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FERTILIZE CORN FOR HIGHER YIELDS



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**AGRICULTURAL EXPERIMENT
STATION
NORTH CAROLINA STATE
COLLEGE
RALEIGH, N. C.**



ON THE COVER: Nitrogen Made The Difference! Except for nitrogen, both plots received the same fertilization, were spaced the same, and were seeded, cultivated and harvested at the same time. The plot on the right received no nitrogen, yielded 7.2 bushels per acre. The plot on the left received 180 pounds of nitrogen per acre, yielded 103.9 bushels.

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FOREWORD

Progress does not always follow a steady course. History records many situations in which little advance is made for many years. Then, following a new discovery or under leadership with a fresh viewpoint, very rapid progress is made for a few years and the enterprise moves forward on an entirely new plane. This is the case with corn production in North Carolina.

Before the turn of the century, the average yield of corn in the State was around 11 to 14 bushels per acre year in and year out. Then came the 4-H corn clubs and an intensive educational program acquainting the farmers and farm youth with what was then known about corn production. In the short space of 12 years, the average yield increased to around 18 to 20 bushels per acre. There it remained for almost three decades.

Now we are in the midst of another period of progress which promises to be much more far reaching than that experienced in the period of 1903 to 1915. This was set off by two research programs, jointly sponsored by the North Carolina Agricultural Experiment Station and the Bureau of Plant Industry, Soils and Agricultural Engineering, namely, (1) a breeding program begun in 1938 to develop corn hybrids adapted to this area; and (2) an intensive program begun in 1943 on the cultural and fertilization requirements for corn production in this area.

New hybrids capable of yielding much greater harvests than our old varieties were developed. Hunger signs, which had long been mistaken for the effects of dry weather, were correctly diagnosed as nitrogen deficiency. With better fertilization and soil management, closer spacing was found necessary to provide the stalks required for high yields. Closer spacing also made weed control easier by providing plant competition. This avoided the necessity for late, deep cultivation which caused root damage. A study of past weather data revealed a favorable climate for corn production.

When these facts and their corrective measures were brought together in one corn production program, it has become common for practical farmers from one end of the State to the other to get yields of 100 bushels per acre or more. The program has

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CORN YIELDS INCREASED BY
RESEARCH AND EDUCATION

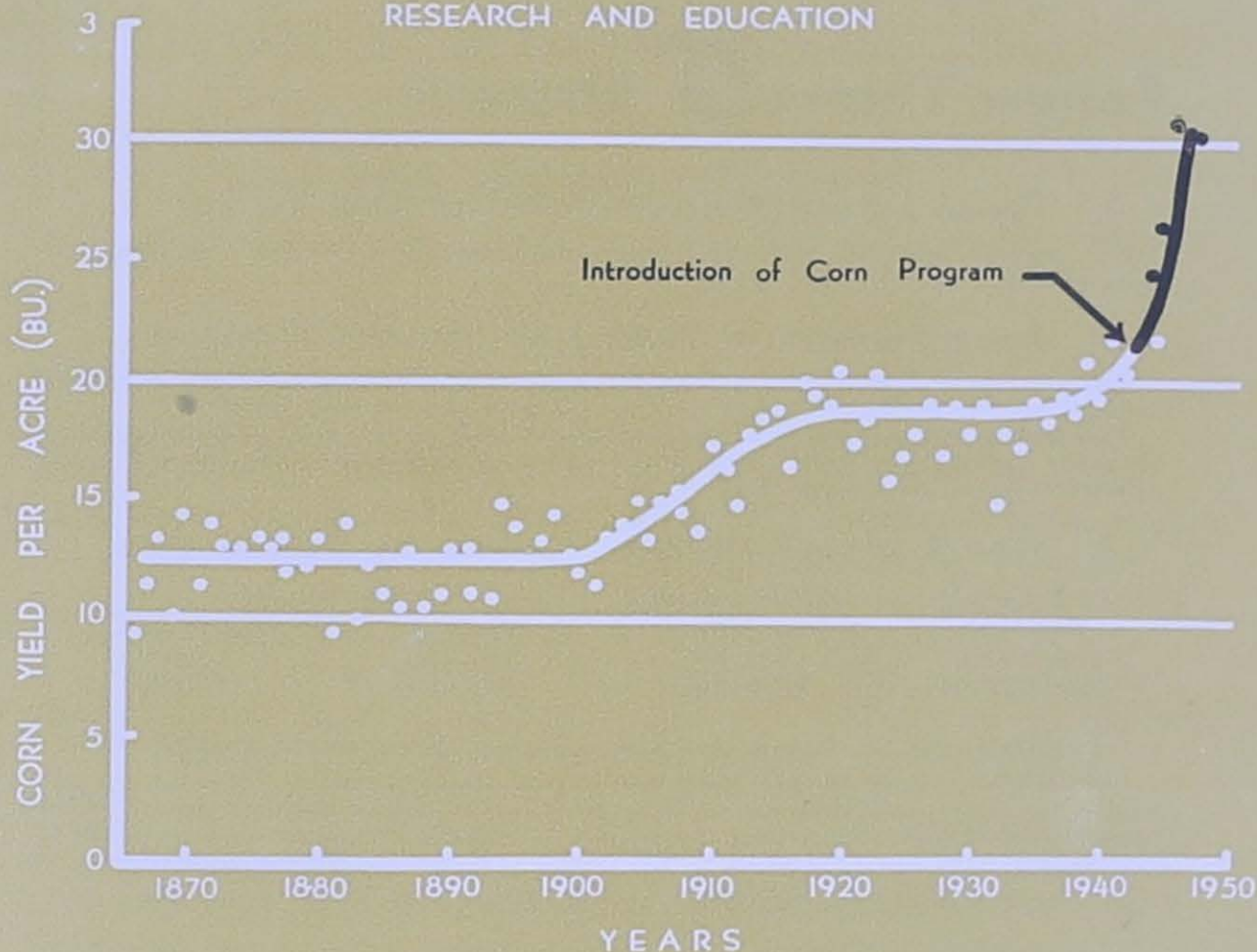


Figure 1: The corn clubs after the turn of the century and research and teaching programs during the 40's mark turning points in North Carolina's corn yield record.

demonstrated the closest possible teamwork of all persons concerned with agriculture in North Carolina. Seldom have we seen the results of a research program receive such widespread adoption by farmers in so short a time. A goal of a 40 bushel per acre average by 1955 seemed ambitious when suggested in 1945, but appears almost in sight now.

This bulletin reports the studies on fertilization and management, a very vital part of the teamwork which has made this phenomenal increase in corn production possible.

R. W. CUMMINGS
Associate Director

Follow These **5** Steps

1. Use an Adapted Hybrid or a Proven Local Variety.

See current issue of bulletin "Measured Crop Performance" or "Recommended Corn Hybrids by Areas."

2. Adapt Fertilizer at Planting to Your Soil Conditions.

Get your soil tested. Use 200 to 300 pounds of 6-8-6 or 7-7-7 per acre following heavily fertilized crops such as tobacco, cotton and truck. †

Use 300 to 500 pounds of 5-10-10 or 6-6-12 following small grains, legumes or other lightly fertilized crops and on potash deficient soils. Do not place fertilizer in contact with seed.

3. Provide Enough Plants to Produce the Desired Yield.

Yield level desired*	Planting in 3½ foot rows**	Final Stand**	
		Spacing	Plants per A.
50 to 75 bu.	18 inches	20 inches	7,500
75 to 125 bu.	13 inches	15 inches	10,000

* Yields below 50 bushels per acre are not considered economical.

** Increase stand 40 per cent for single eared hybrids. The above assumes 95 per cent germination with 5 to 10 per cent loss of stand. Seed germination below 90 per cent should be planted thicker and thinned if necessary.

Note: In 3-foot rows increase planting distance by 10 to 15 per cent.

4. Control Weeds Early but Avoid Late or Deep Cultivation.

Use shallow (1 to 2 inch) cultivation to control weeds until the corn is 2½ feet high. Then stop cultivation. A weeder is a good implement to use until the corn is 6 inches high. Relatively thick stands will help to control weeds by competition and shading after the corn is 2½ feet high. Before each cultivation, dig down and determine the location of the corn roots. Remember that the feeding roots are small. Look carefully. Do not cultivate too close to plants or so deep as to injure many roots. Deep plowing also brings new weed seeds to the surface, where they can germinate.

5. Apply Adequate Side-Dressing.

Determine your nitrogen needs by using the "2-to-1" rule—apply 2 pounds of nitrogen to get an average increase of 1 bushel of corn. For example:

100 lb. of 16.0% material* (16.0 pounds of N) will normally increase the yield 8 bushels.
 100 lb. of 20.5% material* (20.5 pounds of N) will normally increase the yield 10 bushels.
 100 lb. of 32.5% material* (32.5 pounds of N) will normally increase the yield 16 bushels.
 100 lb. of 42.0% material* (42.0 pounds of N) will normally increase the yield 21 bushels.

The "2-to-1" rule applies under average conditions when the first four steps are followed. (Sixty to 100 pounds of elemental nitrogen (N) side-dressing have been found to be profitable under average conditions.)

Apply nitrogen side-dressing at 6 to 8 weeks, or when the corn is 2½ feet high. Mix 75 to 100 pounds of 50 to 60 per cent muriate of potash with the nitrogen side-dressing when extra potash is needed.

* Examples of nitrogen materials of varying analysis are as follows: 16% material—nitrate of soda; 20.5% material—ammonium sulfate, calnitro and cyanamid; 32.5% material—ammonium nitrate; 42% material—uramon.

FERTILIZE CORN FOR HIGHER YIELDS

B. A. Krantz¹

INTRODUCTION

North Carolina farmers plant about one-third of their crop acreage to corn. Therefore, even a bushel per acre increase in yield would mean millions of extra bushels of corn to our farmers.

In 1943 a research program was begun to study the most effective methods of fertilizing corn. Small segments of this work have been reported in numerous popular and technical publications (2, 3, 8, 9, 10, 11). The objective of this bulletin is to present all the findings to date.

Fortunately, when the work was begun, several promising corn hybrids were being released by our corn breeders. These adapted hybrids, which had yields of 20 to 30 per cent above local varieties, furnished an excellent foundation for a corn fertilization program.

Our first concern in beginning these fertilization studies was to answer the question, What does it take to produce good yields? It was recognized that good cultural practices would be necessary to get the full benefits from applied fertilizers or improved soil fertility.

Thus, the aim in this investigation was to find the amount of fertilizer nutrients that could be used effectively by the best hybrids under good cultural practices.

Special Acknowledgment is due to members of the North Carolina Agricultural Experiment Station and the Division of Soil Management and Irrigation, United States Department of Agriculture for helpful suggestions and guidance in the experimental program.

The author is indebted to the Institute of Statistics, for statistical analyses; to J. R. Piland, for soil and plant analyses; to L. E. Brown, W. S. Moore, and B. S. Chronister, for assistance in carrying out the field experiments; to the local county agents, vocational teachers, and Soil Conservation Service men, for their active interest in the field experiments; and to the farmer cooperators, for their careful management of the experimental fields. Photographs were made by L. S. Bennett and the charts by Miss Ruth Gray.

¹ Research Professor of Agronomy, North Carolina Agricultural Experiment Station, and Soil Scientist in Division of Soil Management and Irrigation, Bureau of Plant Industry, Soil and Agricultural Engineering, USDA.

REVIEW OF LITERATURE

Others Find Yields Related to Nitrogen

Numerous workers have related corn yields to the nitrogen content of soils and have found nitrogen to be the first limiting factor in corn production. Jenny, in 1930, made an important study of the influence of climate on soil nitrogen and organic matter (5). His study covered a belt of relatively uniform rainfall extending from eastern North Dakota south to Louisiana.

The average corn yield curve showed an upward trend as the mean annual temperature increased from 38° F (North Dakota) to 49° (Iowa). However, with further increase in mean annual temperature from Iowa south to Louisiana, the corn yields declined sharply and showed an almost perfect correlation ($r = +0.995$) with the nitrogen content of the soils. In regard to this relationship, Jenny states that "On purely climatological ground, no good physiological reason is apparent why the yields should decline sharply in the region south of Iowa."

