95	21.60
21st January	20.34	20.77	21.95	21.02
4th February	19.19	19.33	20.63	19.72
18th February	18.62	19.33	20.19	19.38

This plot received no manure and no water.

TABLE NO. 240.

Percentage moisture in several layers of the soil, expressed on oven-dry basis, in plot receiving *100 lbs. of nitrogen plus water at 2 acre-inches per month at a depth of 2 feet. 1930-31.

Date of sampling.	22.5 to 45 cms.	45 to 67.5 cms.	67.5 to 90 cms.	Average of 22.5 to 90 cms.
4th September	26.10	27.88	27.71	27.23
1st October	29.87	28.53	29.70	29.37
15th October .. .. .	..	..	..	..
29th October	22.70	26.90	26.26	25.28
12th November	24.07	29.37	28.86	27.43
26th November	21.95	26.58	26.58	25.04
10th December	21.95	23.76	24.07	23.26
24th December	22.25	23.00	24.22	23.16
7th January	20.77	21.95	23.76	22.16
21st January	20.48	20.48	21.80	20.92
4th February	19.47	19.76	21.51	20.25
18th February	19.76	19.05	20.19	19.67

*The manure was given with water in 30 equal doses, two doses every week from 15th October to 26th January.

TABLE NO. 241.

Percentage moisture in several layers of the soil, expressed on oven-dry basis, in plot serving as control to plots receiving 40 and 100 lbs. of nitrogen with water at 2 acre-inches per month.

1931-32.

Date of sampling.	22½ to 45 cms.	45 to 67½ cms.	67½ to 90 cms.	Average of 22½ to 90 cms.
30th October	27.71	28.37	28.86	28.31
12th November	27.55	28.20	28.53	28.09
26th November	23.91	25.16	25.62	24.89
11th December	22.55	23.00	24.22	23.26
24th December	22.25	23.30	24.37	23.31
7th January	20.34	21.65	22.55	21.51
21st January	20.05	20.77	21.65	20.82
4th February	18.48	19.33	20.92	19.58
18th February	19.19	19.05	20.19	19.48
3rd March	17.51	17.65	19.05	18.07

TABLE No. 242.

Percentage moisture in several layers of the soil, expressed on oven-dry matter, in plot receiving 40 lbs. of nitrogen as sulphate of ammonia and water at 2 acre-inches per month.

1931-32.

Date of sampling.	22½ to 45 cms.	45 to 67½ cms.	67½ to 90 cms.	Average of 22½ to 90 cms.
30th October	28.86	28.70	28.20	28.59
12th November	29.70	29.03	29.53	29.42
26th November	28.20	27.88	27.88	27.99
11th December	27.88	26.58	27.06	27.17
24th December	27.55	28.20	28.53	28.09
7th January	25.94	26.58	25.62	26.05
21st January	26.10	25.16	23.61	24.96
4th February	22.85	23.61	22.10	22.85
18th February	20.77	19.33	19.76	19.95
3rd March	17.65	18.06	18.06	17.92

TABLE No. 243.

Percentage moisture in several layers of the soil, expressed on oven-dry matter, in plot receiving 100 lbs. of nitrogen plus water at 2 acre-inches per month.

1931-32.

Date of sampling.	22½ to 45 cms.	45 to 67½ cms.	67½ to 90 cms.	Average of 22½ to 90 cms.
30th October	31.75	28.70	31.41	30.62
12th November	29.87	30.89	31.06	30.61
26th November	28.37	28.04	28.37	28.26
11th December	27.71	28.37	27.71	27.93
24th December	27.06	26.90	26.26	26.74
7th January	25.46	25.78	25.00	25.41
21st January	23.15	22.70	22.55	22.80
4th February	20.34	20.19	19.90	20.14
18th February	19.05	20.34	20.19	19.86
3rd March	16.96	17.51	17.92	17.46

TABLE No. 244.

Ammoniacal nitrogen in milligrammes per 100 grammes of oven-dry soil in the plots treated with 40 lbs. of nitrogen per acre and irrigated with 2 acre-inches of water per month at the depth of 60 cms.

1929-30.

Date of sampling.	22.5 to 45 cms.	45 to 67.5 cms.	67.5 to 90 cms.	Average of 22.5 to 90 cms.
11th September	1.31	1.30	2.02	1.54
25th September	1.66	1.31	1.32	1.43
10th October	1.31	1.31	1.66	1.43
24th October	3.32	4.02	3.31	3.55
7th November	4.02	1.23	1.92	2.39
21st November	1.93	2.62	3.65	2.70
5th December	3.16	3.50	3.49	3.38
19th December	1.40	1.40	1.40	1.40
2nd January	2.80	2.46	2.76	2.68
16th January	2.80	2.10	4.20	2.37

TABLE No. 245.

Nitrous nitrogen in milligrammes per 100 grammes of oven-dry soil in the plot treated with 40 lbs. of nitrogen per acre and irrigated with 2 acre-inches of water per month at the depth of 60 cms.

1929-30.

Date of sampling.	22.5 to 45 cms.	45 to 67.5 cms.	67.5 to 90 cms.	Average of 22.5 to 90 cms.
11th September	0.017	0.014	0.004	0.012
25th September	0.012	0.007	0.006	0.008
10th October	0.009	0.008	0.006	0.008
24th October	0.007	0.006	0.006	0.006
7th November	0.012	0.008	0.009	0.010
21st November	0.013	0.006	0.006	0.003
5th December	0.010	0.005	0.006	0.007
19th December	0.004	0.010	0.007	0.007
2nd January	0.022	0.016	0.010	0.016
16th January	0.025	0.003	0.004	0.011

TABLE NO. 246.

Nitric nitrogen in milligrammes per 100 grammes of oven-dry soil in the plot treated with 40 lbs. of nitrogen per acre and irrigated with 2 acre-inches of water per month at the depth of 60 cms.

1929-30.

Date of sampling.	22.5 to 45 cms.	45 to 67.5 cms.	67.5 to 90 cms.	Average of 22.5 to 90 cms.
11th September	0.465	0.375	0.324	0.388
25th September	0.289	0.260	0.321	0.290
10th October	0.173	0.261	0.202	0.212
24th October	0.376	0.404	0.374	0.385
7th November	0.315	0.304	0.201	0.273
21st November	0.188	0.130	0.187	0.168
5th December	0.173	0.188	0.201	0.187
19th December	0.072	0.116	0.087	0.092
2nd January	0.058	0.072	0.072	0.067
16th January	0.130	0.143	0.116	0.130

TABLE NO. 247.

Nitrous and nitric nitrogen in milligrammes per 100 grammes of oven-dry soil in the plot treated with 40 lbs. of nitrogen per acre and irrigated with 2 acre-inches of water per month at the depth of 60 cms.

1929-30.

Date of sampling.	22.5 to 45 cms.	45 to 67.5 cms.	67.5 to 90 cms.	Average of 22.5 to 90 cms.
11th September	0.482	0.389	0.328	0.400
25th September	0.301	0.267	0.327	0.298
10th October	0.182	0.269	0.208	0.220
24th October	0.383	0.410	0.380	0.391
7th November	0.327	0.312	0.210	0.283
21st November	0.201	0.136	0.193	0.176
5th December	0.183	0.193	0.207	0.194
19th December	0.076	0.126	0.094	0.099
2nd January	0.080	0.088	0.082	0.083
16th January	0.155	0.146	0.120	0.141

TABLE NO. 248.

Ammoniacal nitrogen in milligrammes per 100 grammes of oven-dry soil in the plot serving as control to plots treated with 40 and 60 lbs. of nitrogen per acre and irrigated with 2 acre-inches of water per month at the depth of 60 cms.
1929-30.

Date of sampling.	22.5 to 45 cms.	45 to 67.5 cms.	67.5 to 90 cms.	Average of 22.5 to 90 cms.
11th September .. .. .	..	..	..	..
25th September .. .. .	..	..	..	..
10th October	0.98	1.65	2.02	1.55
24th October	0.96	1.31	1.64	1.30
7th November	0.53	0.53	0.18	0.41
21st November	1.23	0.89	1.22	1.11
5th December	1.40	1.40	1.40	1.40
19th December	0.70	1.40	0.70	0.93
2nd January	1.40	1.40	1.74	1.51
16th January	2.10	1.75	2.11	1.99

TABLE NO. 249.

Nitrous nitrogen in milligrammes per 100 grammes of oven-dry soil in the plot control to plots receiving 40 and 60 lbs. of nitrogen per acre and 2 acre-inches of water per month at the depth of 60 cms.
1929-30.

Date of sampling.	22.5 to 45 cms.	45 to 67.5 cms.	67.5 to 90 cms.	Average of 22.5 to 90 cms.
10th October	0.008	0.007	0.004	0.006
24th October	0.006	0.006	0.006	0.006
7th November	0.008	0.006	0.012	0.009
21st November	0.003	0.006	0.006	0.005
5th December	0.009	0.005	0.008	0.007
19th December	0.008	0.011	0.010	0.010
2nd January	0.021	0.015	0.010	0.015
16th January	0.004	0.003	0.004	0.004

TABLE No. 250.

Nitric nitrogen in milligrammes per 100 grammes of oven-dry soil in the plot control to plots receiving 40 and 60 lbs. of nitrogen per acre and 2 acre-inches of water per month at the depth of 60 cms.

1929-30.

Date of sampling.	22.5 to 45 cms.	45 to 67.5 cms.	67.5 to 90 cms.	Average of 22.5 to 90 cms.
10th October	0.206	0.201	0.219	0.209
24th October	0.317	0.347	0.344	0.336
7th November	0.202	0.200	0.315	0.239
21st November	0.130	0.116	0.171	0.139
5th December	0.143	0.131	0.143	0.139
19th December	0.116	0.101	0.129	0.115
2nd January	0.072	0.072	0.086	0.077
16th January	0.072	0.087	0.072	0.077

TABLE No. 251.

Nitrous and nitric nitrogen in milligrammes per 100 grammes of oven-dry soil in the plot control to plots receiving 40 and 60 lbs. of nitrogen per acre and 2 acre-inches of water per month at the depth of 60 cms.

1929-30.

Date of sampling.	22.5 to 45 cms.	45 to 67.5 cms.	67.5 to 90 cms.	Average of 22.5 to 90 cms.
10th October	0.214	0.208	0.223	0.215
24th October	0.323	0.353	0.380	0.342
7th November	0.210	0.206	0.327	0.248
21st November	0.133	0.122	0.177	0.144
5th December	0.152	0.136	0.151	0.146
19th December	0.124	0.112	0.139	0.125
2nd January	0.093	0.087	0.096	0.092
16th January	0.076	0.090	0.076	0.078

TABLE No. 252.

Ammoniacal nitrogen in milligrammes per 100 grammes of oven-dry soil in the plot treated with 60 lbs. of nitrogen per acre and irrigated with 2 acre-inches of water per month at the depth of 60 cms.

1929-30.

Date of sampling.	22.5 to 45 cms.	45 to 67.5 cms.	67.5 to 90 cms.	Average of 22.5 to 90 cms.
11th September .. .. .	..	..	..	..
25th September .. .. .	..	..	..	..
10th October	1.32	1.31	0.62	1.08
24th October	2.36	3.41	3.33	3.03
7th November	3.33	1.93	1.92	2.39
21st November	5.42	6.13	3.34	4.96
5th December	3.16	3.51	3.53	3.40
19th December	1.40	2.81	1.40	1.87
2nd January	1.40	1.40	1.40	1.40
16th January	2.80	3.50	3.50	3.27

TABLE No. 253.

Nitrous nitrogen in milligrammes per 100 grammes of oven-dry soil in the plot treated with 60 lbs. of nitrogen per acre and irrigated with 2 acre-inches of water per month at the depth of 60 cms.

1929-30.

Date of sampling.	22.5 to 45 cms.	45 to 67.5 cms.	67.5 to 90 cms.	Average of 22.5 to 90 cms.
11th September .. .. .	..	..	..	..
25th September .. .. .	..	..	..	..
10th October	0.007	0.008	0.014	0.010
24th October	0.006	0.004	0.003	0.004
7th November	0.014	0.010	0.005	0.010
21st November	0.010	0.010	0.006	0.009
5th December	0.006	0.012	0.007	0.008
19th December	0.004	0.009	0.006	0.006
2nd January	0.007	0.007	0.008	0.007
16th January	0.010	0.003	0.002	0.005

TABLE No. 254.

Nitric nitrogen in milligrammes per 100 grammes of oven-dry soil in the plot treated with 60 lbs. of nitrogen per acre and irrigated with 2 acre-inches of water per month at the depth of 60 cms.

1929-30.

Date of sampling.	22.5 to 45 cms.	45 to 67.5 cms.	67.5 to 90 cms.	Average of 22.5 to 90 cms.
11th September .. .. .	..	..	..	..
25th September .. .. .	..	..	..	..
10th October	0.291	0.203	0.145	0.213
24th October	0.434	0.420	0.173	0.342
7th November	0.231	0.232	0.172	0.212
21st November	0.144	0.144	0.159	0.149
5th December	0.144	0.087	0.174	0.135
19th December	0.140	0.140	0.130	0.137
2nd January	0.072	0.072	0.058	0.067
16th January	0.087	0.116	0.116	0.106

TABLE No. 255.

Nitrous and nitric nitrogen in milligrammes per 100 grammes of oven-dry soil in the plot treated with 60 lbs. of nitrogen per acre and irrigated with 2 acre-inches of water per month at the depth of 60 cms.

1929-30.

Date of sampling.	22.5 to 45 cms.	45 to 67.5 cms.	67.5 to 90 cms.	Average of 22.5 to 90 cms.
11th September .. .. .	..	..	..	..
25th September .. .. .	..	..	..	..
10th October	0.298	0.211	0.159	0.223
24th October	0.440	0.424	0.176	0.346
7th November	0.245	0.242	0.177	0.222
21st November	0.154	0.154	0.165	0.158
5th December	0.150	0.099	0.181	0.143
19th December	0.144	0.149	0.136	0.143
2nd January	0.079	0.079	0.066	0.074
16th January	0.097	0.119	0.118	0.121

TABLE No. 256.

Ammoniacal nitrogen in milligrammes per 100 grammes of oven-dry soil in the plot treated with 80 lbs. of nitrogen per acre and irrigated with 2 acre-inches of water per month at the depth of 60 cms.

1929-30.

Date of sampling.	22.5 to 45 cms.	45. to 67.5 cms.	67.5 to 90 cms.	Average of 22.5 to 90 cms.
12th September	1.68	1.30	0.62	1.20
26th September	1.32	1.67	1.31	1.43
11th October	1.32	1.64	1.31	1.42
25th October	4.69	2.63	2.63	3.32
8th November	1.22	2.63	1.92	1.92
22nd November	3.31	2.29	1.93	2.51
6th December	3.49	6.68	4.90	5.02
24th December	3.49	7.70	5.60	5.60
3rd January	1.30	1.40	2.80	1.87
17th January	2.81	3.51	3.50	3.27

TABLE No. 257.

Nitrous nitrogen in milligrammes per 100 grammes of oven-dry soil in the plot treated with 80 lbs. of nitrogen per acre and irrigated with 2 acre-inches of water at the depth of 60 cms.

1929-30.

Date of sampling.	22.5 to 45 cms.	45 to 67.5 cms.	67.5 to 90 cms.	Average of 22.5 to 90 cms.
12th September	0.007	0.005	0.003	0.005
26th September	0.026	0.011	0.006	0.014
11th October	0.006	0.026	0.041	0.024
25th October	0.015	0.009	0.004	0.009
8th November	0.014	0.005	0.006	0.008
22nd November	0.006	0.004	0.010	0.007
6th December	0.010	0.031	0.036	0.026
24th December	0.010	0.007	0.007	0.008
3rd January	0.015	0.011	0.010	0.012
17th January	0.015	0.005	0.009	0.010

TABLE No. 258.

Nitric nitrogen in milligrammes per 100 grammes of oven-dry soil in the plot treated with 80 lbs. of nitrogen per acre and irrigated with 2 acre-inches of water per month at the depth of 60 cms.

1929-30.

Date of sampling.	22.5 to 45 cms.	45 to 67.5 cms.	67.5 to 90 cms.	Average of 22.5 to 90 cms.
12th September	0.288	0.232	0.203	0.241
26th September	0.349	0.263	0.289	0.300
11th October	0.087	0.142	0.202	0.144
25th October	0.287	0.202	0.144	0.211
8th November	0.170	0.200	0.206	0.190
22nd November	0.143	0.203	0.202	0.183
6th December	0.158	0.173	0.173	0.168
24th December	0.072	0.087	0.115	0.091
3rd January	0.089,	0.102	0.086	0.091
17th January	0.087	0.072	0.058	0.072

TABLE No. 259.

Nitrous and nitric nitrogen in milligrammes per 100 grammes of oven-dry soil in the plot treated with 80 lbs. of nitrogen per acre and irrigated with 2 acre-inches of water per month at the depth of 60 cms.

1929-30.

Date of sampling.	22.5 to 45 cms.	45 to 67.5 cms.	67.5 to 90 cms.	Average of 22.5 to 90 cms.
12th September	0.295	0.237	0.206	0.246
26th September	0.375	0.274	0.295	0.314
11th October	0.093	0.168	0.243	0.168
25th October	0.302	0.211	0.148	0.220
8th November	0.184	0.205	0.212	0.198
22nd November	0.149	0.207	0.212	0.190
6th December	0.168	0.204	0.209	0.194
24th December	0.082	0.094	0.122	0.099
3rd January	0.101	0.113	0.096	0.103
17th January	0.102	0.077	0.067	0.082

TABLE No. 260.

Ammoniacal nitrogen in milligrammes per 100 grammes of oven-dry soil in the plot control to plots receiving 80 and 100 lbs. of nitrogen per acre and 2 acre-inches of water per month at the depth of 60 cms.

1929-30.

Date of sampling.	22.5 to 45 cms.	45 to 67.5 cms.	67.5 to 90 cms.	Average of 22.5 to 90 cms.
12th September	1.30	0.61	0.62	0.84
26th September	1.66	0.96	1.31	1.31
11th October	2.00	1.65	1.65	1.77
25th October	1.65	1.67	1.65	1.66
8th November	1.24	1.59	0.88	1.24
22nd November	1.23	0.89	0.88	0.93
6th December	3.50	3.89	3.80	3.73
24th December	1.41	1.05	0.70	1.05
3rd January	1.40	1.05	1.40	1.28
17th January	1.40	0.69	0.69	0.93

TABLE No. 261.

Nitrous nitrogen in milligrammes per 100 grammes of oven-dry soil in the plot control to plots receiving 80 and 100 lbs. of nitrogen per acre and 2 acre-inches of water per month at the depth of 60 cms.

1929-30.

Date of sampling.	22.5 to 45 cms.	45 to 67.5 cms.	67.5 to 90 cms.	Average of 22.5 to 90 cms.
12th September	0.026	0.090	0.020	0.045
26th September	0.021	0.009	0.006	0.012
11th October	0.052	0.031	0.026	0.038
25th October	0.014	0.008	0.003	0.008
8th November	0.005	0.008	0.008	0.007
22nd November	0.013	Trace	0.005	0.006
6th December	0.012	0.008	0.005	0.008
24th December	0.009	0.011	0.010	0.010
3rd January	0.042	0.017	0.018	0.026
17th January	0.011	0.010	0.009	0.010

TABLE NO. 262.

Nitric nitrogen in milligrammes per 100 grammes of oven-dry soil in the plot control to plots receiving 80 and 100 lbs. of nitrogen per acre and 2 acre-inches of water per month at the depth of 60 cms.

1929-30.

Date of sampling.	22.5 to 45 cms.	45 to 67.5 cms.	67.5 to 90 cms.	Average of 22.5 to 90 cms.
12th September	0.406	0.287	0.231	0.208
26th September	0.232	0.230	0.260	0.241
11th October	0.275	0.288	0.288	0.283
25th October	0.347	0.290	0.201	0.279
8th November	0.203	0.261	0.172	0.212
22nd November	Trace	Trace	Trace	Trace
6th December	0.130	0.145	0.130	0.135
24th December	0.116	0.116	0.130	0.121
3rd January	0.086	0.086	0.072	0.077
17th January	0.058	0.072	0.087	0.072

TABLE NO. 263.

Nitrous and nitric nitrogen in milligrammes per 100 grammes of oven-dry soil in the plot control to plots receiving 80 and 100 lbs. of nitrogen per acre and 2 acre-inches of water per month at the depth of 60 cms.

1929-30.

Date of sampling.	22.5 to 45 cms.	45 to 67.5 cms.	67.5 to 90 cms.	Average of 22.5 to 90 cms.
12th September	0.432	0.377	0.251	0.253
26th September	0.253	0.239	0.266	0.253
11th October	0.327	0.319	0.314	0.321
25th October	0.361	0.298	0.204	0.287
8th November	0.208	0.269	0.180	0.219
22nd November	0.013	Trace	0.005	0.006
6th December	0.142	0.153	0.135	0.143
24th December	0.125	0.127	0.140	0.131
3rd January	0.128	0.103	0.090	0.103
17th January	0.069	0.082	0.096	0.082

TABLE No. 264.

Ammoniacal nitrogen in milligrammes per 100 grammes of oven-dry soil in the plot treated with 100 lbs. of nitrogen per acre and irrigated with 2 acre-inches of water per month at the depth of 60 cms.

1929-30.

Date of sampling.	22.5 to 45 cms.	45 to 67.5 cms.	67.5 to 90 cms.	Average of 22.5 to 90 cms.
12th September .. .. .	..	..	..	..
25th September .. .. .	..	..	..	..
11th October	1.99	2.02	1.67	1.89
25th October	2.96	6.48	6.07	5.17
8th November	1.92	2.53	2.62	2.36
22nd November	1.23	3.34	2.61	2.39
6th December	3.13	5.28	4.18	4.20
24th December	2.09	4.22	3.48	3.26
3rd January	2.80	4.20	4.21	3.74
17th January	3.15	3.52	3.51	3.39

TABLE No. 265.

Nitrous nitrogen in milligrammes per 100 grammes of oven-dry soil in the plot treated with 100 lbs. of nitrogen per acre and irrigated with 2 acre-inches of water per month at the depth of 60 cms.

1929-30.

Date of sampling.	22.5 to 45 cms.	45 to 67.5 cms.	67.5 to 90 cms.	Average of 22.5 to 90 cms.
11th October	0.025	0.031	0.036	0.031
25th October	0.007	0.003	0.003	0.004
8th November	0.011	0.007	0.005	0.008
22nd November	0.002	0.100	0.128	0.077
6th December	0.011	0.006	0.006	0.008
24th December	0.009	0.008	0.007	0.008
3rd January	0.012	0.010	0.015	0.012
17th January	0.022	0.021	0.011	0.018

TABLE NO. 266.

Nitric nitrogen in milligrammes per 100 grammes of oven-dry soil in the plot treated with 100 lbs. of nitrogen per acre and irrigated with 2 acre-inches of water per month at the depth of 60 cms.

1929-30.

Date of sampling.	22.5 to 45 cms.	45 to 67.5 cms.	67.5 to 90 cms.	Average of 22.5 to 90 cms.
11th October	0.215	0.263	0.219	0.233
25th October	0.287	0.363	0.286	0.312
8th November	0.260	0.230	0.216	0.235
22nd November	Trace	0.233	0.201	0.144
6th December	0.143	0.233	0.172	0.182
24th December	0.143	0.116	0.115	0.125
3rd January	0.072	0.072	0.115	0.084
17th January	0.231	0.261	0.231	0.241

TABLE NO. 267.

Nitrous and nitric nitrogen in milligrammes per 100 grammes of oven-dry soil in the plot treated with 100 lbs. of nitrogen per acre and irrigated with 2 acre-inches of water per month at the depth of 60 cms.

1929-30.

Date of sampling.	22.5 to 45 cms.	45 to 67.5 cms.	67.5 to 90 cms.	Average of 22.5 to 90 cms.
11th October	0.240	0.294	0.255	0.263
25th October	0.294	0.365	0.289	0.316
8th November	0.271	0.237	0.221	0.243
22nd November	0.002	0.332	0.329	0.221
6th December	0.154	0.238	0.178	0.190
24th December	0.153	0.124	0.122	0.133
3rd January	0.084	0.083	0.130	0.098
17th January	0.253	0.282	0.242	0.259

TABLE No. 268.

Nitrous nitrogen in milligrammes per 100 grammes of oven-dry soil in plot receiving 40 lbs. of nitrogen plus water at 2 acre-inches per month at a depth of 2 feet.*

1930-31.

Date of sampling.	22.5 to 45 cms.	45 to 67.5 cms.	67.5 to 90 cms.	Average of 22.5 to 90 cms.
4th September	0.022	0.021	0.021	0.021
1st October	0.021	0.012	0.004	0.012
15th October		Work suspended.		
29th October		Do.		..
12th November		Do.		..
26th November	0.023	0.016	0.022	0.020
10th December	0.016	0.008	0.007	0.010
23rd December	0.020	0.011	0.009	0.013
7th January	0.022	0.020	0.020	0.021
21st January	0.028	0.021	0.069	0.039
4th February	0.010	0.021	0.010	0.014
18th February	0.021	0.015	0.017	0.018

* The manure (sulphate of ammonia) was given with water in 30 equal bi-weekly doses from 15th October to 26th January.

TABLE No. 269.

*Nitrous nitrogen in milligrammes per 100 grammes of oven-dry soil in plot * control to plots receiving 40 and 100 lbs. of nitrogen respectively with water.*

1930-31.

Date of sampling.	22.5 to 45 cms.	45 to 67.5 cms.	67.5 to 90 cms.	Average of 22.5 to 90 cms.
4th September	0.021	0.021	0.020	0.021
1st October	0.018	0.011	0.003	0.011
15th October		Work suspended.		
29th October		Do.		..
12th November		Do.		..
25th November	0.016	0.030	0.023	0.023
10th December	0.012	0.010	0.008	0.010
24th December	0.008	0.012	0.011	0.010
7th January	0.022	0.015	0.010	0.016
21st January	0.042	0.027	0.064	0.044
4th February	0.010	0.023	0.023	0.019
18th February	0.022	0.022	0.010	0.018

* The plot received no manure and no water.

TABLE NO. 270.

*Nitrous nitrogen in milligrammes per 100 grammes of oven-dry soil in plot receiving
100 lbs. of nitrogen plus water at 2 acre-inches per month at a depth of 2 feet.

1930-31.

Date of sampling.	22.5 to 45 cms.	45 to 67.5 cms.	67.5 to 90 cms.	Average of 22.5 to 90 cms.
4th September	0.018	0.018	0.016	0.017
1st October	0.021	0.012	0.005	0.013
15th October		Work suspended.		
29th October		Do.		..
12th November		Do.		..
25th November	0.026	0.026	0.016	0.023
10th December	0.026	0.016	0.012	0.018
24th December	0.012	0.006	0.005	0.008
7th January	0.021	0.021	0.022	0.021
21st January	0.012	0.015	0.023	0.018
4th February	0.090	0.021	0.016	0.042
18th February	0.022	0.027	0.021	0.023

* The manure (sulphate of ammonia) was given with water in 30 equal bi-weekly doses from 15th October to 26th January.

TABLE NO. 271.

*Nitric nitrogen in milligrammes per 100 grammes of oven-dry soil in plot receiving
40 lbs. of nitrogen plus water at 2 acre-inches per month at a depth of 2 feet.

1930-31.

Date of sampling.	22.5 to 45 cms.	45 to 67.5 cms.	67.5 to 90 cms.	Average of 22.5 to 90 cms.
4th September	0.345	0.319	0.291	0.318
1st October	0.520	0.260	0.462	0.414
15th October		Work suspended		
29th October		Do.		
12th November		Do.		
25th November	0.208	0.220	0.208	0.212
10th December	0.279	0.176	0.134	0.196
24th December	0.305	0.311	0.308	0.308
7th January	0.207	0.206	0.207	0.207
21st January	0.260	0.225	0.233	0.239
4th February	0.190	0.223	0.161	0.191
18th February	0.216	0.208	0.222	0.215

* The manure (sulphate of ammonia) was given with water in 30 equal bi-weekly doses.