Further evidence of the direct relation between soil nitrogen and corn yields is shown by Salter (17). He found that in Ohio over a 33-year period continuous cropping with corn on untreated plots led to similar declines in both nitrogen content of the soil, and corn yields. Jenny (6) found that with 12 different Missouri soils under similar climatic environment, average corn yields on unfertilized plots were closely associated with soil nitrogen content.

Since it is well known that southern soils are low in nitrogen, it is logical that nitrogen fertilization should receive considerable attention in North Carolina.

Early Workers Study Nutrient Needs

Other workers (7, 13, 16) have determined the chemical composition of the above-ground part of the corn plant. The actual plant uptake has been found to vary widely, depending upon the fertility level of the soil and the environmental conditions. The approximate requirement of a 100-bushel corn crop is 140 pounds of nitrogen, 50 pounds of phosphoric acid, and 100 pounds of potash.

About two-thirds of the nitrogen and phosphorus and one-fourth of the potash found in the plant are in the corn grain, which is normally removed from the land. In addition to these major elements, small amounts of calcium, magnesium, sulphur, and trace elements are needed. The corn plant, however, requires less of these elements than do plants generally grown in rotation with corn.

Early investigations by Jones and Houston (7) and more recently by Sayre (19) clearly indicate that the period of greatest demand for nutrients begins about 10 days before tasseling and ends about 25 to 30 days after tasseling. Sayre (19) found a maximum rate of nitrogen absorption of more than four pounds per acre per day during the tasseling and silking stage. Thus it appears that the key to corn fertilization is to provide ample amounts of nutrients, especially nitrogen, and particularly during this critical five-week period.

MATERIALS AND METHODS

Farmers Cooperate in Field Experiments

Field experiments were carried out in cooperation with individual growers under ordinary farm conditions. These tests were designed to study the effect of fertilization, plant spacing, winter cover crops, and mulching on the yield and quality of corn hybrids and varieties.

All fertilizers at planting were applied in bands about three inches on each side of the seed. Unless otherwise indicated, nitrogen side-dressings were applied just before the last cultivation when the corn was about two feet high. Plow-sole applications were in bands at the bottom of the plow furrow at turning time, usually one to four weeks before planting.

Ammoniacal nitrogen carriers were used in all pre-planting applications. Either nitrate or ammonium-and-nitrate carriers were used for side-dressing applications. The phosphate carrier was either 18 or 47 per cent P_2O_5 . Muriate of potash was the potash carrier. Moisture determinations of the corn grain were made at harvest time, and all yields were adjusted to 15.5 per cent moisture in the kernel.

The fields were divided into small plots and each treatment replicated several times to reduce and evaluate the effect of soil variation. The plots were cultivated shallowly to avoid root damage.

The experiments were conducted over a wide range of soil and cropping conditions, so that the results might have broad application. The initials of the farmer cooperators in each experiment appear in the tables and figures.

DISCUSSION OF RESULTS

Nitrogen Gives Greater Yield Increases

Nitrogen application increased yields in practically all experiments where nitrogen rates were compared, but the amount of increase varied considerably. The degree of response to applied nitrogen was influenced mainly by climatic conditions and the level of nitrogen in the soil.

The greatest direct response to nitrogen was recorded in 1947* when the "no-nitrogen" plot yielded 19.1 bushels, and in the 180-pound plot, 120.9 bushels. Hence, there was a 101.8-bushel increase due to nitrogen application. Considerably higher yields were obtained in other experiments, but this was the greatest increase in yield obtained from the application of nitrogen (Figure 2).

In most of the experiments nitrogen application above the 120-pound level gave little or no response even under conditions of fairly good moisture distribution.

The average yields from plots receiving 0, 40, 80, and 120 pounds of nitrogen were 28, 53, 71, and 81 bushels per acre in the 49 nitrogen experiments conducted during 1944-48.

* This experiment was in progress four years with continuous corn. The "no-nitrogen" plot received only phosphorus and potash during this period. The 180-pound nitrogen plot received the same rate in 1946 and a 120-pound application in 1944 and 1945.

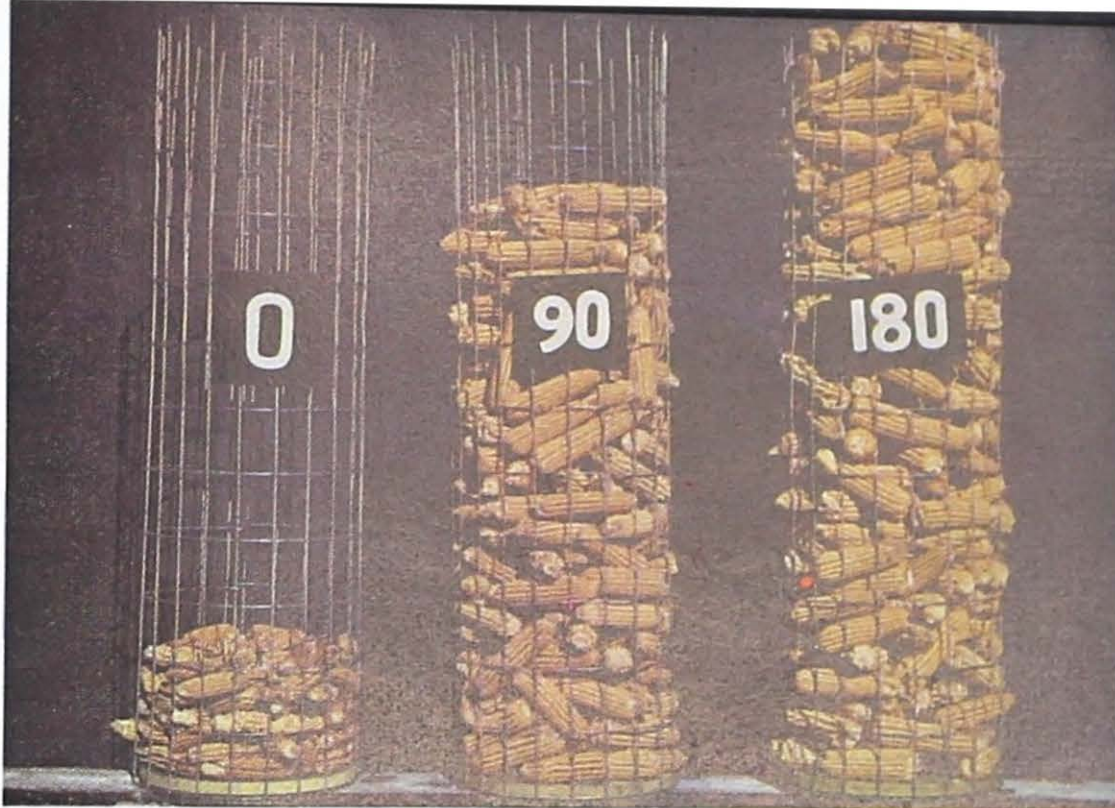


Figure 2: The plots from which this corn was taken gave the greatest direct response to nitrogen of any experiments conducted in North Carolina. The yields were 19.1, 94.5 and 120.9 bushels from plots that had received 0, 90, and 180 pounds of nitrogen, respectively.

Weather Affects Increase From Nitrogen

Weather conditions during the five years of this study were about normal. The June, July and August rainfall ranged from slightly below normal to normal. The driest season was in 1944 when the rainfall during these three months was 79 per cent of normal, the lowest recorded since 1932.

Each year, however, there were wide variations in rainfall in different parts of the State. During the critical period of growth of corn some regions had less than 50 per cent of normal and others as high as 50 per cent above normal. Fortunately, experiments were located in regions that experienced both extremes as well as in others where rainfall was about normal. Thus, the response to fertilization was studied under both dry and wet conditions.

Figure 3 indicates the extent to which weather influenced the yield increase from nitrogen application. (Details in Table 1.) Under fair-to-good* moisture conditions at 39 experimental lo-

* Terms used in Figure 3 for grouping the experiments by weather conditions are defined as follows:

"Dry": during the five-week critical period the soil moisture was low enough to cause leaves to roll for one week or more.

"Good": the rainfall distribution was about normal, and soil moisture conditions were not low enough to cause the leaves to roll during this period.

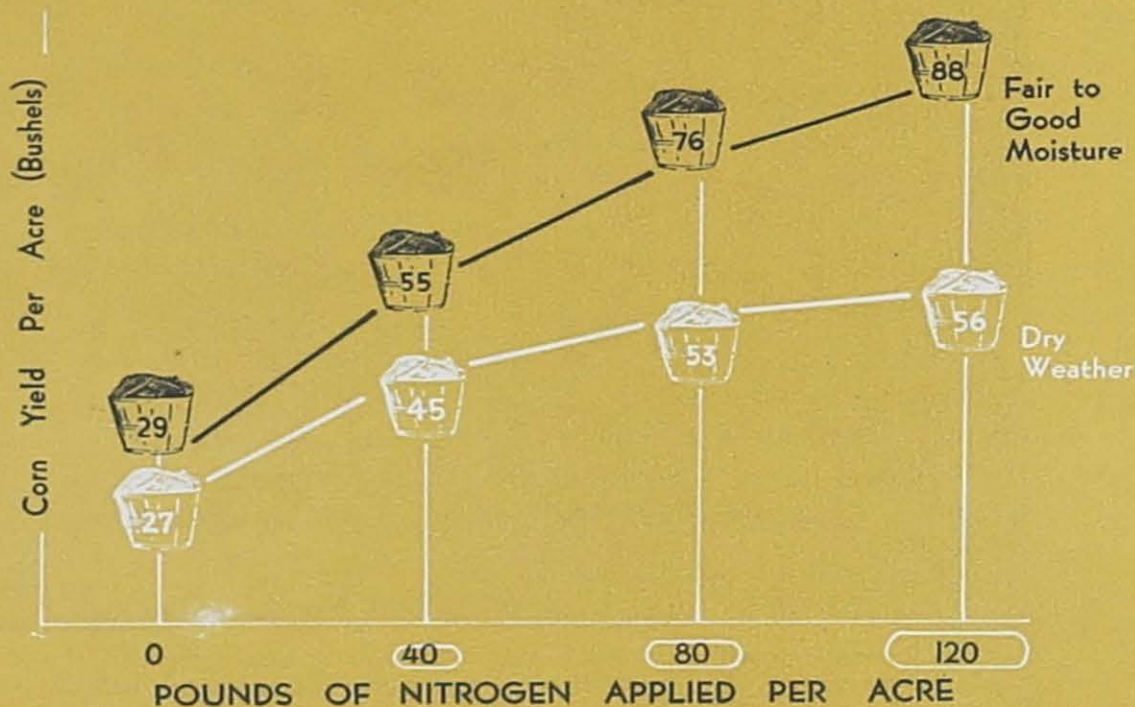


Figure 3: Dry weather cut down the response to high nitrogen, but the yield was still double that of the "no nitrogen" plots. The upper curve represents an average of 39 experiments; the lower, an average of ten, all conducted between 1944 and 1948.

cations there was an excellent response from all rates of nitrogen application. Yields were increased on the average from 29 bushels per acre with no nitrogen to 88 bushels with 120 pounds of nitrogen, or an increase of 59 bushels. This means about one bushel of corn for each two pounds of nitrogen applied.

Even under dry conditions nitrogen application led to profitable responses, although a lack of soil moisture cut down the amount of response.

Plants Show Deficiency Symptoms

A typical symptom of nitrogen deficiency is shown on the left-hand side of the cover picture. Nitrogen was omitted in this plot, while abundant nitrogen was used in the plot on the right. The yield was increased 96.7 bushels per acre. A close-up of a nitrogen-deficient plant is shown in Figure 4.

If soil moisture is low corn leaves will wilt and roll as shown in Figure 5. In this manner the plant slows down its rate of water loss to conserve moisture. The plants in Figure 5 were adequately fertilized, and although the leaves rolled for several weeks, the lower leaves did not fire. Plant growth was stunted, however, and yields were limited by a lack of soil moisture.