TABLE NO. 272.

Nitric nitrogen in milligrammes per 100 grammes of oven-dry soil in plot control to plots receiving 40 and 100 lbs. of nitrogen with water.*

1930-31.

Date of sampling.	22.5 to 45 cms.	45 to 67.5 cms.	67.5 to 90 cms.	Average of 22.5 to 90 cms.
4th September	0.349	0.323	0.289	0.320
1st October	0.404	0.318	0.335	0.352
15th October	Work suspended			
29th October		Do.		
12th November		Do.		
25th November	0.206	0.314	0.195	0.238
10th December	0.174	0.206	0.178	0.186
24th December	0.327	0.379	0.608	0.438
7th January	0.207	0.250	0.235	0.231
21st January	0.225	0.237	0.165	0.209
4th February	0.181	0.206	0.294	0.246
18th February	0.223	0.223	0.206	0.217

* The plot did not receive either manure or water.

TABLE NO. 273.

*Nitric nitrogen in milligrammes per 100 grammes of oven-dry soil in plot receiving *100 lbs. of nitrcgen plus water at 2 acre-inches per month at a depth of 2 feet.*

1930-31.

Date of sampling.	22.5 to 45 cms.	45 to 67.5 cms.	67.5 to 90 cms.	Average of 22.5 to 90 cms.
4th September	0.318	0.318	0.262	0.299
1st October	0.494	0.261	0.434	0.396
15th October	Work suspended			
29th October		Do.		
12th November		Do.		
25th November	0.267	0.284	0.237	0.263
10th December	0.192	0.220	0.209	0.207
24th December	0.225	0.305	0.288	0.273
7th January	0.296	0.296	0.296	0.296
21st January	0.073	0.207	0.222	0.167
4th February	0.341	0.296	0.294	0.310
18th February	0.148	..	..	0.049

* The manure (sulphate of ammonia) was given with water in 30 equal bi-weekly doses from 15th October to 15th January.

TABLE No. 274.

*Nitrous and nitric nitrogen in milligrammes per 100 grammes of oven-dry soil in plot receiving *40 lbs. of nitrogen plus water at 2 acre-inches per month at a depth of 2 feet.*

1930-31.

Date of sampling.	22.5 to 45 cms.	45 to 67.5 cms.	67.5 to 90 cms.	Average of 22.5 to 90 cms.
4th September	0.367	0.340	0.312	0.340
1st October	0.541	0.272	0.466	0.426
15th October	Work suspended			
29th October		Do.		
12th November		Do.		
25th November	0.231	0.236	0.230	0.232
10th December	0.295	0.184	0.141	0.207
24th December	0.325	0.322	0.317	0.321
7th January	0.229	0.226	0.227	0.227
21st January	0.288	0.246	0.302	0.279
4th February	0.200	0.244	0.171	0.205
18th February	0.237	0.223	0.239	0.233

* The manure (sulphate of ammonia) was given with water in 30 equal bi-weekly doses from 15th October to 26th January.

TABLE No. 275.

*Nitrous and nitric nitrogen in milligrammes per 100 grammes of oven-dry soil in plot *control to plots receiving 40 and 100 lbs. of nitrogen with water.*

1930-31.

Date of sampling.	22.5 to 45 cms.	45 to 67.5 cms.	67.5 to 90 cms.	Average of 22.5 to 90 cms.
4th September	0.370	0.344	0.309	0.341
1st October	0.422	0.329	0.338	0.363
15th October	Work suspended			
29th October		Do.		
12th November		Do.		
25th November	0.222	0.344	0.218	0.261
10th December	0.186	0.216	0.186	0.196
24th December	0.335	0.391	0.619	0.448
7th January	0.229	0.265	0.245	0.246
21st January	0.267	0.264	0.229	0.253
4th February	0.191	0.229	0.317	0.246
18th February	0.245	0.245	0.216	0.235

* The plot did not receive either manure or water.

TABLE No. 276.

Nitrous and nitric nitrogen in milligrammes per 100 grammes of oven-dry soil in plot receiving 100 lbs. of nitrogen plus water at 2 acre-inches per month at a depth of 2 feet.*

1930-31.

Date of sampling.	22.5 to 45 cms.	45 to 67.5 cms.	67.5 to 90 cms.	Average of 22.5 to 90 cms.
4th September	0.336	0.336	0.278	0.317
1st October	0.515	0.273	0.439	0.409
15th October	Work suspended			
29th October		Do.		
12th November		Do.		
26th November	0.293	0.310	0.253	0.285
10th December	0.218	0.236	0.221	0.225
24th December	0.237	0.311	0.293	0.281
7th January	0.317	0.317	0.318	0.317
21st January	0.085	0.225	0.245	0.185
4th February	0.431	0.317	0.310	0.353
18th February	0.170	0.027	0.021	0.073

* The manure (sulphate of ammonia) was given with water in 30 equal bi-weekly doses from the 15th October to 26th January.

TABLE No. 277.

*Ammoniacal nitrogen in milligrammes per 100 grammes of oven-dry soil, in plot receiving *40 lbs. of nitrogen plus water at 2 acre-inches per month at a depth of 2 feet.*

1930-31.

Date of sampling.	22.5 to 45 cms.	45 to 67.5 cms.	67.5 to 90 cms.	Average of 22.5 to 90 cms.
4th September	3.43	3.82	2.74	3.33
1st October	0.94	2.00	0.94	1.29
15th October	Work suspended			
29th October		Do.		
12th November		Do.		
25th November	2.06	2.06	2.06	2.06
10th December	0.54	2.42	1.70	1.69
24th December	2.39	3.18	3.14	2.90
7th January	2.14	4.88	1.34	2.79
21st January	2.08	2.59	2.10	2.26
4th February	2.52	1.76	2.10	2.13
18th February	4.78	3.74	3.37	3.96

* The manure (sulphate of ammonia) was given with water in 30 bi-weekly doses from 15th October to 26th January.

TABLE No. 278.

*Ammoniacal nitrogen in milligrammes per 100 grammes of oven-dry soil in *plot control to plots receiving 40 and 100 lbs. of nitrogen with water.*

1930-31.

Date of sampling.	22.5 to 45 cms.	45 to 67.5 cms.	67.5 to 90 cms.	Average of 22.5 to 90 cms.
4th September	3.47	3.14	2.38	3.00
1st October	3.80	2.73	2.39	2.97
15th October		Work suspended		
29th October		Do.		
12th November		Do.		
25th November	1.31	1.72	2.08	1.70
10th December	2.75	2.42	3.18	2.78
24th December	3.54	2.75	2.80	3.03
7th January	2.60	7.74	4.50	4.95
21st January	2.97	7.01	4.16	4.71
4th February	3.71	2.12	1.75	2.53
18th February	4.12	2.14	2.12	2.79

* The plot received no manure and water.

TABLE No. 279.

*Ammoniacal nitrogen in milligrammes per 100 grammes of oven-dry soil in plot receiving *100 lbs. of nitrogen plus water at 2 acre-inches per month at a depth of 2 feet.*

1930-31.

Date of sampling.	22.5 to 45 cms.	45 to 67.5 cms.	67.5 to 90 cms.	Average of 22.5 to 90 cms.
4th September	3.09	2.37	2.39	2.62
1st October	1.66	2.38	1.29	1.78
15th October		Work suspended		
29th October		Do.		
12th November		Do.		
25th November	2.80	2.83	3.18	2.94
10th December		2.42	2.83	2.62
24th December	2.83	3.47	2.37	2.89
7th January	2.60	3.37	1.34	2.44
21st January	3.31	3.37	2.57	3.08
4th February	1.34	1.34	2.12	1.60
18th February	2.94	1.76	1.32	2.01

* The manure (sulphate of ammonia) was given with water in 30 equal bi-weekly doses from 15th October to 26th January.

TABLE No. 280.

Effect of the application of 100 lbs. of phosphoric acid with 2 acre-inches of water per month at the depth of 45 cms. from the middle of October, in small and equal bi-weekly doses. (Protected plants.)

1930-31.

(Average results of ten plants.)

Plant Organs.	Two inches of water with	
	Water only. (Control.)	100 lbs. Phos- phoric acid.
	Performance before commencement of treatment.	
Vegetative buds	130.9	147.0
Flower-buds	107.1	122.2
	Final performance.	
Vegetative buds	219.4	237.6
Flower-buds	207.2	226.4
Flowers	78.5	74.6
Bolls	41.4	40.7
Total seed-cotton in gms.	76.0	74.2
Seed-cotton in gms. per boll	1.84	1.82
Percentage success of—		
Buds into flowers	37.9	33.0
Flowers into bolls	52.8	54.6
Buds into bolls	20.0	18.0

TABLE No. 281.

Effect of the application of 40 lbs. of nitrogen in combination with 100 lbs. of phosphoric acid per acre with 2 acre-inches of water per month at the depth of 45 cms., in 20 small and equal bi-weekly doses. (Protected plants.)

1931-32.

(Average of 10 plants.)

Plant Organs.	Two inches of water with			
	Water only. (Control.)	100 lbs. P ₂ O ₅ with 40 lbs. Nitrogen.	100 lbs. P ₂ O ₅ .	40 lbs. Nitrogen.
	Performance before commencement of treatment.			
Vegetative buds.. .. .	109.0	80.4	117.4	124.7
Flower-buds	50.3	18.4	62.9	65.1
	Final performance.			
Vegetative buds	296.2	574.3	311.0	580.7
Flower-buds	295.6	597.3	294.0	704.5
Flowers	127.7	264.0	123.3	311.0
Bolls	50.5	88.2	58.0	109.7
Total seed-cotton in gms.	91.8	179.5	89.8	222.0
Seed-cotton in gms. per boll	1.80	2.04	1.55	2.02
Percentage success of—				
Bud to flower	43.2	44.2	41.9	44.1
Flower to boll	39.5	33.4	47.0	35.3
Bud to boll	17.1	14.8	19.7	15.6

TABLE NO. 282.

Effect of the application of 40 lbs. of nitrogen in combination with 100 lbs. of phosphoric acid and 100 lbs. of potash with 2 acre-inches of water per month at the depth of 45 cms., in 20 small and equal bi-weekly doses from 26th October, 1931. (Protected.)

1931-32.

(Average of 10 plants in each set.)

Plant Organs.	Two inches of water with				
	Water as control.	Water with 40 lbs. N.	Potash & Water.	Water, Nitrogen & Potash.	Water with Potash.
	Performance before commencement of treatment.				
Vegetative buds ..	109.0	124.7	133.6	124.5	102.8
Flower-buds	50.3	65.1	63.4	45.1	48.5
	Final performance.				
Vegetative buds ..	296.2	580.7	312.9	652.1	645.7
Flower-buds	295.6	704.5	342.5	743.8	796.6
Flowers	127.7	311.0	133.8	345.9	264.0
Bolls	50.5	109.7	56.2	111.9	111.5
Weight of seed-cotton in gms.	91.8	222.0	91.6	218.3	222.3
Dry plant body ..	52.2	148.2	59.5	160.7	171.7
Ratio $\frac{\text{Kapas Wt.}}{\text{Body Wt.}}$..	1.76	1.5	1.54	1.36	1.29
Percentage success of—					
Bud to flower ..	43.2	44.1	39.1	46.5	45.3
Flower to boll ..	39.5	35.3	42.0	32.3	30.9
Bud to boll	17.1	15.6	16.4	15.0	14.0

TABLE NO. 283.

Organic and inorganic nitrogen combination series (Green-manure with Dhaincha grown in situ). Spacing 4' x 3' ridges.

1928-29.

(Average performance of 10 plants in each set.)

Treatment.	Vegetative buds.	Flower-buds.	Flowers.	Bolls.	Seed-cotton in gms.	Percentage success of—		
						Bud to Flower.	Flower to Boll.	Bud to Boll.
Control. (Average of control numbers 7 & 14.)	474.5	376.9	104.7	37.8	71.5	27.8	36.1	10.0
12.5 lbs. N. per acre as sulphate of ammonia on sowing and 25 lbs. N. per acre as nitrate of soda in August along with burying green-manure.	723.7	510.8	181.0	62.9	132.9	35.4	34.7	12.3
12.5 lbs. N. per acre as sulphate of ammonia on sowing and 25 lbs. N. per acre with green-manure in August in combination with 50 lbs. of P ₂ O ₅ per acre as superphosphate.	773.7	596.0	206.0	72.4	132.5	34.5	35.1	12.1
35.5 lbs. N. per acre as sulphate of ammonia on sowing and burying green-manure in August	593.4	524.2	152.2	53.1	105.0	29.0	34.8	10.1
12.5 lbs. N. per acre as sulphate of ammonia on sowing and burying green-manure in August.	430.2	321.9	95.9	32.3	65.4	29.6	33.6	9.9
Green-manure by collecting from outside.								
Control	436.0	292.2	74.4	28.9	57.1	25.4	38.8	57.1
Green-manure from outside buried by the end of September.	615.3	467.3	121.4	39.8	74.4	25.9	32.7	74.4
Time of application series @ 50 lbs. N. per acre in the form of nitrate of soda.								
Control	472.6	386.3	102.6	36.4	71.1	26.5	35.4	9.4
On sowing, i.e., in July ..	744.2	586.1	177.4	59.0	126.7	30.2	33.2	10.0
In August ..	763.9	540.3	181.5	59.7	119.3	33.5	32.9	11.0
In October ..	628.6	451.1	139.2	47.0	97.7	30.8	33.7	10.4

TABLE No. 284.
 Dry manurial series.
 Yield of seed-cotton in lbs. per plot of 72 plants (2 cents). Manure was given in the form
 of nitrate of soda.
 1928-29.

Treatment.	Block number.			Mean.	Per cent. in- crease over control.
	II.	III.	IV.		
Control	7.53	10.68	10.08	9.43	..
50 lbs. N. per acre as nit- rate of soda in July ..	19.80	19.38	16.48	18.55	96.7
50 lbs. N. per acre as nit- rate of soda in August ..	15.20	18.40	14.63	16.08	70.5
50 lbs. N. per acre as nit- rate of soda in Oct.	11.53	12.85	14.75	13.04	38.3
Block mean	13.51	15.33	13.98	14.27	..

Analysis of variance.