In other plots where the nitrogen supply was low, nitrogen deficiency or firing apparently was accentuated by droughty conditions. Some of the reasons for this are: first, during dry spells, when soil moisture moves upward, nitrates also move upward (12); second, as the topsoil dries out, it restricts the zone of major nutrient absorption, because plant roots cannot function in dry soil.

In cases of extreme or prolonged drought, leaves may die partially or completely all over the plant. Upper as well as lower leaves may fire and die even under adequate fertilization. The effect of an extreme, prolonged drought is shown in Figure 6. Although this condition was not general during any of the last five years, it did occur in isolated areas where rainfall was exceptionally low. According to weather records (Table 2), severe droughts should not be expected to occur as often as in the Middle West.

Compare Methods of Placement

Workers (18, 20) in the Middle West and Northeast have obtained good results by placing nitrogen at the bottom of the plow furrow. Scarseth and co-workers (20) reported inconsistent results when nitrogen side-dressing was applied just before tasseling. They demonstrated that plow-sole methods were superior for applying ammoniacal forms of nitrogen. A series of experiments was conducted in North Carolina during 1944, 1945 and 1946 in which these different methods of nitrogen application were used.

Comparisons of side-dressing and plow-sole placement of nitrogen at both 60- and 100-pound rates of application were made on Norfolk fine sandy loam in 1944 (Table 3). The side-dressing method gave higher yields than the plow-sole method at both



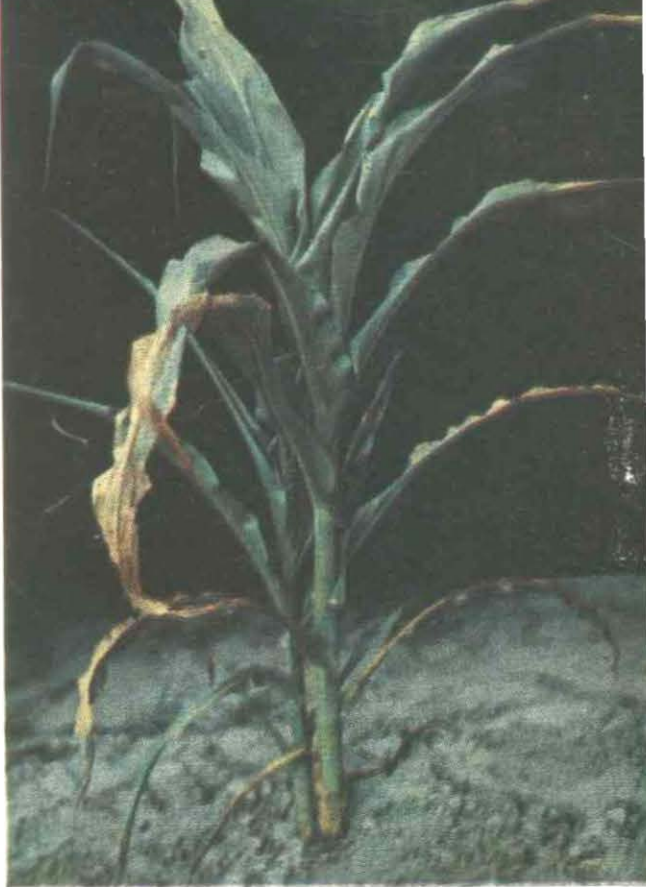
rates. The monthly rainfall was about normal, and its distribution was fairly uniform throughout the growing season. Other environmental factors were also favorable for rapid growth.

Under these conditions, the plants given plow-sole treatments made more vigorous early growth and were slightly more advanced at tasseling, but the nitrogen supply became exhausted earlier than in the side-dressing treatments. This indicates that there may have been a greater leaching loss when the nitrogen was placed at the plow-sole.

There was no significant yield difference between nitrogen placements at the other five locations. Two of these five, both on heavy Piedmont soils (Lloyd and Cecil clay loams), encountered dry conditions which should have favored deep application. The other three were on medium-textured, Lower Coastal Plain soils with fairly high organic matter content under above-normal rainfall.

An average of the yields from the six locations showed no difference between the two methods of placement. Since North Carolina farmers are equipped for and accustomed to the side-dressing method there is no apparent reason for recommending a change.

← **Figure 4:** The yellowing along the midrib of the fourth and fifth leaves while the leaf margins remain green is the telltale sign of nitrogen deficiency. At this advanced stage of nitrogen starvation, the bottom three leaves have already yellowed and died.



Figures 5 (above) and 6 (below): Moisture deficiency, shown in these two pictures, is sometimes confused with nitrogen deficiency. The usual sign of moisture deficiency is a rolling of the leaves (below) but no firing of lower leaves. Under extremely dry and hot weather conditions (above), the tip half of the upper as well as the lower leaves wilt and die.



Time of Application Important

Experiments where an 80-pound rate of nitrogen was used (Table 4) showed the consistent advantage of applying part of the nitrogen in a complete fertilizer at planting time and the rest as a side-dressing, as compared with applying all of it as a side-dressing. The plants in early growth were noticeably stunted in plots where all the nitrogen was applied late. Tasseling was delayed about 10 days. This slow early growth also made cultivation difficult. Since the 80-pound rate is intermediate greater differences might be expected from higher and more adequate rates of application.

Four experiments conducted during 1945 and 1946 compared two other treatments: (1) all the side-dressing was applied when the corn was two feet high; and (2) half the nitrogen was applied when the corn was two feet high and the rest of the pre-tasseling stage (Table 5). An average of the four experiments showed no difference. Records indicated that during both years the rainfall was 25 to 35 per cent above normal during June and July. The greatest hazard of leaching would be expected during these two months.

In another 1946 experiment all side-dressing plots received 500 pounds of 4-10-10 in the row at planting. There was an excellent response (Figure 7) to nitrogen application. Yields were increased 83 bushels per acre. At low rate of application there was no yield difference between side-dressings made at the knee-high stage and those at the pre-tassel stage. At all the higher rates, the pre-tassel treatments gave lower yields than knee-high treatments. When 20 pounds of side-dressing was applied early and the rest late, the yields were better than when all was applied late.

Plants that received all the side-dressing late had three or four nitrogen-deficient leaves by the time the application was made. Where only 20 pounds of nitrogen was applied at the two-foot high stage, there were also some visual nitrogen-deficiency symptoms. In the plots where 60 pounds of nitrogen was applied early and the rest at pre-tassel, the plants had an adequate supply, and the yield was equal to that of the single early application.

These data indicate no advantage for splitting the side-dressing over that of making a single application at the two-foot, or knee-high stage. They also show that substantial yield increases

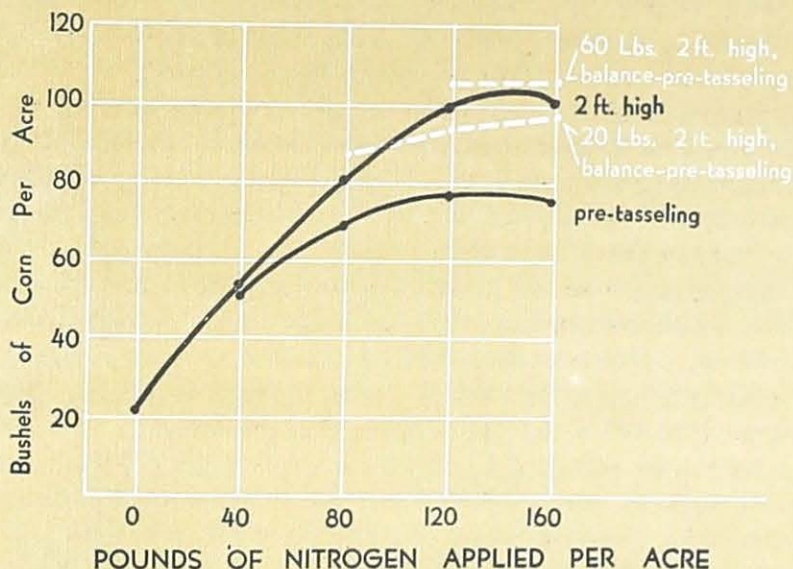


Figure 7: The time of nitrogen application can be almost as important as rate. Yields were highest when all or most of the nitrogen was applied at the two foot stage. When most of the nitrogen was applied at pre-tasseling yields were considerably lower. Twenty pounds of the nitrogen was applied in the mixed fertilizer at planting and the rest as a side-dressing.

resulted when nitrogen was applied to a plant showing nitrogen deficiency symptoms. As much as a 44-bushel increase was obtained by applying 120 pounds of nitrogen to plants that had received 20 pounds at planting time and 20 pounds at the knee-high stage, but still showed visual deficiency symptoms. The efficiency, however, was considerably less than that of the early single application.

Legumes in Rotation Furnish Nitrogen

A good growth of winter legumes can furnish much of the nitrogen needed for a corn crop. In practice winter legumes are not used as widely as would be desired. Research has still to solve the problem of securing effective nodulation on winter legumes and their proper management.

Excellent corn yield response can be obtained (Table 6) when winter legumes are planted for several years and good management practices are followed. These soils had never grown winter legumes before, and the growth the first season was limited, owing to poor nodulation. During the next two seasons, however, the legume growth and the corn yield response became progressively better at all locations.

Figure 8 shows the effect of an excellent growth of winter legumes on corn yields with and without additional nitrogen. Corn yields were increased 71 bushels per acre by turning under about two tons of Austrian winter peas, containing approximately 160 pounds of nitrogen. This was a slightly greater increase than that produced by a 90-pound nitrogen application alone. The 90-pound application in addition to the legume produced a further increase of 20 bushels per acre.

Alfalfa grown in rotation with corn is especially promising. A yield of 127.2 bushels per acre was produced in 1947, following a four-year stand of alfalfa on a Cecil loam. A 500-pound-per-acre application of 4-10-10 was used in this plot. Additional nitrogen side-dressings gave no further yield response. Mulch in addition to side-dressing increased the yield to 139.2 bushels.

Nitrogen Increases Grain More Than Stover

Nitrogen application increased grain yields three to four times as much as stover weight (stalks and leaves) at two locations (Table 7). In both experiments the stover-grain ratio was narrowest at the highest nitrogen rate. In the "no nitrogen" plots about three pounds of stover was produced for each pound of grain. At the highest nitrogen rate only about 0.8 to 0.9 pound of stover was produced per pound of grain.

Boosts Protein Content of Grain

Nitrogen application increased the protein content of the corn grain in practically all experiments. The increase was as much as 4.7* per cent for a 180-pound nitrogen application on Norfolk sandy loam (CHP)** in 1947. The protein content was 5.7 and

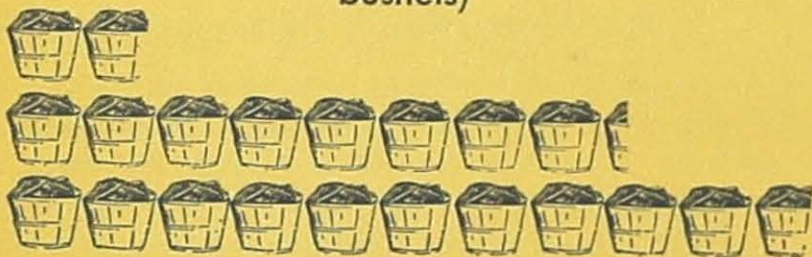
* Protein percentage = 6.25 X per cent nitrogen. (It is recognized that corn protein is not a well-balanced protein and should not be used as the only source of protein in feeding livestock.)

** Letters in parentheses are the initials of the farmer cooperator (Table 1).

NO COVER CROP
Lbs Nitrogen Applied

Bushels Corn Per Acre (Each basket equals 10 bushels)

0
90
180



WINTER LEGUMES
TURNED
Lbs Nitrogen Applied

Bushels Corn Per Acre

0
90



Figure 8: Winter legumes, turned under before corn, can furnish most of the needed nitrogen. The yields shown above are an average of two experiments (CHP and DFP) conducted in 1946.