Due to	Degrees of freedom.	Sum of squares.	Variance.
Between treatments	3	139.599	46.533
Within treatments	8	25.6309	3.2039
Between Blocks	2	7.1412	3.5706
Random variation	6	18.4897	3.0816

Standard residual error of the whole experiment	1.76
Standard error of comparison of two treatment means	1.43
Value of "t" for $P=0.05$ and 6, the degrees of freedom	2.447
Value for a significant difference between two treatment means	3.50

Conclusions :—

- (1) All treatments are significantly superior to control.
- (2) July manuring is significantly superior to October manuring.
- (3) The difference between August manuring and October manuring is not significant.
- (4) The difference between July manuring and August manuring is not significant.

TABLE No. 285.

Plant performance of dry manurial series. Spacing 4' x 3' ridges.

1929-30.

(Average performance of 20 plants.)

Treatment.	Vegetative buds.	Flower-buds.	Flowers.	Bolls.	Seed-cotton in gms.	Percentage success of—		
						Bud to Flower.	Flower to Boll.	Bud to Boll.
Average of two controls ..	375.8	330.2	77.7	27.3	53.61	23.5	35.1	8.3

Time of application series @ 50 lbs. N. per acre as sulphate of ammonia.

July	449.5	422.7	69.3	34.7	66.02	21.8	37.6	8.3
August	394.1	366.7	84.4	31.2	64.90	23.0	37.0	8.5
October	331.7	314.7	77.3	27.6	54.80	24.6	35.7	8.8

Quantity of application series @ 20, 30 and 40 lbs. N. per acre as sulphate of ammonia.

20 lbs. .. .. .	..	..	101.4	37.7	78.25	..	37.2	..
30 lbs. .. .. .	..	..	85.9	28.8	57.40	..	33.5	..
40 lbs. .. .. .	..	..	76.2	27.3	53.35	..	35.8	..

Frequency of application series.

25 lbs. N. in July and 25 lbs. N. in August ..	459.7	448.2	94.3	33.4	63.32	21.0	35.4	7.5
12.5 lbs. N. in July and 37.5 lbs. N. in August.	394.5	387.8	72.1	27.5	49.05	18.6	38.2	7.1
50 lbs. N. as nitrate of soda in August.	389.9	338.4	68.5	24.9	43.62	20.3	36.3	7.4

July manuring was done on 20th July, 1929.

August manuring was done on 6th September, 1929.

October manuring was done on 5th October, 1929.

TABLE No. 286.

Dry manurial series.

Yield of seed-cotton in lbs. per plot of 126 plants (3.5 cents). Manure was given in the form of sulphate of ammonia.

1929-30.

Treatment.	Block number.				Mean.
	I.	II.	III.	IV.	
50 lbs. nitrogen per acre on 20-7-29 ..	20.75	16.00	14.77	14.36	16.47
50 lbs. nitrogen per acre on 6-9-29 ..	16.35	19.66	16.16	15.78	16.99
50 lbs. nitrogen per acre on 5-10-29 ..	14.77	19.03	16.29	16.00	16.52
Control	21.38	13.70	17.20	12.85	16.28
Block mean	18.31	17.10	16.10	14.75	16.56 (Mean of all)

Analysis of variance.

Due to	Degrees of freedom.	Sum of squares.	Variance.
Between treatments	3	1.0920	0.3640
Within treatments	12	90.5365	7.5447
Between blocks	3	27.3672	9.1224
Random variation	9	63.1693	7.0188

The residual standard error of the whole experiment 2.65
 The standard error of the comparison of two treatment means 1.87
 The value of "t" for $P=0.05$ for 9, the degree of freedom 1.833
 Value for a significant difference between two treatment means 3.42

Conclusion :—The difference in yield between any two of the above treatments is not significant.

TABLE No. 288.

Nitrous and nitric nitrogen in milligrammes per 100 grammes of oven-dry soil, in several layers of the soil, in plots receiving 40 and 200 pounds nitrogen per acre.

(Uncropped land.)

1931-32.

Period ending	Up to 10 cms.			10 to 20 cms.			20 to 30 cms.			30 to 40 cms.		
	Con- trol.	40 lbs. N.	200 lbs. N.	Con- trol.	40 lbs. N.	200 lbs. N.	Con- trol.	40 lbs. N.	200 lbs. N.	Con- trol.	40 lbs. N.	200 lbs. N.
1st September ..	0.593	0.311	0.385	0.335	1.102	0.329	0.328	0.803	0.774	0.541	0.496	0.238
8th September ..	0.087	0.063	0.516	0.087	0.476	0.537	0.136	0.705	0.840	0.107	0.137	0.410
15th September ..	0.370	2.348	1.637	0.408	5.017	4.044	0.304	2.909	1.058	0.317	0.702	0.948
22nd September ..	0.438	2.430	3.014	0.496	7.612	0.558	0.387	3.827	5.401	0.719	1.339	1.100
29th September ..	1.637	2.428	3.788	1.597	3.573	8.427	0.612	2.161	5.093	1.249	1.592	2.489
20th October ..	..	..	..	0.474	1.281	6.309	0.470	2.968	3.042	0.349	1.532	2.997
3rd November ..	..	..	..	..	..	..	0.552	0.296	5.956	0.434	0.307	2.890
17th November ..	..	..	..	..	..	..	0.726	1.479	8.833	0.593	1.316	3.028
15th December ..	..	..	..	..	..	..	..	..	..	0.334	1.051	3.043
29th December ..	..	..	..	..	..	..	..	..	..	1.115	1.567	2.236
26th January ..	..	..	..	..	..	..	..	..	..	..	..	..
9th February ..	..	..	..	..	..	..	..	..	..	..	..	..

TABLE No. 288—(contd.)

Nitrous and nitric nitrogen in milligrammes per 100 grammes of oven-dry soil, in several layers of the soil, in plots receiving 40 and 200 pounds nitrogen per acre.

(Uncropped land.)

1931-32.

Period ending	40 to 50 cms.			50 to 60 cms.			60 to 70 cms.			70 to 80 cms.		
	Con- trol.	40 lbs. N.	200 lbs. N.	Con- trol.	40 lbs. N.	200 lbs. N.	Con- trol.	40 lbs. N.	200 lbs. N.	Con- trol.	40 lbs. N.	200 lbs. N.
1st September ..	..	..	..	..	..	..	..	..	..	..	..	..
8th September ..	..	..	..	..	..	..	..	..	..	..	..	..
15th September ..	..	..	..	..	..	..	..	..	..	..	..	..
22nd September ..	..	..	..	..	..	..	..	..	..	..	..	..
29th September ..	..	..	..	..	..	..	..	..	..	..	..	..
20th October ..	2.079	3.025	2.132	..	..	..	..	..	..	..	..	..
3rd November ..	0.288	0.192	1.078	0.054	0.628	0.593	..	..	..	..	..	..
17th November ..	0.682	0.611	1.065	0.699	0.395	1.769	..	..	..	..	..	..
15th December ..	0.389	1.061	2.131	0.386	0.610	1.081	0.333	0.475	0.630	..	..	..
29th December ..	0.791	1.509	1.794	0.930	0.988	1.675	0.983	0.973	1.719	..	..	..
26th January ..	0.294	0.337	2.321	0.579	0.393	0.743	0.345	0.294	0.197	0.396	0.184	0.664
9th February ..	0.326	0.621	1.496	0.638	0.587	1.718	0.198	0.293	1.196	0.197	0.275	0.929

TABLE No. 289—(contd.)

Ammoniacal nitrogen in milligrammes per 100 grammes in oven-dry soil in several layers of the soil, in plots receiving 40 and 200 grammes of nitrogen per acre.

(Uncropped land.)

1931-32.

Period ending	40 to 50 cms.			50 to 60 cms.			60 to 70 cms.			70 to 80 cms.		
	Con- trol.	40 lbs. N.	200 lbs. N.	Con- trol.	40 lbs. N.	200 lbs. N.	Con- trol.	40 lbs. N.	200 lbs. N.	Con- trol.	40 lbs. N.	200 lbs. N.
1st September ..	..	..	..	..	..	..	..	..	..	..	..	..
8th September ..	..	..	..	..	..	..	..	..	..	..	..	..
15th September ..	..	..	..	..	..	..	..	..	..	..	..	..
22nd September ..	..	..	..	..	..	..	..	..	..	..	..	..
29th September ..	..	..	..	..	..	..	..	..	..	..	..	..
22nd October ..	2.86	2.88	..	..	..	..	..	..	..	..	..	..
3rd November ..	4.74	2.66	2.18	3.66	2.62	..	..	..	..	..	..	..
17th November ..	3.48	3.85	..	4.15	3.48	..	..	..	..	..	..	..
15th December ...	4.54	3.82	5.92	4.68	2.81	7.29	5.22	2.47	8.25	..	..	..
29th December ..	5.17	3.82	2.79	5.17	4.54	3.48	4.15	3.48	2.10	..	..	..
26th January ..	7.03	6.89	6.82	6.12	6.25	6.25	7.91	6.63	6.57	6.89	5.93	6.25
9th February ..	7.91	7.91	..	7.58	7.58	..	5.89	5.89	..	5.17	5.17	..

TABLE No. 290.

Dry manurial series.

Average performance of 20 plants receiving 40 lbs. of nitrogen per acre.

1930-31.

Treatment.	Control.	July application.		August application.	
		On ridges.	In furrows.	On ridges.	In furrows.
Vegetative buds ..	315.6	511.1	507.85	473.35	389.5
Flower-buds	235.0	381.1	380.15	358.0	257.3
Flowers	93.0	130.7	138.6	129.95	118.7
Bolls	30.7	39.4	39.7	38.55	34.7
Weight in gms. of—					
Seed-cotton	66.5	86.0	87.0	86.0	76.8
Plant body	39.2	86.1	68.3	62.6	53.9
Ratio of seed-cotton to plant body.	1.70	1.00	1.27	1.37	1.42
Percentage success of—					
Bud to flower.. ..	39.6	34.3	36.5	36.3	46.0
Flower to boll	33.0	30.1	28.6	29.7	29.2
Bud to boll	13.1	10.3	10.4	10.8	13.5

July manuring was done on 12th July, 1930.

August manuring was done on 26th August, 1930.

TABLE No. 291.
 Dry manurial series.
 Average performance of 20 plants receiving 40 lbs. of nitrogen per acre.
 1931-32.

Treatment.	Control.	July application.		August application.	
		On ridges.	In furrows.	On ridges.	In furrows.
Vegetative buds ..	497.2	619.4	649.9	604.3	611.8
Flower-buds	278.5	422.9	350.0	304.8	336.9
Flowers	103.5	122.5	129.7	106.8	121.4
Bolls	42.5	51.0	51.0	41.6	46.4
Weight in gms. of—					
Seed-cotton	82.1	98.0	99.6	82.6	94.8
Plant body	51.9	79.7	77.8	63.0	68.8
Ratio $\frac{\text{Seed-cotton}}{\text{Plant body}}$..	1.58	1.23	1.28	1.31	1.38
Percentage success of—					
Bud to flower.. ..	37.2	29.0	37.0	35.0	36.0
Flower to boll ..	41.0	41.6	39.3	39.0	38.2
Bud to boll	15.2	12.1	14.6	13.7	13.8

July manuring was done on 15th July, 1931.

August manuring was done on 27th August, 1931.

TABLE NO. 292.

Dry manurial series.

*Progressive production of vegetative buds and flower-buds in plants receiving
40 pounds of nitrogen per acre in July and August.*

1930-31.

J=July. A=August. R=Ridge. F=Furrow.

(Average of 20 plants in each set.)

Treatment.	Period ending				
	9th Sept.	7th Oct.	4th Nov.	2nd Dec.	30th Dec.
VEGETATIVE BUDS.					
Control	15.50	63.85	187.10	297.05	337.65
Control	13.55	56.20	177.05	266.15	293.55
40 J.R.	28.3	133.7	390.9	495.7	511.1
40 J.F.	19.50	84.10	302.50	476.15	507.85
40 A.R.	15.40	81.75	277.40	433.55	473.35
40 A.F.	14.1	59.2	217.8	367.4	389.5
FLOWER-BUDS.					
Control	0.20	19.40	80.90	204.35	254.30
Control	0.05	16.45	89.75	180.10	215.75
40 J.R.	4.6	63.1	231.5	366.5	381.1
40 J.F.	0.75	30.30	135.10	334.10	380.15
40 A.R.	0.20	28.15	140.20	304.50	358.0
40 A.F.	0.1	16.9	87.5	227.8	257.3

TABLE No. 293.

Dry manurial series.

Progressive production of vegetative buds and flower-buds in plants receiving 40 lbs. of nitrogen per acre in July and August.

1931-32.

J=July. A=August. R=Ridge. F=Furrow.

(Average of 20 plants in each set.)

Treatment.	Period ending					
	16th Sept.	30th Oct.	1st Dec.	29th Dec.	27th Jan.	23rd Feb.
VEGETATIVE BUDS.						
Control	18.0	140.6	335.0	449.5	497.2	..
40 J.R.	36.3	243.8	500.1	593.4	619.4	..
40 J.F.	16.1	120.9	443.2	600.7	641.1	649.9
40 A.R.	15.8	112.2	417.3	550.3	597.4	604.3
40 A.F.	13.7	103.4	366.2	541.2	601.1	611.8
FLOWER-BUDS.						
Control .. .. .	..	47.2	167.1	254.8	278.5	..
40 J.R.	3.7	117.6	321.3	403.0	422.9	..
40 J.F. .. .. .	..	44.6	191.2	313.4	343.4	350.1
40 A.R. .. .. .	..	34.6	162.9	271.5	299.8	304.8
40 A.F. .. .. .	..	30.7	148.3	277.7	327.3	336.9

TABLE No. 294.

Weekly flower-opening and its relative success in plots receiving 40 lbs. of nitrogen per acre at different times and in different positions.

J=July. A=August. R=Ridge. F=Furrow.

(Average of 20 plants in each set.)

1930-31.