10.4 per cent, respectively, for the “no nitrogen” and the 180-pound nitrogen plots.

The next largest increase due to nitrogen—4.5 per cent—was obtained under droughty conditions where the yields were about 50 bushels per acre. There was an increase of more than three per cent protein due to nitrogen fertilization in a large number of the experiments.

Nitrogen application which greatly increased grain yields did not increase the protein content very much. In other words, as the yield response to nitrogen decreased, the protein content of the grain generally increased. This relationship is shown in Figure 9.

Weather conditions and other environmental factors also influenced protein content. Where weather limited the yield response to nitrogen, the protein content appeared to increase to its apparent genetic maximum. Thus, some of the high nitrogen application will be reflected in increased protein content of the grain and stover in case of dry weather. The extremes in protein content for all experiments during the four years were 5.7 to 12.5 per cent.

Although corn is sold primarily for its carbohydrate content, farmers would need smaller quantities of high-priced protein concentrates if they fed corn containing 11 to 12 per cent protein instead of corn with 6 to 7 per cent protein.

Recover Much Nitrogen in Corn Grain

The relation between nitrogen application and nitrogen recovery in corn grain is shown in Figures 9 and 10. It is important to note that the nitrogen recovery curve usually continued to rise after the yield response curve leveled off. For instance, in Figure 9 the total nitrogen content was increased 8.3 per cent, while yields were increased only 1.5 per cent by the last 40-pound increment of nitrogen.

With excellent growing conditions as much as 54, 58 and 65 per cent of a 120-pound nitrogen application was recovered in the grain at HCS and JPM, in Figure 10, and DHY in Figure 9. Even with the 160-pound application shown in Figure 9, 54 per cent of the nitrogen was recovered. These nitrogen-recovery figures are higher than those usually reported. Ohlrogge (15), however, did obtain as much as 60 per cent recovery of nitrogen in corn grain when the side-dressing method of application was used under "ideal conditions." In most of the North Carolina experiments 40 to 50 per cent of applied nitrogen was recovered in fields that had responded to nitrogen.

Adequate Stands Necessary For High Yields

Stands of 3,000 to 4,000 plants per acre cannot produce high yields even if all other conditions are favorable. Attempts to increase yields by thicker planting, however, have often failed because fertilization was not increased at the same time.

Results of numerous experiments under widely varying conditions have demonstrated the interdependence of spacing and fertilization (Table 8).

At the adequate nitrogen rate the yield was increased by 29 bushels, or 47 per cent, in going from 4,000 to either 10,000 or 13,000 plants per acre. The total weight of ears per plant decreased considerably, but was still 0.63 pound at the 10,000 plant stand.

At the medium (70-pound) nitrogen rate, yields increased as the plant population was increased up to 7,000 plants per acre. Since there was no yield increase at the thicker stands and the total ear weight dropped to 0.48 and 0.39 pound per plant, the optimum stand at this fertilization was 7,000 plants per acre.

At the low (20-pound) nitrogen level the yield remained about constant. However, the total weight of ears per plant decreased

progressively from 0.67 pound down to only 0.19 in going from the wide to the close spacing. At this low level of fertilization, 4,000 plants per acre was the best spacing. The rather general use of wide spacings by farmers using relatively little fertilization appears logical on the basis of these data.

With prolific hybrids these results show that best yields are obtained when the stand is adjusted so that weight of ears per plant is about 0.6 to 0.7 pound. With single-eared hybrids Huber (4) found the ear weight to be about 0.5 pound per plant at optimum stands.

What about dry weather? Since droughty conditions cannot be foreseen at planting time, the ideal stand would be one low enough to avoid yield reduction in dry years and still high enough to capitalize on good moisture conditions and high fertilization. In prolific corn hybrids where both ear size and number vary with environmental conditions, a small change in each will markedly change the yield. Thus within limits, *prolific corn hybrids can adjust to fit the weather.*

The adjustment of ear number per plant to weather conditions is illustrated by the following example. With plant stands of 4,000, 10,000 and 13,000 plants per acre the respective ear number per plant was 2.37, 1.90 and 1.74 under moist conditions and 2.08, 1.30 and 1.09 under droughty conditions. These data each represent an average of two experiments where adequate fertilization was used.

Even under extremely dry conditions, plots with 10,000 plants per acre yielded as high or higher than plots with a 4,000 or 7,000 plant stand where there was adequate fertilization. In one experiment under very droughty conditions stands of 4,000, 7,000 and 10,000 plants per acre yielded 37.8, 47.5 and 49.9 bushels per acre, respectively.

Data in Figure 19 indicate that there was very little difference in soil moisture between the plots with 4,000 and 10,000 plant seeds, especially at the 6- and 12-inch depths. Although wilting did not start as early in the widely spaced corn, there was severe wilting and rolling in both plots.

The results given in Figure 11 show that a stand of 10,000 plants per acre yielded slightly better than the wide spacings under droughty conditions and was thick enough to capitalize on good moisture and fertility conditions. In other fertilization experiments, yields of as much as 120 bushels per acre were found frequently with 10,000 plant-per-acre stands of prolific hybrids.

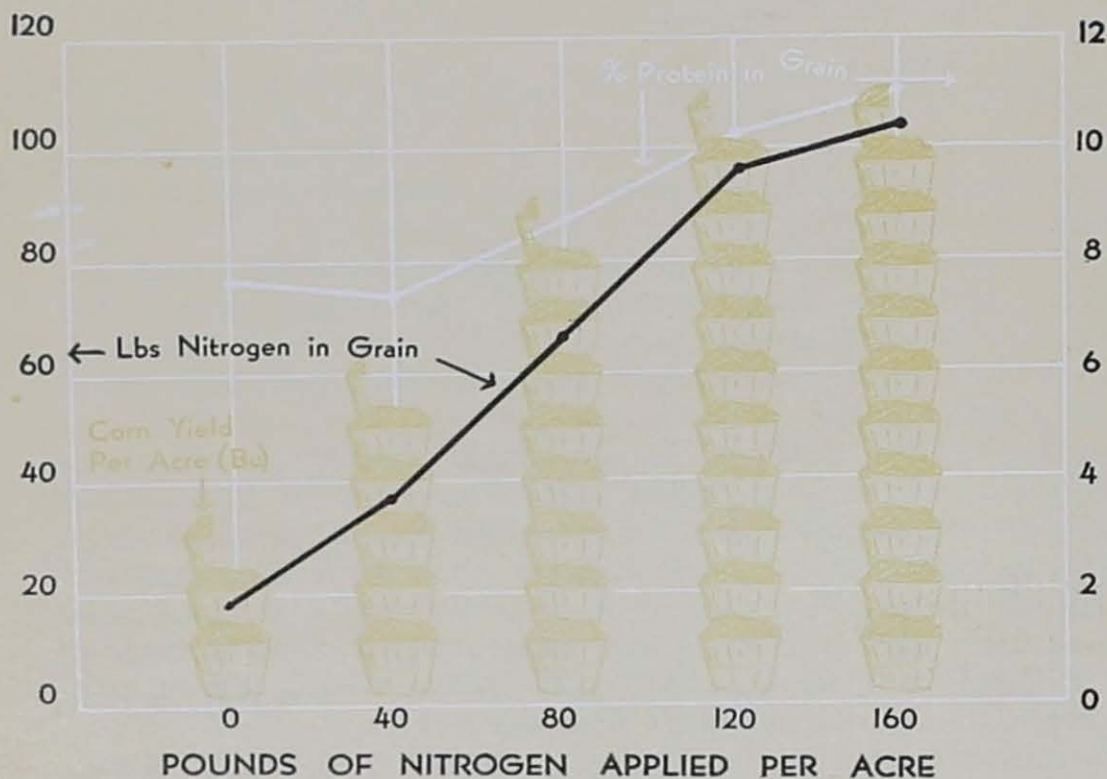


Figure 9: Ample nitrogen boosts the protein percentage and nitrogen content of the grain. These data (DHY, good environmental conditions, 1946) show that nitrogen uptake and protein content continue to increase above the 120-pound nitrogen rate. Each basket equals 10 bushels.

In these experiments it was interesting to note the differences in weed growth in plots with 4,000 plants per acre as compared with thicker plantings, particularly during wet seasons. The corn in all plots was practically free of weeds at "laying-by" time (about 2½ feet high). By roasting-ear time, however, the plots with 4,000 plants per acre had a solid cover of weeds (mainly cockleburrs) about hip high, while the thickly planted plots had only a few small weeds. In the latter case the corn was able to compete favorably with the weeds until it was "made."

With a relatively non-prolific hybrid, U. S. 282, in 1948, corn yields from plots with stands of 7,000, 10,500, 14,000, and 17,500 plants per acre were 85.2, 107.0, 124.1, and 125.8 bushels per acre, respectively. The respective weights of ear corn per plant were 0.84, 0.70, 0.61, and .49 pounds. These data indicate that 14,000 plants per acre is the best stand with relatively non-prolific hybrids.

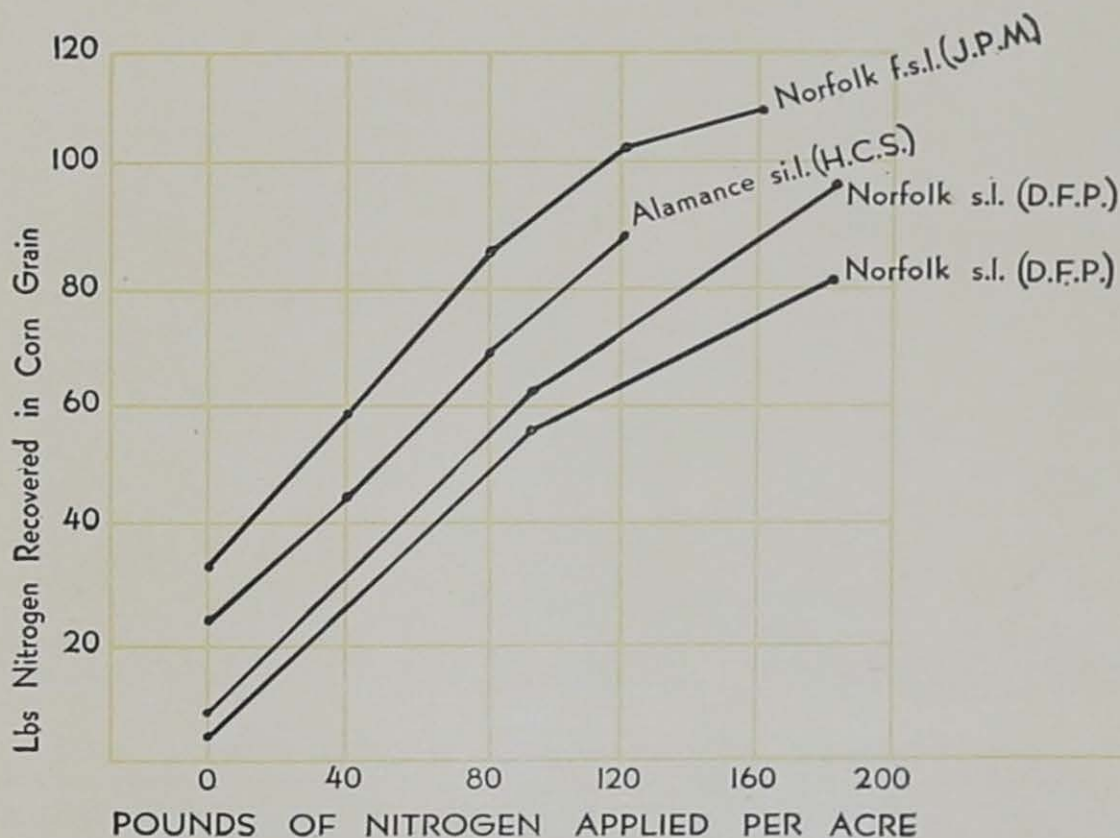


Figure 10: Much of the applied nitrogen is recovered in the corn grain at all rates of application. Though the nitrogen content of different soils may vary, the rate of recovery follows the same general pattern. The test represented by the bottom curve was made in 1947, the remainder in 1946.