Week ending	CONTROL.		CONTROL.		40 J. R.		40 J. F.		40 A. R.		40 A. F.	
	Flowers opened.	Relative boll success.	Flowers opened.	Relative boll success.	Flowers opened.	Relative boll success.	Flowers opened.	Relative boll success.	Flowers opened.	Relative boll success.	Flowers opened.	Relative boll success.
19th October ..	..	..	..	..	0·10	..	0·05	..	..	..	..	..
20th October ..	0·15	..	0·05	..	0·30	..	0·25	..	0·15	..	0·10	..
2nd November	0·20	..	0·10	..	0·20	..	0·10	..	0·20	..	0·30	..
9th November	0·05	..	..	..	0·10	..	0·05	..	..	..	..	..
16th November	..	..	..	..	0·10	0·10	..	..	0·10	0·05	..	..
23rd November	0·05	0·05	0·10	0·10	0·30	0·10	0·20	0·10	0·15	0·10	0·20	0·10
30th November	0·20	0·20	0·20	0·05	1·40	0·40	0·30	0·10	0·60	0·30	0·40	0·30
7th December	1·60	1·10	2·10	0·95	5·60	2·90	2·85	1·75	3·30	2·05	3·40	2·10
14th December ..	7·25	5·30	6·20	4·90	15·80	11·00	12·15	9·80	11·30	8·85	9·30	8·10
21st December ..	12·55	9·80	12·00	9·20	21·30	14·30	21·60	15·30	18·40	12·75	15·60	10·10
28th December ..	20·25	10·70	17·35	9·45	30·60	7·70	32·05	9·00	26·15	9·75	25·40	12·30
4th January	18·25	3·00	16·95	5·05	26·50	1·90	30·20	1·75	25·85	2·80	21·30	3·30
11th January ..	20·05	0·90	15·85	1·55	21·70	0·90	26·50	1·30	24·30	1·35	22·80	1·20
18th January ..	12·85	..	9·90	0·45	5·70	0·10	10·30	0·40	14·45	0·45	14·10	0·80
25th January ..	5·35	..	4·75	0·10	0·70	..	1·95	0·20	4·15	0·10	5·40	0·10
1st February ..	0·40	..	1·05	..	0·30	..	0·05	..	0·75	..	0·40	..
8th February	0·05	..	0·15	..	..	..	..	..	0·10	..	..	..
Total ..	99·25	31·65	86·75	29·80	130·70	39·40	138·60	39·70	129·95	38·55	118·70	34·70

TABLE No. 295.

Weekly flower-opening and its relative success in plots receiving 40 lbs. of nitrogen per acre at different times and in different positions.

J=July. A=August. R=Ridge. F=Furrow.

(Average of 20 plants in each set.)

1931-32.

Week ending	CONTROL.		40 J. R.		40 J. F.		40 A. R.		40 A. F.	
	Flowers opened.	Relative boll success.	Flowers opened.	Relative boll success.	Flowers opened.	Relative boll success.	Flowers opened.	Relative boll success.	Flowers opened.	Relative boll success.
22nd November ..	..	..	0·1	0·1	..	..	..	..	0·1	..
29th November. ..	1·0	0·4	1·3	0·4	0·6	0·2	0·3	0·1	0·3	0·1
6th December ..	2·1	1·0	3·1	1·6	2·1	1·2	1·3	0·4	1·0	0·5
13th December ..	3·8	2·5	5·5	2·9	3·9	2·6	1·2	0·6	1·6	1·2
20th December ..	7·3	5·2	10·2	7·1	7·0	6·1	4·3	3·5	5·0	4·0
27th December ..	9·9	7·7	17·1	13·1	11·2	9·2	3·3	6·6	3·4	6·3
3rd January ..	11·5	8·0	16·7	11·7	14·0	9·7	3·3	6·2	9·4	7·1
10th January ..	14·6	8·0	23·6	10·6	20·0	11·0	16·8	12·1	14·6	10·6
17th January ..	16·4	5·8	20·8	2·8	22·5	6·8	18·7	7·5	19·00	3·3
24th January ..	17·1	1·3	17·0	0·6	22·6	1·4	21·0	1·7	21·4	3·1
31st January ..	12·5	1·5	5·7	0·3	16·5	1·5	15·4	1·5	19·7	2·2
7th February ..	6·2	0·9	1·3	..	7·6	1·1	3·5	1·0	13·6	2·5
14th February ..	1·3	0·3	0·4	..	1·8	0·1	2·7	0·4	6·5	0·8
21st February ..	0·1	0·1	..	..	0·1	..	0·1	..	1·0	0·1
Rest ..	..	0·2	..	0·2	..	0·3	..	0·3	..	0·3
Total ..	103·5	42·5	122·5	51·0	129·7	51·0	106·8	41·6	121·4	46·4

TABLE NO. 296.
 Dry-manurial series.
 Yield of seed-cotton in lbs. per plot (3 cents) receiving 20, 30 and 40 lbs. of
 nitrogen per acre.
 1930-31.

Manuring in July (J).
 Application on Ridge (R).

Manuring in August (A).
 Application in furrow (F).

Treatment.	Block number.				Mean.
	I.	II.	III.	IV.	
Control	16.44	12.92	12.78	14.48	14.16
20 J.F.	19.25	17.03	20.00	20.53	19.20
20 J.R.	16.13	18.56	14.18	18.78	16.91
30 J.F.	20.40	15.66	15.78	18.60	17.61
30 J.R.	21.58	16.93	20.01	18.73	19.31
40 J.F.	21.73	20.37	18.22	20.48	20.20
40 J.R.	21.21	18.48	21.26	19.21	20.04
20 A.F.	17.99	18.13	13.10	18.18	16.85
20 A.R.	14.05	18.83	14.48	17.53	16.22
30 A.F.	14.79	18.05	15.02	21.31	17.29
30 A.R.	17.23	17.79	15.42	19.44	17.47
40 A.F.	16.55	18.41	20.78	20.34	19.02
40 A.R.	20.12	18.28	23.85	18.45	20.18
Block mean	18.27	17.65	17.30	18.93	18.04 (Mean of all)

ANALYSIS OF VARIANCE.

Due to	Degrees of freedom.	Sum of squares.	Variance.
Between treatments	12	157.1848	13.0987
Within treatments	39	172.8583	4.4323
Between blocks	3	20.0811	6.6937
Random variation	36	152.7772	4.2438

The standard error of the comparison of two treatment means 1.46
 The value of "t" for P=0.05 for 36, degrees of freedom 1.96
 Value for a significant difference between two treatment means 2.86

Conclusions :—

(1) The following treatments are significantly superior to control in yield :—

(A) 20 J.F., 30 J.F., 30 J.R., 40 J.F., and 40 J.R.
30 A.F., 30 A.R., 40 A.F., and 40 A.R.

(B) 20 J.R., 20 A.R., and 20 A.F. are not significantly superior to control.

(2) The following treatments are significantly superior to 20 lbs. N in July on ridge :—

40 J.F., 40 J.R., and 40 A.R.

(3) The following treatments are significantly superior to 20 lbs. N in August in furrow :—

40 J.F., 40 J.R., and 40 A.R.

(4) The following treatments are significantly superior to 20 lbs. N in August on ridge :—

20 J.F., 30 J.R., 40 J.F., 40 J.R., and 40 A.R.

(5) The following treatments are significantly superior to 30 lbs. N in August in furrow :—

40 J.F., and 40 A.R.

The following are the conclusions by arranging the treatments according to quantities (time and place of application being constant) :—

Treatment.	Difference in favour of.	Difference significant or not.
<i>July manuring on ridge.</i>		
20 J.R. & 30 J.R.	30 J.R.	Not significant.
20 J.R. & 40 J.R.	40 J.R.	Significant.
30 J.R. & 40 J.R.	40 J.R.	Not significant.
<i>July manuring in furrow.</i>		
20 J.F. & 30 J.F.	20 J.F.	Do.
20 J.F. & 40 J.F.	40 J.F.	Do.
30 J.F. & 40 J.F.	40 J.F.	Do.
<i>August manuring on ridge.</i>		
20 A.R. & 30 A.R.	30 A.R.	Do.
20 A.R. & 40 A.R.	40 A.R.	Significant.
30 A.R. & 40 A.R.	40 A.R.	Not significant.
<i>August manuring in furrow.</i>		
20 A.F. & 30 A.F.	30 A.F.	Do.
20 A.F. & 40 A.F.	40 A.F.	Do.
30 A.F. & 40 A.F.	40 A.F.	Do.

TABLE NO. 297.
 Dry manurial series.
 Yield of seed-cotton in lbs. per plot of 4.85 cents receiving 20, 30 and
 40 lbs. of nitrogen per acre.
 1931-32.

Treatment.	Block number.				
	I.	II.	III.	IV.	Mean.
	Control	27.0	31.9	23.8	21.4	26.02
20 J.R.	31.7	32.2	31.1	30.9	31.47
30 J.R.	33.9	36.8	34.9	30.0	33.90
40 J.R.	38.8	35.6	38.3	34.4	36.78
20 J.F.	29.5	30.2	29.4	30.2	29.82
30 J.F.	32.1	32.7	30.8	28.4	31.00
40 J.F.	41.4	39.0	33.4	35.5	37.32
20 A.R.	32.3	30.3	32.8	24.3	29.92
30 A.R.	36.1	35.6	38.5	33.8	36.00
40 A.R.	34.0	32.2	29.4	28.9	31.12
20 A.F.	27.8	32.1	29.4	28.4	29.42
40 A.F.	34.2	32.7	27.0	26.6	30.12
Block mean	33.23	33.44	31.57	29.40	31.91 (Mean of all)

ANALYSIS OF VARIANCE.

Due to	Degrees of freedom.	Sum of squares.	Variance.
Between treatments	11	510.9740	46.4522
Within treatments	36	274.7884	7.6330
Between blocks	3	125.9880	41.9960
Random variation	33	140.8004	4.5091

The residual standard error of the comparison of treatment means .. 1.50
 The value of "t" for P=0.05 for 33, degrees of freedom .. 1.96
 Value for a significant difference between two treatment means .. 2.94

Conclusions :—

(1) All the treatments are significantly superior to control.

Treatment.	Increase over control %	Treatment.	Increase over control %
20 J.R.	20.9	20 A.R.	15.0
20 J.F.	14.6	20 A.F.	13.1
30 J.R.	30.3	30 A.R.	33.4
30 J.F.	19.1	Not tried.	
40 J.R.	41.4	40 A.R.	10.6
40 J.F.	43.4	40 A.F.	15.8

(2) Comparison of treatments.

Treatments.	Difference in favour of Significance.	
20 J.R. and 30 J.R.	2.43	30 J.R. Not significant.
20 J.R. and 40 J.R.	5.31	40 J.R. Significant.
30 J.R. and 40 J.R.	2.88	40 J.R. Not significant.
20 J.F. and 30 J.F.	1.18	30 J.F. Do.
20 J.F. and 40 J.F.	7.50	40 J.F. Significant.
30 J.F. and 40 J.F.	6.32	40 J.F. Do.
20 A.R. and 30 A.R.	6.08	30 A.R. Do.
20 A.R. and 40 A.R.	1.20	40 A.R. Not significant.
30 A.R. and 40 A.R.	4.88	30 A.R. Significant.
20 A.F. and 40 A.F.	0.70	40 A.F. Not significant.

(3) The following treatments are significantly superior to 20 J.R. :—
40 J.R., 40 J.F., and 30 A.R.(4) The following treatment is significantly superior to 30 J.R. :—
40 J.F.

(5) No treatment is significantly superior to 40 J.R.

(6) The following treatments are significantly superior to 20 J.F. :—
30 J.R., 40 J.R., 40 J.F., and 30 A.R.(7) The following treatments are significantly superior to 30 J.F. :—
40 J.R., 40 J.F., and 30 A.R.

(8) No treatment is significantly superior to 40 J.F.

- (9) The following treatments are significantly superior to 20 A.R. :—
30 J.R., 40 J.R., 40 J.F., and 30 A.R.
- (10) No treatment is significantly superior to 30 A.R.
- (11) The following treatments are significantly superior to 40 A.R. :—
40 J.R., 40 J.F., and 30 A.R.
- (12) The following treatments are significantly superior to 20 A.F. :—
30 J.R., 40 J.R., 40 J.F., and 30 A.R.
- (13) The following treatments are significantly superior to 40 A.F. :—
30 J.R., 40 J.R., 40 J.F., and 30 A.R.

TABLE No. 298.

Effect of the application of green-manure (Ikad, wild Indigo and Udid) in deep trenches (60 cms.)

(Average of 5 plants in each set.)

1927-28.

Organs.	Control.	@ 16,000 lbs. per acre of Dhaincha.	Control.	@ 13,600 lbs. per acre of wild Indigo.	Control.	@ 6,144 lbs. per acre of Udid.
FINAL PERFORMANCE.						
Vegetative buds ..	1215.2	1273.2	1120.8	1156.6	949.8	1262.6
Flower-buds ..	587.6	824.2	504.8	508.6	464.6	651.8
Flowers	204.8	285.5	202.4	190.2	147.0	205.2
Bolls	79.2	112.2	78.4	73.8	62.0	77.4
Seed-cotton in gms.	150.22	216.87	136.10	149.48	118.08	153.24
Percentage success of—						
Bud to flower ..	34.8	34.6	40.0	37.3	31.6	31.4
Flower to boll ..	38.6	39.3	38.8	38.8	42.1	37.7
Bud to boll ..	13.4	13.6	15.5	14.5	13.3	11.8

TABLE NO. 299.

*Yield of seed-cotton in lbs. per lot of 2 cents receiving green-manure and nitrogen.
1928-29.*

Treatment.	Block number.			Average.	Per cent. increase over control.
	II.	III.	IV.		
Average of two control-plots situated on either side of green-manure series.	8.66	10.84	10.58	10.03	..
12.5 lbs. nitrogen per acre as sulphate of ammonia on sowing and 25 lbs. nitrogen per acre with green-manure August.	15.60	19.00	13.10	15.90	58.5
12.5 lbs. nitrogen per acre as sulphate of ammonia on sowing and 25 lbs. nitrogen per acre with green-manure in August in combination with 50 lbs. of P ₂ O ₅ per acre.	13.93	18.13	15.90	15.99	59.4
37.5 lbs. nitrogen per acre as sulphate of ammonia on sowing and green-manure in August.	10.20	14.50	11.83	12.18	21.4
12.5 lbs. nitrogen per acre as sulphate of ammonia and green-manure in August.	10.93	11.15	10.63	10.90	8.7

TABLE NO. 300.