Ear Size, Number Altered by Nitrogen, Spacing

Nitrogen application increased both ear size and ear number per plant. With prolific hybrids or with wide spacings the number of ears was increased more than ear size.*

At low nitrogen levels all, or practically all, of the plants were found to be single-eared with some barren plants. As the nitrogen level was increased, the ear size increased. However, the

* The way in which these increases occur can be shown by the ratio of the increase in average ear weight in pounds to the increase in ear number per plant. For example, in the case of the prolific hybrid, N. C. 26, this ratio was

Increase in average ear weight—0.1

Increase in number of ears per plant—0.6 or 1 to 6

This means that with applications of nitrogen the increase in ear number per plant was six times as great as the increase in ear weight in pounds. However, the ratio was influenced greatly by the prolific tendency of the corn. A non-prolific open-pollinated corn, grown in the same experiment had a ratio of only 1 to 1.3.

As the plant population was decreased ear number increased more than ear weight. This relation is illustrated by the data from a spacing-fertilization experiment (JSJ) in 1946. Here, ratios of average ear weight to ear number were 1 to 13.4; 1 to 12.0; 1 to 4, and 1 to 1.4 with plant populations of 4,000, 7,000, 10,000 and 13,000 plants per acre, respectively.

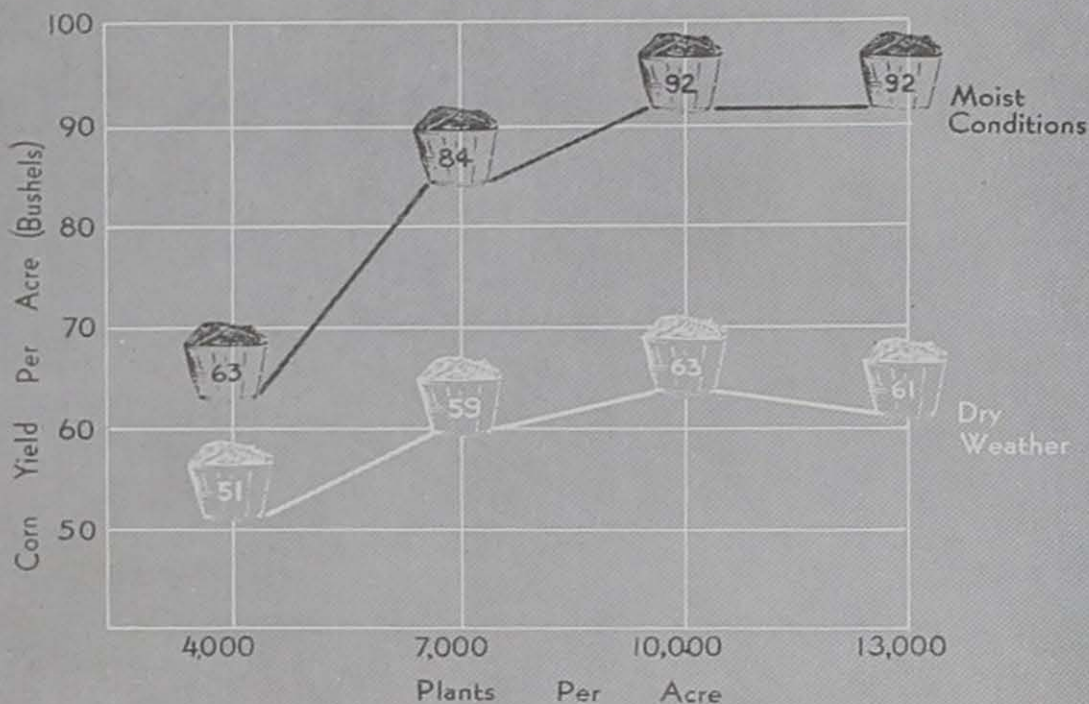


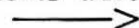
Figure 11: The ideal plant population is one that adjusts to moisture conditions—takes full advantage of moist seasons yet is not too thick under dry conditions. Ten thousand plants per acre came close to the ideal in these tests. The upper curve represents an average of six experiments, the lower curve, two.

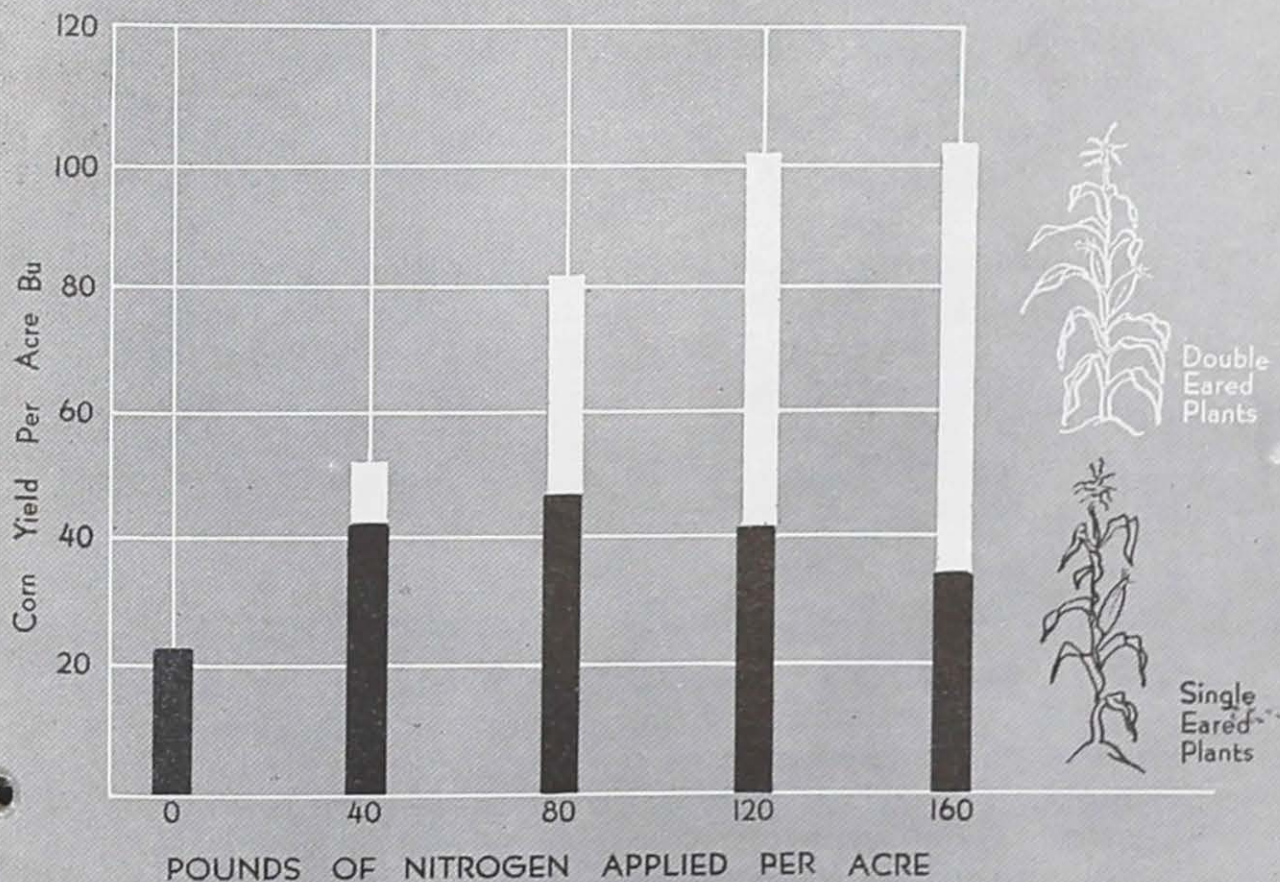
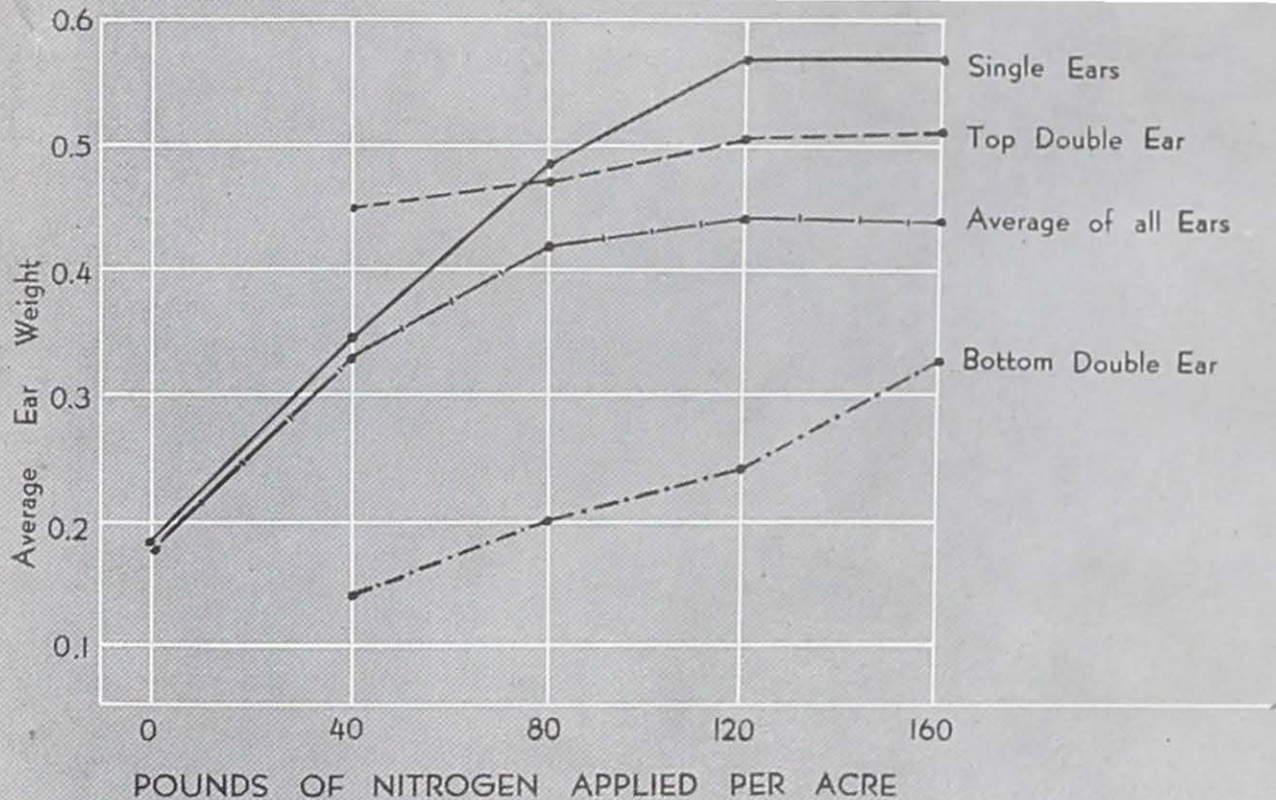
second ear developed on some plants long before the average ear size of first ears had reached its maximum (Figure 12).

It is also interesting to note that the weight in each of the ear groups increased considerably, while the average ear weight increased much less. This, of course, is due to the increase in the proportion of second ears which are relatively smaller than the single ears or the top ear of the doubles (Figures 12 and 13). When all ears are included, the average ear weight of prolific hybrids usually does not exceed 0.5 pounds, even when wide spacings are used (Table 9, Figure 12).

Plants with three ears have been found only under the very best conditions. On a Cecil loam in 1947, as high as 44 per cent of the yield was produced on three-eared plants where only

Figures 12 and 13: These charts tell the story of why prolific hybrids yield better than single-eared varieties under a wide range of conditions. With added nitrogen (top), the bottom ear of N. C. 1032 continued to increase in size after the others had leveled off. Double-eared plants (bottom) accounted for a much larger proportion of the total yield at high nitrogen levels. Hence, prolific varieties increase in both ear number and ear size as nitrogen is added. The experiments were conducted in 1946 on Norfolk sandy loam.





4,500 plants per acre were grown. With 11,500 plants per acre about 5 per cent of the yield was on three-eared plants (Table 9). These results indicate that the average ear size of ears from one-eared plants and of top ears of two- and three-eared plants was about the same. As the relative proportion of two- or three-eared plants was increased, the size of the lower ears increased to a greater degree than that of the top ears.

At any given nitrogen level, average ear weight and number were both decreased by increased stands, even though the total yield per acre was substantially increased (Tables 8 and 9).'

Response on Low Phosphorus Soils

Yield responses to phosphoric acid application have been obtained on soils low in phosphorus (Table 10). Most of these cases were found in the Piedmont region. The amount of this increase, however, is much less than that usually obtained from nitrogen application.

A 23.4 bushel-per-acre increase resulted from phosphoric acid application on Alamance silt loam in 1946 under good moisture conditions (Figure 15). Although this was the biggest response to phosphoric acid found in any experiment, it was still only about one-third as great as that obtained from nitrogen in this case.

The yield response to phosphate application correlated very well with previous fertilization history. Corn yields responded significantly where only lightly fertilized crops had been grown except for one experiment in 1946 on an Alamance silt loam, HCS (N). No response was noted in corn following heavily fertilized crops (Table 10). There was also a fair correlation between soil analysis and yield response.

Plants Respond Early to Phosphorus

Early vegetative response to phosphoric acid application is common, even on soils high in native phosphorus. A lack of phosphorus stunts growth and can often be recognized in young plants by a purpling or bronzing of the leaves as shown in Figure 14. Unphosphated plants were found to be slightly delayed in maturity at tasseling and silking time, but in most cases there was little or no yield response.

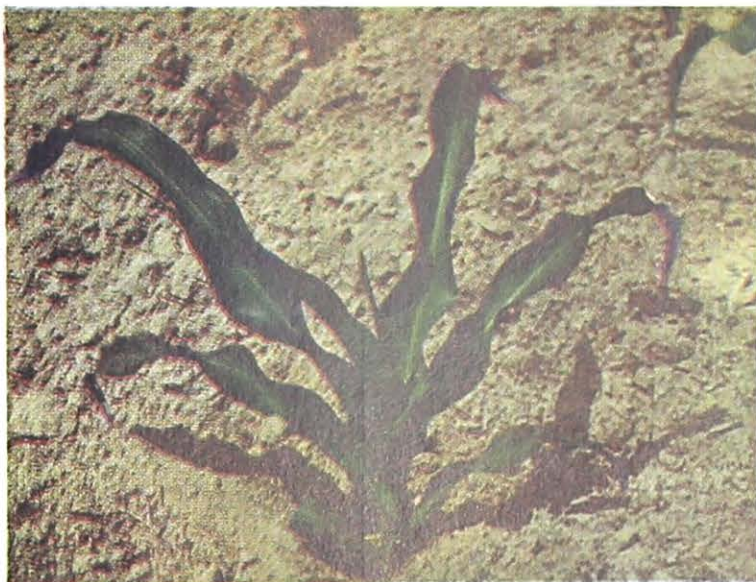


Figure 14: The curling of the leaves and general stunting of growth shown on this plant indicates a severe phosphorus deficiency.

A striking example was found in 1945 on a Norfolk fine sandy loam (HCS). Five weeks after planting, the corn in the unphosphated plots was only about seven inches high, while the phosphated corn was about knee high. There was a maturity difference at tasseling and silking time, but the growth difference had diminished by the roasting-ear stage and there was no yield difference (Table 10). The delay in maturity is not generally critical, because of the long warm growing season.

One possible reason for this behavior is that unphosphated plants may be stunted only in the early stages while the root system is small. As the extensive fibrous root system develops, the plant may utilize the native soil phosphorus more effectively. Supporting evidence for this is found in the 1947 results where radioactive-phosphoric acid was used on corn. These data (14) indicate that in the early stages of growth a high proportion of the phosphorus in the plant has come from the fertilizer. In the later stages most of it comes from the soil.

It must be pointed out that all these results are from experiments of only one year's duration. The frequency and magnitude of responses to phosphorus application undoubtedly would be greater in long-time experiments.

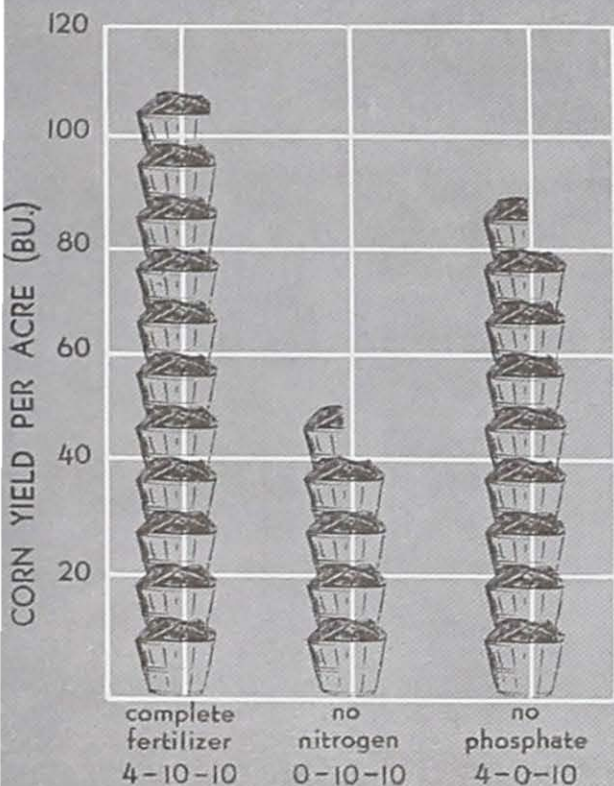


Figure 15: Though nitrogen is the most limiting factor in corn yields, the lack of phosphate may also cut yields severely—23 bushels per acre in this case. This test was made on an Alamaance silt loam (HCS) in 1946.

Environment Affects Phosphorus Content of Grain

In experiments where corn yields responded to phosphoric acid application the average phosphorus content of the corn grain was increased from 0.51 to 0.57 per cent P_2O_5 by the fertilizer. However, where there was no yield response, the P_2O_5 content was increased an average of only .02 per cent by phosphate application. The phosphorus content of grain in all experiments during the four-year period ranged from 0.42 to 0.81 per cent P_2O_5 .

Although the phosphorus content of the corn grain was relatively constant at a single location, there was considerable variation between locations, seasons and levels of soil phosphorus. In a cover-crop-rotation experiment where corn had been grown continuously for four years, there was 25 to 35 per cent difference in phosphorus content of the grain on the same soil and under the same treatment but in different seasons.

Two Bladen loam soils containing 150 and 65 pounds per acre of available P_2O_5 , respectively, were compared in another test for phosphorus content of the grain. Corn grain from the high-

phosphorus soil had 35 to 40 per cent more phosphorus in it than corn from the low-test soil. The phosphorus content of the growing plant has also been found to be markedly influenced by the phosphorus level of the soil.

Experiments Show Potash Need

There are many dark-colored soils in the Coastal Plain on which corn and soybeans have been grown for many years with little or no fertilization. As a result, the available potash supply has been depleted. Several experiments conducted on such soils showed that additional potash was needed.

One of these was a Coxville fine sandy loam which, under local practices, produced about four bushels of soybeans and 10 to 20 bushels of corn per acre. Where a sufficient stand of an adapted hybrid was adequately fertilized the corn yield was 93.4 bushels per acre. When potash was omitted the corn leaves showed marginal burning (Figure 17), the plants lodged badly, and the yield was only 62 bushels. The need for a nitrogen and potash balance is clearly illustrated in Figure 18.

The magnitude of yield response to potash was generally higher than that from phosphate. There was a fairly good correlation between yield response and soil analyses (Table 11). Corn responded to potash in four of the six experiments on soils that contained less than 100 pounds per acre of exchangeable potash. With one exception, there was no response on soils that contained more than 103 pounds of potash per acre.

The greatest yield increase from potash came in 1945 on a Dunbar sandy loam that had been cropped to soybean hay for four years without fertilization. The potash plot yielded 41.5 bushels more than the "no potash" plot. This experiment (Table 11) also tells a striking story of nitrogen-potash balance. In contrast to the marked increase due to potash at the high nitrogen level, there was no response to potash at the low nitrogen rate. Likewise, there was a 48.9-bushel increase due to nitrogen at the high potash level, but no response to nitrogen at the low potash rate.

When the soil potash supply did not become depleted until late in the growing season, translucent spots appeared in the leaves over the whole plant instead of the usual marginal burning shown in Figure 17. In these cases no other visual symptom appeared before the translucent spots developed at the late



Figures 16 and 17: Leaf spot diseases (left), are sometimes confused with visual potash deficiency symptoms (right). Marginal burning of lower leaves and shortened stalks are the distinguishing marks of potash deficiency. With the leaf spot diseases (in this case *Helminthosporium maydis*) yellow margins or "halos" around each of the spots in the leaf are the things to look for.

roasting-ear stage. In the most severe cases marginal burning appeared late but predominantly on the upper leaves. *The translucent spots offer another visual means of detecting potash deficiency developing late in the growing season.*

The advanced stages of some corn leaf spot diseases resemble the visual symptoms of potash deficiency. An example of one of these leaf spot diseases appears in Figure 16. This one, caused by *Helminthosporium maydis*, is characterized by the yellow margin or "halo" around each of the spots. Visual disease symptoms usually can be diagnosed best in their early stages of development. In later stages the leaf tissue around and between the spots dies. When this takes place along the edges of the leaf, it is sometimes mistaken for potash deficiency.

In the potash experiments (Table 11) the average potash content of the corn grain was about 0.34 per cent in both the potash treated and untreated plants. As in the case of phosphorus, however, the potash content of the grain was influenced considerably by seasonal conditions.

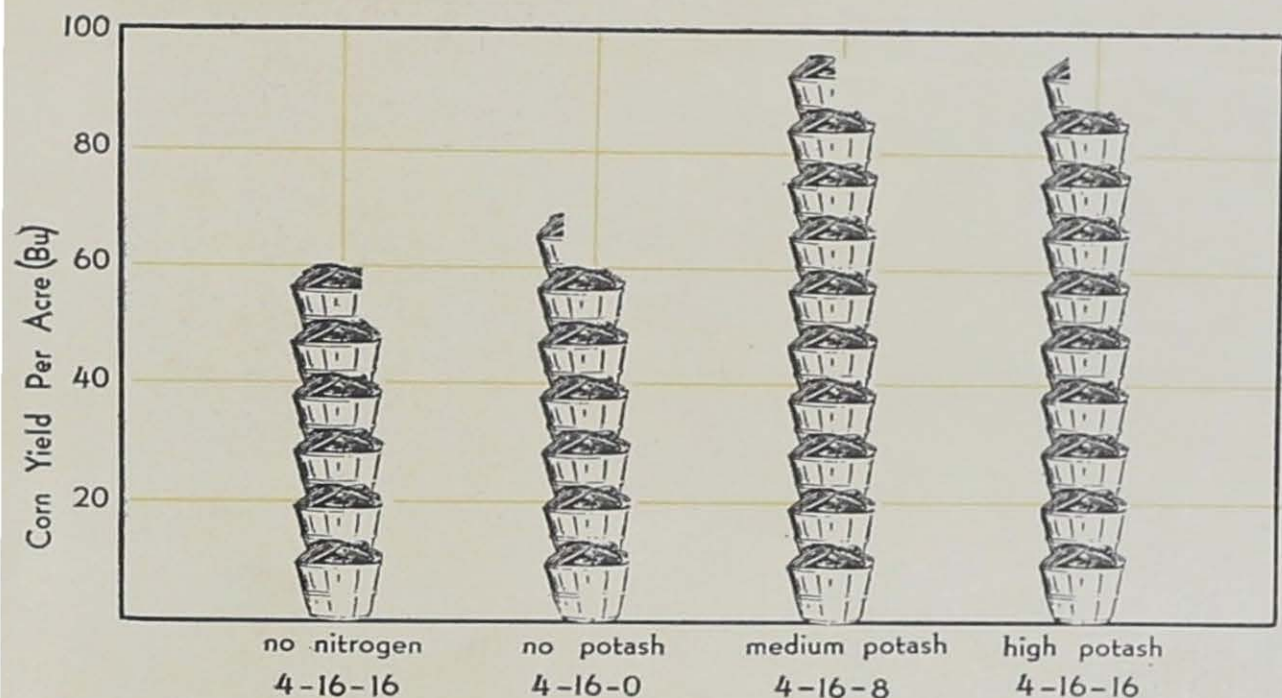


Figure 18: Potash was almost as important as nitrogen, increasing yields by 32 bushels per acre.