*Total bud and boll-shedding in five plants defoliated partially or wholly.
1923-24.*

Days after operation.	Treatment.		
	Complete defoliation.	Defoliated side.	Undefoliated side.
3	94	48	14
5	158	26	1
7	82	29	13
6	26	46	10
11	26	5	20
14	31	17	2
17	13	10	..
19 .. .. .	..	11	3
22 .. .. .	..	4	2
24 .. .. .	..	3	2
26 .. .. .	..	1	2
Total ..	430	200	69

TABLE No. 300—(contd.)
Total bud and boll-shedding in five plants defoliated in their different parts.
 1923-24.

Days after operation.	Upper half of plant (defoliated).	Lower half (undefoliated).	Days after operation.	Lower half of the plant (defoliated).	The upper half (undefoliated).
2 ..	17	8	2	37	..
4 ..	17	..	4	6	2
6 ..	9	3	7	20	5
9 ..	45	..	9	24	10
13 ..	16	..	11	17	3
16 ..	67	6	14	16	58
18 ..	65	25	16	6	1
20 ..	28	43	18	..	4
23 ..	14	11	21	2	..
			23	9	11
			25	1	2
Total ..	278	96	Total ..	138	96

TABLE No. 301.
Average progressive production of vegetative buds in de-budding experiments.
 (Protected plants.)
 1930-31.

Period ending	Control.	Flower-buds removed up to			
		31-10-30.	4-12-30.	1-1-31.	29-1-31.
5th September ..	13·0	12·0	12·6	14·4	13·2
3rd October ..	65·2	54·9	61·6	66·5	54·2
31st October ..	159·7	150·7	173·1	169·4	144·4
28th November ..	228·7	227·0	258·0	249·8	222·4
26th December ..	232·1	259·2	335·1	324·7	303·8
23rd January ..	..	262·4	348·6	372·4	352·4
20th February ..	..	..	..	382·6	414·4
20th March ..	..	..	..	..	426·6
Number of plants under study ..	10	10	10	9	5

TABLE No. 301—(contd.)
Average progressive production of vegetative buds in de-budding experiments.
(Protected plants.)
1931-32.

Period ending	Control.	12-11-31.	3-12-31.	31-12-31.	28-1-32.
17th September ..	15.5	14.4	13.2	12.8	13.5
1st October	41.0	35.5	29.9	25.7	32.5
22nd October	100.9	90.0	78.1	67.8	84.9
29th October	124.6	106.9	93.6	81.5	103.7
5th November	139.8	127.2	114.4	97.0	117.5
12th November	169.0	160.9	144.6	125.6	152.3
19th November	203.9	211.2	191.2	166.0	211.5
31st December	321.5	347.8	397.9	358.2	402.9
27th January .. ..	..	359.0	427.7	398.8	553.3
25th February .. ..	..	..	..	413.2	620.7
11th March .. ..	..	..	..	..	634.2
Number of plants under study	10	10	9	10	10

TABLE No. 302.
Weekly average flower-opening and its relative boll success in sets of ten protected plants where flower-buds were removed, once a week, for varying periods.
1930-31.

Week ending	Control.		Buds removed up to 31-10-30.		Buds removed up to 4-12-30.		Buds removed up to 1-1-31.		Buds removed up to 29-1-31.	
	Flowers opened.	Relative bolls.	Flowers opened.	Relative bolls.	Flowers opened.	Relative bolls.	Flowers opened.	Relative bolls.	Flowers opened.	Relative bolls.
19th October ..	0.4	..	..	..	..	..	..	..	..	..
6th October ..	10.9	2.8	..	..	..	..	..	..	..	..
2nd November ..	17.0	8.7	..	..	..	..	..	..	..	..
9th November ..	10.3	9.2	..	..	..	..	..	..	..	..
16th November ..	2.1	1.4	..	..	..	..	..	..	..	..
23rd November ..	4.5	2.6	..	..	..	..	..	..	..	..
30th November ..	7.5	4.7	0.4	0.4	..	..	..	..	..	..
7th December ..	15.6	9.0	15.4	14.2	..	..	..	..	..	..
14th December ..	13.9	6.2	25.7	14.6	..	..	..	..	..	..
21st December ..	9.5	1.5	28.0	2.9	..	..	..	..	..	..
28th December ..	3.8	0.2	26.5	0.4	1.0	0.9	..	..	..	..
4th January ..	1.0	..	16.5	0.8	4.5	4.4	..	..	..	..
11th January ..	0.8	..	4.8	0.1	40.4	31.9	..	..	..	..
18th January ..	0.1	..	0.5	..	42.8	6.0	0.1	0.1	..	..
25th January ..	..	..	0.1	..	42.4	0.1	0.8	0.8	..	..
1st February ..	..	..	..	..	16.5	0.1	11.4	9.7	..	..
8th February ..	..	..	..	..	1.1	..	38.8	20.8	..	..
15th February ..	..	..	..	..	..	..	35.8	3.2	0.4	0.2
22nd February ..	..	..	..	..	..	..	25.7	0.7	2.2	1.6
1st March .. ..	..	..	..	..	..	..	4.1	..	20.6	13.6
8th March .. ..	..	..	..	..	..	..	0.1	..	34.8	5.2
15th March .. ..	..	..	..	..	..	..	..	..	19.2	..
22nd March .. ..	..	..	..	..	..	..	..	..	5.6	..
Total	96.7	46.8	117.9	33.4	148.7	43.4	116.8	34.8	82.8	20.6

TABLE No. 303.

Weekly average flower-opening and its relative boll success in sets of ten protected plants where flower-buds were removed, once a week, for varying periods.

1931-32.

Week ending	Control.		Buds removed up to 12-11-31.		Buds removed up to 3-12-31.		Buds removed up to 31-12-31.		Buds removed up to 25-1-32.	
	Flowers opened.	Relative bolls.	Flowers opened.	Relative bolls.	Flowers opened.	Relative bolls.	Flowers opened.	Relative bolls.	Flowers opened.	Relative bolls.
22nd November	0·1	0·1	..	..	..	..	..	..	..	..
29th November	2·4	2·0	..	..	..	..	..	..	..	..
6th December ..	6·6	5·4	..	..	..	..	..	..	..	..
13th December ..	13·2	9·5	0·3	0·2	..	..	..	..	..	..
20th December ..	19·0	14·6	13·7	12·2	..	..	..	..	..	..
27th December ..	26·4	17·4	27·5	22·6	..	..	..	..	..	..
3rd January ..	22·0	4·4	26·4	9·2	0·6	0·3	..	..	..	..
10th January ..	23·6	0·7	30·4	0·6	11·9	11·2	..	..	..	..
17th January ..	17·4	0·4	24·1	0·5	34·6	31·1	..	..	..	..
24th January ..	7·4	0·1	13·7	0·2	44·4	7·9	0·8	0·6	..	..
31st January ..	1·0	0·1	4·8	..	40·4	0·1	5·8	5·3	..	..
7th February ..	0·1	..	0·1	..	27·8	..	35·7	27·6	..	..
14th February ..	..	..	..	..	7·3	..	60·3	9·1	..	..
21st February ..	..	..	..	..	0·3	..	47·1	0·3	4·6	3·9
28th February ..	..	..	..	..	..	..	17·0	0·2	30·7	23·6
6th March ..	..	..	..	..	..	..	0·4	..	68·2	11·8
13th March ..	..	..	..	..	..	..	..	..	53·5	1·2
20th March ..	..	..	..	..	..	..	..	..	11·2	0·2
27th March ..	..	..	..	..	..	..	..	..	0·1	..
Rest ..	..	..	..	..	..	0·4	..	..	..	0·4
Total ..	139·2	54·7	140·9	45·5	167·3	51·0	167·1	43·1	168·3	41·1

TABLE No. 304.

*Average plant performance under boll-worm-damage-imitation experiments
carried out on protected plants.*

1929-30.

Organs.	Un-protected.	Protected.		
		Control.	Shoot damage imitation.	Flower-bud damage imitation.
Vegetative buds	311.5	277.6	268.0	249.0
Flower-buds	212.6	274.8	233.4	237.2
Flowers	61.2	144.9	121.1	71.7
Bolls	20.6	45.6	37.9	29.4
Percentage success of—				
Bud to flower	28.8	52.7	51.9	25.0
Flower to boll	33.7	31.5	31.3	41.0
Bud to boll	9.7	16.6	16.2	10.2
Weight in grammes of—				
Seed-cotton	41.1	92.7	83.6	60.2
Dry plant	36.0	44.5	40.7	46.6
Ratio of $\frac{\text{Seed-cotton}}{\text{Dry plant}}$	1.14	2.08	2.05	1.3
Number of plants studied	8	8	8	8

TABLE No. 305.

Average plant performance under boll-worm-damage-imitation experiments carried out on protected plants.

1930-31.

Organs.	Un-protected.	Protected		
		Control.	Shoot damage imitation.	Flower-bud damage imitation.
Vegetative buds	324.5	232.1	246.4	261.2
Flower-buds	286.3	254.6	246.1	315.5
Flowers	85.8	96.7	88.6	85.2
Bolls	28.3	46.3	41.6	28.8
Percentage success of—				
Bud to flower	30.0	38.0	36.0	27.0
Flower to boll	33.0	47.9	47.0	33.8
Bud to boll	9.9	18.2	17.0	9.1
Weight in grammes of—				
Seed-cotton	60.3	84.4	81.0	61.75
Dry plant	43.8	46.85	39.35	43.85
Ratio of $\frac{\text{Seed-cotton}}{\text{Dry plant}}$	1.38	1.80	2.06	1.41
Number of plants studied	10	10	10	10

TABLE NO. 306.

Average plant performance under boll-worm-damage-imitation experiments carried out on protected plants.

1931-32.

Organs.	Un-protected.	Protected.		
		Control.	Shoot damage imitation.	Flower-bud damage imitation.
Vegetative buds	369.4	287.2	336.2	442.3
Flower-buds	205.2	288.2	265.6	480.4
Flowers	65.7	121.9	115.8	116.5
Bolls	30.6	44.9	44.1	44.3
Percentage success of—				
Bud to flower	32.0	42.3	43.6	24.3
Flower to boll	46.6	36.8	38.1	38.0
Bud to boll	14.9	15.6	16.6	9.2
Weight in grammes of—				
Seed-cotton	53.45	84.1	80.85	90.55
Dry plant	28.90	44.8	46.50	68.90
Ratio of $\frac{\text{Seed-cotton}}{\text{Dry plant}}$	1.85	1.88	1.74	1.31
Number of plants studied	10	10	10	10

TABLE No. 307.

Average flower-opening in shoot and flower-bud-damage-imitation experiments.

1929-30.

Week ending	Protected.		
	Control.	Shoot damage imitation.	Flower-bud damage imitation.
20th October	0·1	0·5	..
27th October	1·0	1·2	..
3rd November	1·8	2·0	..
10th November	6·2	10·1	0·6
17th November	23·5	28·0	5·4
24th November	42·2	31·1	11·0
1st December	37·3	25·9	8·6
8th December	26·0	15·6	8·9
15th December	6·8	5·4	10·0
22nd December .. .. .	..	0·9	10·2
29th December .. .. .	..	0·1	6·1
5th January .. .. .	..	..	4·6
12th January .. .. .	..	..	3·8
19th January .. .. .	..	..	1·6
26th January .. .. .	..	..	0·9
Number of plants studied	8	8	8
Total ..	144·9	121·1	71·7

TABLE No. 308.

Average flower-opening in shoot and flower-bud-damage-imitation experiments.

1930-31.

(Average of plants in each set.)

Period ending	Protected.		
	Control.	Shoot damage imitation.	Flower-bud damage imitation.
19th October	0.4	0.2	..
26th October	10.9	6.2	0.1
2nd November	17.0	9.3	0.3
9th November	10.3	8.8	0.3
16th November	2.1	2.6	..
23rd November	4.5	4.9	..
30th November	7.5	7.3	..
7th December	15.6	13.3	1.7
14th December	13.9	14.1	6.0
21st December	9.5	10.2	10.7
28th December	3.6	7.2	17.7
4th January	1.0	3.9	17.8
11th January	0.3	0.6	17.6
18th January	0.1	..	7.9
25th January .. .. .	..	..	4.2
1st February .. .. .	..	..	0.9
Total ..	96.7	88.6	85.2

TABLE No. 309.
Average flower-opening in shoot and flower-bud-damage-imitation experiments.
 1931-32.

(Average of 10 plants in each set.)

Period ending	Protected.		
	Control.	Shoot damage imitation.	Flower-bud damage imitation.
22nd November	0.3	0.1	..
29th November	2.9	1.6	..
6th December	7.3	5.0	0.1
13th December	9.6	8.5	0.3
20th December	15.2	12.9	1.3
27th December	23.8	18.7	4.1
3rd January	18.5	18.6	5.4
10th January	21.1	18.7	9.9
17th January	13.1	15.5	13.8
24th January	7.9	10.2	19.5
31st January	2.0	4.4	17.2
7th February	0.1	1.4	16.5
14th February	0.1	0.1	13.1
21st February .. .. .	..	0.1	7.2
28th February .. .. .	..	..	6.3
6th March .. .. .	..	..	1.4
13th March .. .. .	..	..	0.4
Total ..	121.9	115.8	116.5

TABLE No. 310.

Flower-opening and its relative bolls in bud-damage-imitation experiments.
1929-30.

(Average of 8 plants in each set.)