The potash content of corn grain is low when compared with that of the other parts of the plant. Only about a fourth of the potash of the plant is contained in the grain. Thus, potash removal by the corn grain is relatively unimportant. With nitrogen and phosphorus about two-thirds of the total plant content is in the grain.

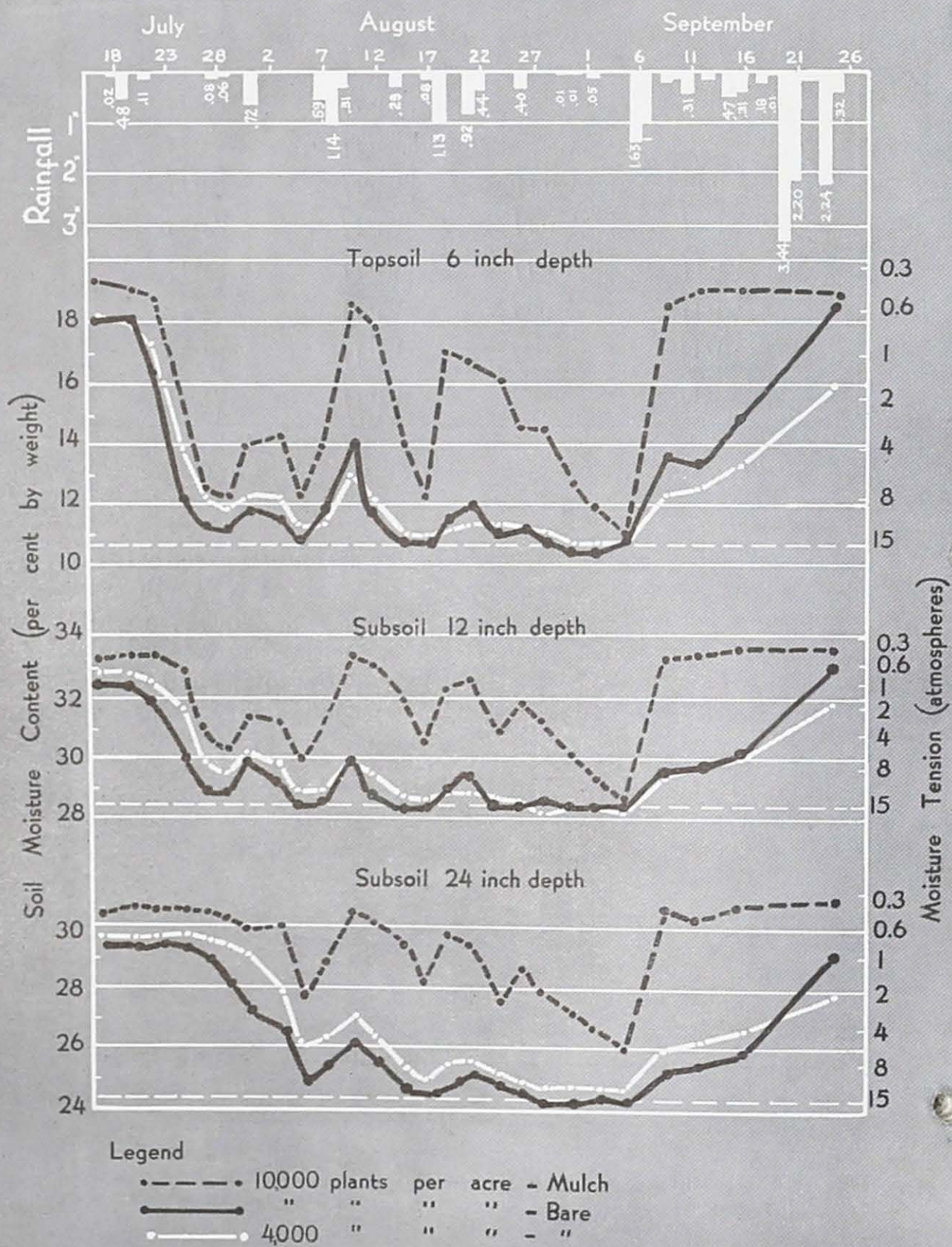
Minor Element Experiments on Corn

In 1947, 33 small minor-element experiments were conducted on corn or corn and soybeans in seven lower Coastal Plain counties. The treatments included varying amounts of manganese, magnesium, zinc, boron, copper, and iron.

No significant yield response followed minor-element application on corn or soybeans, even where untreated plots showed slight visual minor-element deficiency symptoms.

Visual manganese deficiency symptoms were observed on soybeans and occasionally on corn. Usually this was in small spots where oyster-shell piles had been burned or lime had been piled or in fields that were heavily limed (usually with a relatively soluble calcitic lime, such as burned shell lime).

Where corn and soybeans both appeared in a manganese-deficient area, soybeans showed more severe symptoms and appeared to be more sensitive than corn as an indicator plant.



Mulch Conserves Moisture, Increases Yields

Under droughty conditions, corn yields were markedly increased by the use of a surface mulch. In eight experiments under droughty conditions (Table 12) the average increase due to mulch was 21 bushels per acre. The greatest increase from mulch application as shown in Figure 19 was 45.0 bushels. Under good moisture conditions, however, yields were not significantly influenced by mulch application in most cases.

Since adequate fertilization was supplied in all comparisons, the increases were due to the effect of the mulch upon the soil moisture supply and soil temperature. The moisture content of the surface two inches of soil under the mulched area was higher (Table 13) and the temperature lower than that of the unmulched plot during the dry periods.

The soil moisture* content at 6-, 12-, and 24-inch depths from July 18 to September 26 in comparable bare and mulched plots is shown in Figure 19. The soil in the mulched plot dried out more slowly than that of the unmulched plot due to reduced evaporation. Also the soil in the mulched plot appeared to be wetted more by a moderate rain than was the unmulched soil. The data in Figure 19 show a close correlation between corn yields and the moisture content of the soil.

In these experiments the plants and leaves in the unmulched plots rolled and wilted more severely than those of the mulched plots during the droughty periods. During the late August and early September drought, the leaves of plants in the unmulched plot dried up prematurely, while those in the mulched plots remained green and matured normally.

* Acknowledgment is due to G. S. Taylor, graduate assistant, for taking the moisture readings shown in Figure 19.

← Figure 19: As shown by these soil moisture readings, the mulched plots absorbed and held moisture better at all three depths than did either of the bare plots. As the solid lines indicate, plant population has little effect on the moisture level in bare plots. The yields were 37.8 bushels for the bare plot with 4,000 plants per acre; 49.9 bushels for the bare plot with 10,000 plants; and 94.9 bushels for the mulched plot. The soil moisture readings were made by the Bouyoucos plaster block method (1) with duplicate blocks at the 6 inch depth and single blocks at the lower depths in each of four replicates. Rainfall during the period of soil moisture measurement is given at the top. The rainfall prior to that time was May, 2.63 inches; June, 4.66 inches; July 1 to 17, 4.39 inches. The corn was planted May 26 and started tasseling August 2. Notice that as the per cent water decreases the force (tension) with which it is held increases. It is the force rather than the percentage that determines the availability of the soil moisture. When the force reaches about 15 atmospheres tension (shown by the dotted line) the plants wilt. If it goes much above 15 atmospheres for any considerable time, the plants may die.

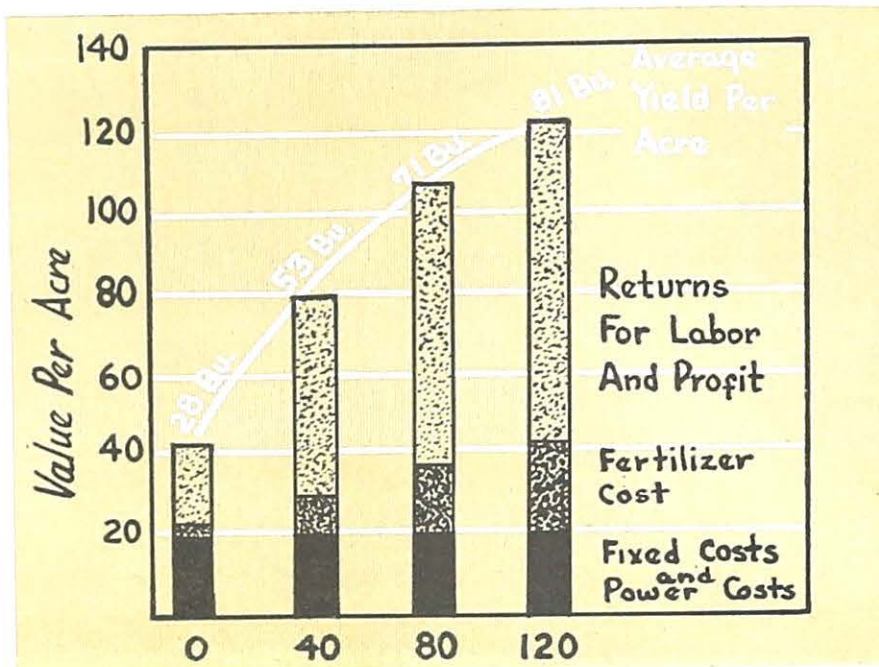


Figure 20: With fixed and power costs remaining constant, a slight increase in fertilizer cost can mean a tremendous increase in yields and profits. These yields and returns are average from 49 corn experiments conducted during 1944 to 1948. Values are figured at 1944 to 1948 prices (corn, \$1.50 per bushel; labor, 30 cents; mule power, 22 cents per hour).

Nitrogen applied per acre—pounds	0	40	80	120
Average yield of 49 experiments 1944-48—bu. per acre	28	53	71	81
Value of corn at \$1.50	\$42.00	\$79.50	\$106.50	\$121.50
Fixed and mule power costs per acre ²	19.60	19.90	20.15	20.30
Cost of phosphoric acid and potash ³	2.60	4.50	6.20	7.10
Cost of nitrogen side-dressing	0	5.00	10.00	15.00
RETURNS FOR LABOR	19.80	50.19	70.15	79.10
Cost of man labor ²	12.50	13.70	14.60	15.20
NET PROFIT PER ACRE	7.30	36.40	55.55	63.90
Cost of fertilizer per bushel		0.18	0.23	0.27
Cost of production per bushel	1.24	0.81	0.72	0.71
Returns per hour spent on corn	0.48	1.09	1.44	1.56

¹ All cost figures and price of corn was figured on 1944 and 1945 basis by the N. C. Agricultural Economics Department.

² Fixed cost which includes use of land, equipment, buildings and cost of hybrid seed equals \$10.00. Mule power costs were figured at 25 cents an hour and man labor at 30 cents an hour. (Power, labor, and equipment costs were all based on mule operation and hand harvesting. These costs have been found to be considerably less on mechanized farms.)

³ This represents about twice the amount of phosphoric acid and potash actually removed in the grain by the yields shown. (In the experiments 50 or 80 pounds per acre of both P_2O_5 and K_2O were used at a constant rate for all nitrogen rates.)

High Yields Bring Greatest Profit

In corn production, like most undertakings, there are certain fixed or overhead costs that remain constant regardless of production efficiency. With high yields the fixed cost per bushel will be relatively low, and opportunities for profit will be greatest.