Week ending	Unprotected.		Protected.		Protected with damage imitation to buds only.	
	Flowers opened.	Relative bolls.	Flowers opened.	Relative bolls.	Flowers opened.	Relative bolls.
20th October ..	0.1	..	0.1	0.1	..	..
27th October ..	..	..	1.0	0.9	..	..
3rd November ..	0.4	..	1.8	1.5	..	..
10th November ..	1.9	0.2	6.2	5.4	0.6	0.5
17th November ..	5.2	1.1	23.5	11.7	5.4	4.1
24th November ..	6.5	2.2	42.2	24.4	11.0	8.7
1st December ..	6.2	3.4	37.3	1.5	8.6	5.9
8th December ..	7.5	4.1	26.0	..	8.9	3.6
15th December ..	7.4	3.6	6.8	0.1	10.0	2.5
22nd December ..	7.5	2.1	..	..	10.2	1.3
29th December ..	4.4	1.4	..	..	6.1	1.0
5th January ..	6.1	0.7	..	..	4.6	0.3
12th January ..	5.1	1.0	..	..	3.8	0.9
19th January ..	2.6	0.6	..	..	1.6	0.4
26th January ..	0.2	..	..	..	0.9	0.2
Total ..	61.2	20.6	144.9	45.6	71.7	29.4

TABLE No. 311.

Flower-opening and its relative bolls in bud-damage-imitation experiments.

1930-31.

(Average of 10 plants in each set.)

Week ending	Unprotected.		Protected.		Protected with damage imitation to buds only.	
	Flowers opened.	Relative bolls.	Flowers opened.	Relative bolls.	Flowers opened.	Relative bolls.
19th October .. ..	..	..	0.4	..	..	..
26th October	0.9	..	10.9	2.8	0.1	..
2nd November	1.7	..	17.0	8.7	0.3	..
9th November	0.5	..	10.3	9.2	0.3	0.2
16th November	0.3	..	2.1	1.4	..	..
23rd November	0.4	0.3	4.5	2.6	..	..
30th November	1.4	0.8	7.5	4.7	..	..
7th December	3.3	2.3	15.6	9.0	1.7	1.7
14th December	8.8	7.2	13.9	6.2	6.0	5.6
21st December	13.2	9.9	9.5	1.5	10.7	8.3
28th December	18.5	6.2	3.6	0.2	17.7	7.4
4th January	16.5	1.1	1.0	..	17.8	4.4
11th January	12.5	0.3	0.3	..	17.6	1.1
18th January	7.1	0.2	0.1	..	7.9	..
25th January	0.7	..	..	..	4.2	..
1st February .. ..	..	..	..	..	0.9	..
Rest .. ..	..	..	..	..	..	0.1
Total ..	85.8	28.3	96.7	46.3	85.2	28.8

TABLE No. 312.

Flower-opening and its relative bolls in bud-damage-imitation experiments.

1931-32.

(Average of 10 plants in each set.)

Week ending	Unprotected.		Protected.		Protected with damage imitation to buds only.	
	Flowers opened.	Relative bolls.	Flowers opened.	Relative bolls.	Flowers opened.	Relative bolls.
22nd November ..	0.1	0.1	0.3	0.3	..	..
29th November ..	0.6	0.4	2.9	2.2	..	..
6th December	1.6	1.0	7.3	5.7	0.1	0.1
13th December	3.4	2.8	9.6	5.6	0.3	0.2
20th December	5.8	4.4	15.2	9.4	1.3	1.1
27th December	11.5	8.8	23.8	15.1	4.1	4.1
3rd January	8.3	5.7	18.5	5.7	5.4	4.9
10th January	8.5	3.2	21.1	0.6	9.9	8.2
17th January	10.9	1.5	13.1	..	13.8	8.1
24th January	7.8	1.1	7.9	0.2	19.5	7.0
31st January	4.3	1.2	2.0	0.1	17.2	3.8
7th February	2.3	0.4	0.1	..	16.5	3.2
14th February	0.6	..	0.1	..	13.1	2.3
21st February .. ..	..	..	..	..	7.2	1.1
28th February .. ..	..	..	..	..	6.3	0.1
6th March .. ..	..	..	..	..	1.4	..
13th March .. ..	..	..	..	..	0.4	..
Rest .. ..	..	..	..	..	..	0.1
Total ..	65.7	30.6	121.9	44.9	116.5	44.3

TABLE No. 313.

Weekly average flower-opening and its relative boll success in sets of 10 protected plants where flower-buds were removed on a single day to imitate the damage by the storm.

1931-32.

Week ending	Control.		Buds removed on 4-12-31.		Buds removed on 18-12-31.		Buds removed on 31-12-31.	
	Flowers opened.	Relative success of bolls.	Flowers opened.	Relative success of bolls.	Flowers opened.	Relative success of bolls.	Flowers opened.	Relative success of bolls.
22nd November..	0.1	0.1	0.6	0.6	..	..	..	..
29th November ..	2.4	2.0	2.4	2.2	1.9	1.2	1.3	1.0
6th December ..	6.6	5.4	7.4	6.7	6.6	5.0	6.5	5.4
13th December ..	13.2	9.5	..	..	11.5	7.4	12.1	8.5
20th December ..	19.0	14.6	..	..	16.0	14.4	18.4	13.2
27th December ..	26.4	17.4	..	..	..	..	23.2	15.3
3rd January ..	22.0	4.4	..	..	..	..	20.0	4.4
10th January ..	23.6	0.7	7.7	7.6	..	..	..	..
17th January ..	17.4	0.4	25.9	23.9	0.7	0.5	..	..
24th January ..	7.4	0.1	32.4	14.9	8.2	7.4	..	..
31st January ..	1.0	0.1	29.7	0.7	17.1	15.2	..	..
7th February ..	0.1	..	25.1	0.4	13.4	5.2	0.2	0.2
14th February ..	..	..	7.8	..	9.7	0.6	..	..
21st February ..	..	..	0.6	..	3.8	..	..	..
28th February ..	..	..	..	..	0.2	..	..	..
Rest ..	..	..	..	0.1	..	0.2	..	0.4
Total ..	139.2	54.7	139.6	57.1	89.1	57.1	81.7	48.4

TABLE No. 314.

Weekly production of flowers and their relative success into bolls in defloration experiments.

Protected plants.

1930-31.

(Average of 5 plants.)

Week ending	Control.		Flowers removed up to 16-11-30.		Flowers removed up to 7-12-30.		Flowers removed up to 21-12-30.	
	Flowers opened.	Relative success of bolls.	Flowers opened.	Relative success of bolls.	Flowers opened.	Relative success of bolls.	Flowers opened.	Relative success of bolls.
19th October ..	..	..	1.4	..	1.0	..	0.6	..
26th October ..	5.4	..	10.2	..	11.6	..	7.6	..
2nd November ..	7.2	4.0	20.4	..	11.6	..	11.2	..
9th November ..	3.8	3.6	8.8	..	8.8	..	5.6	..
16th November ..	0.4	0.4	0.2	..	2.4	..	0.2	..
23rd November ..	3.8	3.2	1.6	1.4	4.4	..	2.2	..
30th November ..	6.2	4.8	7.2	6.2	6.8	..	4.2	..
7th December ..	22.2	15.6	16.0	12.6	19.2	..	13.0	..
14th December ..	22.8	9.6	27.6	9.0	25.8	25.4	22.8	..
21st December ..	15.8	1.2	21.6	0.4	29.2	12.8	24.8	..
28th December ..	13.2	0.4	27.8	..	30.8	0.4	31.4	29.0
4th January ..	6.2	..	13.6	1.0	20.6	..	18.4	7.2
11th January ..	1.2	..	2.6	0.2	5.2	..	18.0	..
18th January ..	..	..	0.2	..	..	..	12.4	0.2
25th January ..	..	..	..	..	..	..	4.4	..
1st February ..	..	..	..	..	..	..	0.6	..
Total ..	108.2	42.8	159.2	30.8	177.4	38.6	177.4	36.4

TABLE No. 315.

Weekly average flower-opening and its relative boll-success in sets of protected plants where flowers were daily removed for varying periods.

1931-32.

(Average of 10 plants.)

Week ending	Control.		Flowers removed up to 31-12-31.		Flowers removed up to 27-12-31.		Flowers removed up to 10-1-32.	
	Flowers opened.	Relative success of bolls.	Flowers opened.	Relative success of bolls.	Flowers opened.	Relative success of bolls.	Flowers opened.	Relative success of bolls.
15th November ..	..	..	..	..	0.1	..	..	..
22nd November ..	1.5	1.2	0.5	..	0.0	..	0.8	..
29th November ..	4.2	3.6	5.1	..	6.1	..	6.2	..
6th December ..	8.8	6.3	11.1	..	13.9	..	10.8	..
13th December ..	12.5	7.9	19.1	..	16.5	..	13.4	..
20th December ..	19.4	11.5	24.8	22.7	22.3	..	17.2	..
27th December ..	24.0	12.7	33.6	25.8	31.2	..	22.5	..
3rd January ..	19.5	1.5	24.8	3.4	25.6	25.0	19.7	..
10th January ..	16.3	0.3	26.4	..	24.3	19.9	18.7	..
17th January ..	9.0	0.8	16.9	..	23.2	1.7	19.5	19.2
24th January ..	4.5	0.5	7.7	..	19.9	0.2	14.7	12.1
31st January ..	1.3	0.1	0.5	..	9.1	..	12.9	2.2
7th February ..	0.4	0.2	..	..	3.2	..	10.9	0.2
14th February ..	0.4	..	..	..	0.4	..	8.8	..
21st February ..	..	..	..	..	..	..	1.3	..
Rest ..	..	0.6	..	0.4	..	0.2	..	0.1
Total ..	121.8	47.2	170.5	52.3	196.7	47.0	177.4	33.8

TABLE No. 316.
Results of defloration experiments.
 (Unprotected plants.)
 1925-26.

Week ending	Control.		Flowers removed up to 15th December, 1925.		Flowers removed from 16th December, 1925 to 19th January, 1926.		Flowers removed till the end.
	Flowers opened.	Relative bolls.	Flowers opened.	Relative bolls.	Flowers opened.	Relative bolls.	Flowers opened.
27th October	0.4	..	..	..	..	..	..
3rd November	0.4	..	0.1	..	..	..	..
10th November	1.0	0.2	1.2	..	0.8	0.4	..
17th November	2.6	1.4	2.4	..	1.5	0.8	0.2
24th November	10.6	7.2	7.7	..	5.9	4.6	7.2
1st December	11.4	8.6	15.7	..	10.1	7.7	13.8
8th December	18.0	8.0	23.5	..	17.5	11.0	17.2
15th December	16.4	4.6	22.0	..	15.3	7.2	20.0
22nd December	12.8	1.2	13.7	11.1	13.9	..	18.8
29th December	5.4	0.4	15.2	12.2	12.2	..	18.2
5th January	4.6	..	15.6	7.1	8.2	..	18.2
12th January	0.2	..	6.4	0.7	1.2	..	8.6
19th January .. ..	..	..	4.2	0.5	0.4	..	4.6
26th January .. ..	..	..	0.3	0.1	..	..	1.2
Total ..	83.8	31.6	128.0	31.7	87.0	31.7	128.0
Flowers removed .. ..	..	..	72.6	..	35.9	..	128.0
Flowers remaining .. ..	..	..	55.4	..	51.1	..	..
Success per cent.	37.7		24.7		36.4		
Plants under study	5		10		10		5

TABLE No. 317.
Results of defloration experiments.
 (Field cage plants.)
 1925-26.
 (Average of 5 plants in each set.)

Week ending	Control.		Removal of November flowers.		Removal of December flowers.		Removal of January flowers.	
	Flowers opened.	Relative bolls.	Flowers opened.	Relative bolls.	Flowers opened.	Relative bolls.	Flowers opened.	Relative bolls.
2nd November..	2.2	0.8	2.8	..	0.4	0.2	0.4	0.4
9th November..	3.4	1.2	15.4	..	4.0	1.6	4.4	1.4
16th November..	3.2	..	15.4	..	5.8	0.6	8.0	0.4
23rd November..	3.4	1.6	18.4	..	4.6	3.0	5.0	3.4
30th November..	0.4	0.2	4.0	..	0.6	0.6	..	..
7th December..	4.0	3.6	6.2	5.2	4.4	..	3.2	2.8
14th December..	6.4	5.0	7.0	5.8	8.2	..	5.0	4.8
21st December..	9.4	5.6	10.0	6.6	13.8	..	8.8	6.6
28th December..	13.0	7.2	16.4	10.6	23.0	..	23.2	16.8
4th January..	25.2	13.0	35.6	18.6	17.6	15.2	18.2	11.6
11th January..	13.0	5.4	20.8	6.2	19.4	16.8	38.0	..
18th January..	9.6	2.8	14.8	2.4	15.6	5.6	18.6	..
25th January..	6.8	1.2	4.6	0.2	8.2	0.6	5.0	..
1st February..	2.4	0.6	1.6	..	1.6	..	00.8	..
8th February..	..	..	0.2	..	..	..	..	..
Total ..	102.4	48.2	173.2	55.6	141.8	44.2	169.6	48.2
Success per cent. ..	47.0		32.1		31.1		28.0	
Flowers removed	..		56.0		64.0		93.4	

TABLE No. 318.
*Results of de-fruited experiments.**
 (Unprotected plants.)
 1925-26.
 (Average of 10 plants in each set.)

Week ending	Treated inner row.		Control inner row.	
	Flowers opened.	Relative bolls.	Flowers opened.	Relative bolls.
12th December	5.8	3.9	5.4	1.4
19th December	25.9	21.0	24.9	2.6
26th December	17.7	9.1	15.1	0.8
2nd January	10.7	1.2	5.9	0.2
9th January	2.6	0.3	..	..
16th January .. .. .	..	..	..	..
23rd January .. .. .	..	..	..	..
30th January .. .. .	..	..	..	..
Total ..	62.7	35.5	51.3	5.0
Success per cent.	56.9		9.7	

* All bolls removed on the 10th December, 1925.

TABLE No. 319.
*Results of de-fruited experiments.**
 (Unprotected plants.)
 1925-26.
 (Average of 10 plants in each set.)

Week ending	Treated border row.		Control border row.	
	Flowers opened.	Relative bolls.	Flowers opened.	Relative bolls.
12th December	9.5	7.4	14.2	6.2
19th December	37.1	26.9	40.8	13.0
26th December	40.7	22.8	42.0	11.3
2nd January	55.2	19.1	52.4	15.9
9th January	42.3	10.3	28.0	8.5
16th January	21.8	4.9	11.6	2.0
23rd January	7.8	1.3	2.6	0.3
30th January	1.0	0.1	0.1	..
Total ..	215.4	92.8	191.7	57.2
Success per cent.	43.0		29.8	

* All bolls removed on the 10th December, 1925.

TABLE No. 320.

Average progressive production of vegetative buds, flower-buds and the total shedding of the latter in the protected plants, sown at different times in the season.

1930-31.

Period ending	Set No. I. Sown on 3-7-30.			Set No. II. Sown on 14-8-30.			Set No. III. Sown on 28-8-30.		
	Vegetative buds.	Flower-buds.	Bud & boll shedding.	Vegetative buds.	Flower-buds.	Bud & boll shedding.	Vegetative buds.	Flower-buds.	Bud & boll shedding.
	26th September ..	58.55	21.55	3.85	7.8	4.2	..
10th October ..	105.45	74.45	7.95	19.4	0.6	..	7.1	..	..
24th October ..	149.15	140.40	24.80	55.7	8.5	0.4	15.8	..	..
7th November ..	190.90	190.30	113.90	89.6	18.9	9.6	28.4	0.9	0.1
21st November ..	218.05	223.00	130.75	136.4	54.0	15.8	52.2	8.9	0.5
5th December ..	224.50	230.40	155.30	194.2	115.8	18.8	91.8	23.2	4.3
19th December ..	226.75	230.95	168.95	234.7	176.1	23.3	131.0	46.8	8.2
2nd January ..	..	..	186.35	260.0	211.7	31.0	181.7	88.1	10.9
16th January ..	..	..	188.70	278.8	221.2	89.3	236.2	155.8	15.7
30th January ..	..	..	..	282.8	224.4	158.8	294.9	215.9	36.1
13th February ..	..	..	..	..	..	182.4	324.0	258.7	112.1
27th February ..	..	..	..	..	..	182.8	332.4	282.3	195.8
13th March ..	..	..	..	..	..	..	..	..	238.6
Total ..	..	..	..	..	..	..	..	..	240.5

TABLE No. 321.

Average progressive production of vegetative buds, flower-buds and the total shedding of the latter in the protected plants sown at different times in the season.

1931-32.

Period ending	Sowing at normal time on 2nd July, 1937.			Sowing six weeks late on 14th August, 1931.		
	Vegetative buds.	Flower-buds.	Total sheds.	Vegetative buds.	Flower-buds.	Total sheds.
30th October ..	114.40	54.35	21.80	12.1	..	..
13th November ..	176.00	124.85	38.45	20.5	0.2	..
27th November ..	216.85	195.30	55.05	39.7	4.8	..
11th December ..	253.35	249.75	69.55	67.8	17.3	0.6
25th December ..	285.55	284.65	122.80	101.0	35.2	4.7
8th January ..	298.90	294.85	188.30	139.9	67.4	9.6
22nd January ..	299.85	..	242.50	186.0	113.6	12.9
5th February ..	..	..	249.00	224.2	162.3	19.4
19th February ..	..	..	..	244.4	184.2	51.2
4th March ..	..	..	..	251.0	194.0	131.5
18th March ..	..	..	..	..	..	163.4
1st April ..	..	..	..	..	..	165.2

TABLE NO. 322.

Periodical flowering in protected plants grown at different times in the season.

(Weekly figures.)

1930-31.

Week ending	Set No. I. Sown on 3rd July, 1930.		Set No. II. Sown on 14th August, 1930.		Set No. III. Sown on 28th August, 1930.	
	Flowers.	Relative bolls.	Flowers.	Relative bolls.	Flowers.	Relative bolls.
19th October	0.20	..	..	..	..	..
26th October	7.50	1.75	..	..	..	..
2nd November	14.70	7.75	..	..	..	..
9th November	10.25	9.10	..	..	..	..
16th November	1.20	0.80	..	..	..	..
23rd November	3.10	1.65	..	..	..	..
30th November	5.35	3.65	..	..	..	..
7th December	13.45	8.95	0.3	0.3	..	..
14th December	13.75	6.85	2.6	2.4	..	..
21st December	9.25	1.50	10.0	9.2	0.2	0.2
28th December	4.50	0.25	18.5	12.9	0.5	0.5
4th January	1.70	..	20.2	7.7	2.7	2.1
11th January	0.40	..	23.5	6.1	5.2	4.6
18th January	0.05	..	22.6	2.1	7.2	5.5
25th January .. ..	..	..	20.2	0.6	11.6	5.6
1st February .. ..	..	..	10.5	0.3	14.6	7.4
8th February .. ..	..	..	2.8	..	18.3	6.4
15th February .. ..	..	..	0.4	..	19.5	3.5
22nd February .. ..	..	..	..	..	24.1	4.7
1st March .. ..	..	..	..	..	15.4	1.0
8th March .. ..	..	..	..	..	9.5	0.3
15th March .. ..	..	..	..	..	2.0	..

TABLE No. 323.
Periodical flowering in protected plants grown at different times in the season.
 1931-32.

Week ending	Plants sown at usual time.		Sowing six weeks late.	
	Flowers.	Relative bolls.	Flowers.	Relative bolls.
22nd November	0.25	0.25	..	..
29th November	2.25	1.80	..	..
6th December	7.00	5.65	..	..
13th December	10.50	6.60	..	..
20th December	15.60	10.25	..	..
27th December	24.60	15.00	..	..
3rd January	18.30	5.40	..	..
10th January	20.25	0.50	1.2	0.8
17th January	12.55	0.15	2.0	1.7
24th January	7.45	0.15	3.3	2.8
31st January	1.90	0.05	6.2	5.2
7th February	0.20	0.05	9.0	5.7
14th February	0.05	..	14.2	6.5
21st February .. .. .	..	..	15.5	3.0
28th February .. .. .	..	..	18.6	1.5
6th March .. .. .	..	..	13.8	0.1
13th March .. .. .	..	..	5.3	1.3
20th March .. .. .	..	..	0.9	..
27th March .. .. .	..	..	0.1	..

APPENDIX II.

ANALYTICAL METHODS.

A.—PLANT ANALYSIS—MATERIAL AND ANALYTICAL METHODS FOLLOWED DURING THE YEARS 1926-27 AND 1927-28.

Material.—Samples were removed from the field between 9 and 10 A.M. The number of plants taken varied every time. With regard to every organ, material sufficient for analysis was taken. On the day of sampling, plants were lightly shaken and of the buds and bolls shed, those of about 10 days growth were selected for analysis. Non-shed buds and bolls of approximately the same size as those shed were also removed. Analysis was confined to soft parts of the plant, stem, branches, the roots being excluded. The samples were brought to the laboratory quickly and cut into fine pieces without much loss of time. Analysis was conducted, in all cases, on fresh samples.

Moisture.—This was determined by the usual method on samples of 20 grams.

Ash.—A known quantity of plant material was first completely charred at low temperature. The temperature was then raised to and maintained at a dull red heat until all the matter was converted into ash.

Total Nitrogen.—This was estimated by the Kjeldhal method.

Total Albuminoid Nitrogen.—This was determined by the Strutzer's method as modified by Barnstein (Lunge ; Vol. II, Part I, page 450).

Insoluble Albuminoid Nitrogen.—A known quantity of the material was crushed to a fine paste and washed free of soluble constituents in a Buchner funnel under pressure. The washed substance was then analysed for insoluble albuminoid nitrogen by the Kjeldhal method.

Soluble Albuminoid Nitrogen.—This was determined by subtracting the insoluble albuminoid nitrogen from the total albuminoid nitrogen.

Ammoniacal Nitrogen.—This was determined by crushing the material to a paste and distilling it with magnesia.

Amide Nitrogen.—This was obtained as the difference between the total nitrogen and all other forms of nitrogen determined.

Nitrates.—These could not be detected.

(Methods followed in 1928-29 and the succeeding years.)

Time of drawing the samples.—Samples were removed from the field just after sunrise. This time was considered to be the best as it avoided the widely disturbing effects of photosynthesis which are at their minimum at this hour.

Moisture.—Plants representing average growth were cut off at the junction of the cotyledons and immediately removed to the balance room, specially erected

in the field for the purpose. The different organs were separated and their green weight recorded without loss of time. They were then placed in suitable containers and brought to the laboratory situated at a distance of about one mile and reweighed. The samples were then cut into fine pieces and their moisture determined as usual. Finally, a correction for the loss of moisture during transit from the field to the laboratory was made in the results obtained.

Immediately after removing the shoot, the root-system was profusely watered for facilitating its excavation the next day. When plants were small, the removal of the root-system generally took one day; later in the season, however, when the roots had gone deeper in the soil, one and a half days or sometimes even two days were required for digging out only one root-system. The analytical material, therefore, consisted generally of four to six plants removed at the rate of one per day or one per two days as occasion demanded. The material of the plants so dug out within a week was ground to powder in a grinding mill and this represented the sample for the week. Here, it may be noted that owing to the difficulty of digging out the root-system, more than four to six plants could not be taken for analysis.

Total Hydrolysable Carbohydrates.—These were determined as usual by subtracting from the total dry weight, the total proteids, total ether-extract, total ash and fibre.

Sap Analysis.—Foliage leaves were removed between 1 to 2 p.m. This time was particularly chosen because at this time the photosynthetic activity of the plant is the highest. The leaves while still on the plant were cleaned with a muslin cloth and then removed to a wide-mouthed, metallic container submerged in a mixture of ice and salt. The container was kept closed by means of a water-tight lid and was only occasionally opened to introduce the leaf material.

The ice box was then brought to the laboratory and kept in that condition for over an hour. After removing the lid, the leaves were chopped into pieces in the container. The material was then transferred to a dry cold mortar and the sap pressed out with the aid of an extractor thickly coated with tin. The extracted sap was kept in air-tight, stoppered bottles and was placed in ice mixture till all the material had been extracted. The sap was then filtered through a dry filter paper, after allowing the suspended particles to settle. The cold filtered sap was subsequently raised to 30 degrees Centigrade in the vicinity of the laboratory temperature and measured out for different estimations.

Total solids.—These were determined after evaporating a known quantity of sap at 98 degrees Centigrade (steam oven temperature). A thin glass stirrer was used during the last stages of evaporation.

Ash.—This was determined with the usual precautions on the residue left after evaporation.

Density.—This was determined with the aid of a specific gravity bottle.

Reducing Sugars.—A known quantity of the sap was treated with basic lead acetate and made to volume. It was then filtered through a dry filter paper and the excess lead removed by solid potassium oxalate. The reducing sugars were then determined by titrating the treated sap against Fehling's solution with Methylene Blue as an internal indicator (Henry Lane and Lewis Eynon, Jour. of Soc. of Chem. Indus. January 26, 1923—32T).

Hydrolysable Sugars.—These were determined after inversion.

Total Nitrogen.—This was determined by the Kjeldhal method on the untreated sap.

Total Organic Matter.—This was estimated as the difference between total solids and total ash.

Phosphorus.—This was determined by Kjeldhalising the plant material and then determining the element by double precipitation with ammonium molybdate and magnesia mixture (W. Jones and M. E. Perkis ; the Gravimetric Determination of Organic Phosphorus : Jour. Biol. Chem. 1913, page 343).

Lime.—A known quantity of plant material was carefully burnt and the resulting ash was extracted with hydrochloric acid in the usual way. An aliquot portion of the acid solution was then taken in a beaker and slight excess of ammonium hydroxide was added. It was then acidified with acetic acid and filtered. The lime was precipitated as oxalate and estimated as CaO.

Potash.—A known quantity of the hydrochloric acid extract was treated with barium chloride, ammonium hydroxide, ammonium carbonate, and ammonium oxalate solutions in the order named and the whole made to volume and filtered. The filtrate was acidified with hydrochloric acid, evaporated to dryness, and ignited at a dull-red heat. The ignited residue was then lixiviated with distilled water, filtered and potash estimated by the platinum chloride method.

B.—SOIL ANALYSIS.

Total Moisture.—This was determined by drying samples of 10 grams in the steam oven.

Water Holding Capacity.—This was determined by Hilgard's Cylinder method.

Water-Supplying Power of the Soil.—This was measured with the Soil Points of Dr. Livingston and Koketsu (The Water-Supplying Power of the Soil as related to the wilting of Plants : Soil Sc., Vol. IX, No. 6, June, 1920).

Unfree Water.—This was determined by Bouyoucos' Method with the dilatometer. (Measurement of the Unfree or the inactive moisture in the soil : Jour. Agr. Res., Vol. VIII, No. 6, 1917.) It was found that more water than was recommended had had to be added to obtain readings with the class of soils under study and though the amount of water that froze did depend to an extent on the amount of water added (M. M. McCool and Weidemann :—Study of certain organic soil profiles. Soil Sc. Vol. XVIII, 1924), a large amount was resorted to for ease of working the soil and of freezing the water not unfree. The experiments were performed with 20 grams of soil and 10 cc. of water, in all cases. Even then, the wetting of the soil mass evenly, was a difficult task and after a number of trials with different methods of mixing, it was at last found that the introduction of the soil and the water into the dilatometer alternately, and every time a small quantity of each, worked very satisfactorily, ensuring uniform wetting. It was customary with the workers before, to calculate and express their results as so many c.cs. of water held unfree,

out of 100 c.cs. of water added. But for our purposes here, it was found more convenient to express the results as so many c.cs. of water held unfree by 100 grams of air dry soil, on the authority of Bouyoucos himself who holds that the amount of water unfree is a constant for a given soil, independent of the total moisture present, though Keen and also McCool and Weidemann obtained results to show that this was not the case.

Organic Nitrogen.—This was determined by the Kjeldhal's process as modified by Bal (Determination of Nitrogen in heavy clay Soils. Jour. Agr. Sc., Vol. XV, Part IV, 1925), where the soil was always moistened with a quantity of water and shaken and allowed to stand before the requisite amount of the acid was added.

The Ammoniacal, Nitrite and Nitrate Nitrogen.—These were determined as described by Sahasrabuddhe and Daji (Nitrogen Recuperation in the soils of the Bombay Deccan. Pusa Memoirs : Chem. Series, Vol. VIII, No. 5, 1925). But an essential alteration was made in that the soil had had to be dried immediately and quickly at a temperature of not more than 55° Centigrade.

The ammoniacal nitrogen was determined by distilling with magnesia.

The nitrate nitrogen was determined by the Phenol-disulphonic Method and the nitrite nitrogen by the Griess Ilosvay process.

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