The average corn yields, fixed costs, fertilizer costs, and returns for labor or profit obtained in 49 corn experiments conducted during 1944-48 are shown in Figure 20. (The average yields shown in Figure 20 are given in detail in Table 1.) These data indicate that the most profitable corn production results from ample fertilization and high yields.

SUMMARY AND CONCLUSIONS

Field experiments were conducted over a wide range of soil and climatic conditions from 1944 through 1948. The aim was to find out how to fertilize corn effectively when good hybrids were used along with good cultural practices. The results of these studies are summarized as follows:

1. Nitrogen was found to be the most limiting factor for producing corn in North Carolina. Corn yields increased about one bushel for each two pounds of nitrogen applied within the range of response to nitrogen.
2. Climatic conditions greatly influenced the amount of response to nitrogen, although substantial responses were obtained under droughty conditions when good management practices were followed. Under droughty conditions in heavy Piedmont soils, soil moisture was conserved and yields increased by mulching after the last cultivation.
3. The conventional side-dressing method of nitrogen application was as good or better than the plow-sole method. Withholding all nitrogen until side-dressing time led to stunted early growth, delayed maturity, and a significantly lower yield than on plots where one-fourth of the nitrogen was applied at planting and the rest as a side-dressing. Single side-dressings applied when the corn was two to three feet high were better than pre-tasseling applications and as good as any of the split applications.
4. Winter legumes turned under for corn furnished considerable nitrogen, although supplemental nitrogen applications were generally necessary for maximum yields.

5. Nitrogen application markedly increased the protein content of corn grain in most experiments. Three to four times as much grain was produced per pound of stover at high nitrogen application as in the "zero nitrogen" plots.
6. The plant population needed was greatly influenced by fertilization practices or the fertility level of the soil. Considering ear size as well as yield, the optimum stands for prolific hybrids appeared to be 4,000, 7,000 and 10,000 to 13,000 plants per acre at low, medium and adequate nitrogen levels, respectively. Under good fertilization practices, prolific corn hybrids proved to be remarkably capable of adjusting both ear number and ear size to fit weather conditions.
7. The average ear size and number both were increased by nitrogen application at any given stand. Ear number appeared to be more flexible and was increased to a greater degree than ear size, especially at wide spacings. The average size of ears from single-eared plants and the top ear of double and triple-eared plants was about the same. The second ear of doubles usually averaged about half to two-thirds that of the top ear.
8. Where corn followed lightly fertilized crops (mostly on Piedmont soils) it usually responded to applied phosphorus, but where heavily fertilized crops had been grown in the rotation there was no yield response. Early vegetative response to phosphate applications was found in most cases, even where the soil phosphorus level was high.
9. Response to potash depended largely on the potash level of the soil. Corn responded on soils that contained less than 100 pounds per acre of exchangeable potash. With one exception, there was no response on soils containing more than 103 pounds of potash per acre.
10. Nitrogen gave the highest yield response, with increases up to fivefold or even sevenfold; potash response was next, with about 20 to 60 per cent increase; phosphoric acid response was least—about 15 to 25 per cent increase.
11. In a preliminary survey study of minor-elements no significant yield responses were obtained even where slight visual deficiency symptoms were found.
12. The lowest cost of production per bushel and the greatest profit per acre was obtained where nitrogen was applied at the rate of 120 pounds per acre with adequate phosphorus and potash.

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Table 1.—The Effect of Nitrogen Application Upon Corn Yields in 49 Fertilizer Experiments.—1944-48.

(The data from these experiments are grouped by weather conditions in each of the five years. Averages were calculated for the 0, 40, 80, and 120 pound rates of nitrogen only.)

Nitrogen applied per acre ¹ —pounds			0	20	40	60	80	100	120	140	160	180 or above
Initials of cooperator ² and soil type ³ and location	Weather conditions ⁴	Degree of infestation with leaf disease	Yield per acre ⁵									
			Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.
1944												
MGB, Lloyd c.l., Mocksville ⁶	Dry	None	18.0	29.9	44.5		50.4		52.1			
FAA, Alamance s.l., Marshville ⁶	Dry	None	33.3	41.1	51.1		62.3		60.2			
RMcB, Norfolk sand, Red Springs	Dry	None	21.3		(43) ⁷	52.6	(57)		61.3			
GDK, Norfolk s.l., Four Oaks	Dry	None	9.4		(30)	37.8	(41)		43.9			
DAA, Norfolk s.l., Willow Springs	Dry	None	(11)	21.0	(37)	50.6	(52)	53.4	(53)	52.5		
Average of 5 experiments	Dry	None	19		41		53		54			
DFP, Norfolk f.s.l., Princeton	Fair	None	9.9		(38)	52.2	(59)		72.0			
CHP, Norfolk f.s.l., Princeton	Fair	None	31.3		(55)	66.0	(70)		74.1			
CHP, Norfolk f.s.l., Princeton	Fair	None	(32)	43.4	(59)	74.0	(78)	81.0	(83)	83.6		
JP, Norfolk s.l., Raeford ⁶	Fair	None	24.2		(52)	64.3	(70)		78.8			
JMM, Norfolk f.s.l., Lumber Bridge ⁶	Good	None	18.8	27.3	44.9		79.0		107.0			
JMM, Norfolk f.s.l., Lumber Bridge	Good	None	(25)	49.1	(58)	77.3	(87)		102.5			
Average of 6 experiments	Fair-Good	None	24		51		74		86			
1945												
WBA, Lloyd c.l., Mocksville	Very dry	None	35.6		37.0		37.7		39.2			
BTB, Davidson c.l., Advance	Very dry	None	(40)	48.5	(50)	50.4	(51)	51.0	(51)	51.1		
JSB, Alamance s.l., Monroe	Dry	None	31.7		54.9		54.5		57.8			
Average of 3 experiments	Dry-V. Dry	None	36		47		48		49			
DFP, Norfolk f.s.l., Princeton	Good	None	2.8		(24)	34.0	(47)		68.7			
CHP, Norfolk f.s.l., Princeton	Good	None	17.4		(46)	58.5	(68)		78.1			
RMcB, Norfolk sand, Red Springs	Good	Slight	14.6		(39)	49.5	(56)		62.4			
REF, Dunbar s.l., Smithfield	Good	Slight	25.8	35.3	(49)	62.2	(69)		(74)			74.7
JP, Norfolk s.l., Raeford	Good	Moderate	13.3		(39)	50.1	(60)		69.8			
WAD, Norfolk s.l., Clayton	Good	Moderate	(33)	42.2	(51)		68.6		(85)	86.9		
HGS, Norfolk v.f.s.l., Speed	Good	Moderate	19.8		40.2	(70N)	59.8		80.8		81.5	
CFT, Norfolk s.l., Raeford	Good	Slight	(25)	35.7	(46)	59.0	(64)		73.0		72.9	
Average of 8 experiments	Good		19		42		62		74			

Table 1 (Continued).

Nitrogen applied per acre ¹ —pounds			0	20	40	60	80	100	120	140	160	180 or above
Initials of cooperator ² and soil type ³ and location	Weather conditions ⁴	Degree of infestation with leaf disease	Yield per acre ⁵									
			Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.
1945												
JVT, Bladen v.f.s.l., Bethel	Very wet	Severe	52.3		67.9		79.2		76.0		80.0	
HTS, Coxville f.s.l., Ayden	Very wet	Severe	57.9		63.4		86.4		84.5		79.6	
DHY, Coxville v.f.s.l., Raeford	Very wet	Severe	24.5		35.2		53.6		65.0		62.0	
Average of 3 experiments	Very wet	Severe	45		56		73		75			
1946												
JEK, Lynchburg s.l., Farmville	Wet	Moderate	18.6		46.3		53.7		76.5		88.5	
JPM, Norfolk s.l., Tarboro	Good	None	63.9		96.9		102.0	90N	117.0		117.1	
CHP, Norfolk f.s.l., Princeton	Good	None	24.4		(59)		(82)	88.1	(100)			110.3
DHY, Norfolk s.l., Raeford	Good	None	22.8		52.1		81.7		100.5		102.3	
JPM, Norfolk s.l., Tarboro ⁶	Good	None	51.7		85.1		107.1		115.5		114.3	
DFP, Norfolk f.s.l., Princeton	Good	None	11.6		(47)		(72)	77.2	(90)			102.7
RMcB, Norfolk sand, Red Springs	Fair	None	14.4		(34)		48.5		(56)		59.0	
JP, Norfolk s.l., Raeford	Good	None	20.8		(43)		59.0		(67)		70.2	
HCS(S), Alamance s.l., Monroe	Wet	None	43.9		71.4		97.5		109.4			
HCS(N), Alamance s.l., Monroe	Wet	None	39.2		65.1		90.5		104.0			
JSJ, Norfolk s.l., Raeford	Good	None	(38)	50.1	(63)	80.0	(84)		92.1		101.0	
CPK, Norfolk f.s.l., Selma	Good	None	(46)	56.0	(62)	69.0	(73)		83.9		83.9	
Average of 12 experiments	Fair-Good	None	33		60		79		93			
GWM, Lloyd c.l., Advance	Dry	None	52.0		63.8		67.1		74.5			
1947												
CHP, Norfolk f.s.l., Princeton	Good	None	19.1		(57)		(88)	94.4	(108)			120.9
DFP, Norfolk f.s.l., Princeton	Good	None	7.2		(45)		(78)	86.7	(97)			103.9
Average of 2 experiments	Good	None	13		52		83		103			112

Table 1 (Continued).

Nitrogen applied per acre ¹ —pounds			0	20	40	60	80	100	120	140	160	180 or above
Initials of cooperator ² and soil type ³ and location	Weather conditions ⁴	Degree of infestation with leaf disease	Yield per acre ⁵									
			Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.
1948			Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.
JP, Norfolk s.l., Raeford	Dry	None	20.4		(43)		(59)	<i>90N</i>	60.8	(67)		68.6
RMcb, Norfolk sand, Red Springs	Good	None	16.6		(56)		(79)	83.6	(93)			98.2
JHD, Norfolk f.s.l., Columbia	Good	None	(24)	42.1	63.6		94.6		96.3		104.9	
RVM, Barclay v.f.s.l., Columbia	Good	None	55.2		77.3		101.8		112.0		113.9	
TES, Bladen si.l., Plymouth	Fair	None	39.8		63.5		78.1	<i>110N</i>	89.0		90.0	
DFP, Norfolk f.s.l., Princeton	Fair	None	3.7		(32)		(51)	60.5	(62)			70.7
CHP, Norfolk f.s.l., Princeton	Fair	None	15.2		(48)		(69)	80.9	(81)			70.7
EM, Balfour c.l., Brevard	Good	None	81.7		112.0		120.6		120.9		130.5	81.2
AW, Congaree si.l., Brevard	Good	None	32.3		67.9		95.5		113.1		117.6	
Average of 8 experiments	Fair-Good	None	34		65		86		96			
Average of 49 experiments—1944-48			28		53		71		81			

¹ Twenty pounds of the nitrogen was applied with adequate phosphate and potash in bands at planting time and the balance of the nitrogen was applied as a side-dressing.

² Initials of farmer cooperators are given in capital letters; for example, MGB refers to M. G. Boger.

³ Soil type names are abbreviated as follows: c, clay; si., silt; v, very; f, fine; s, sandy; l, loam.

⁴ The corn plant has its greatest need for fertilizer and moisture during the 6-week period of most rapid growth, starting just before tasseling. The terms used to describe the weather conditions during this period are defined as follows:

"Dry"—During this important period the soil moisture was low enough to cause the leaves to roll for one or more weeks.

"Good"—The rainfall distribution was about normal and soil moisture was not low enough to cause the leaves to roll during this period.

"Very wet"—Refers to a condition in 1946 where rainfall was about 40 to 50% above normal during July and August. There was a severe infestation of leaf blight disease (caused by *Helminthosporium maydis*). Normal rainfall (average 1887 to 1947) in North Carolina for June, July, and August is 4.64, 6.00, and 5.52 inches, respectively.

⁵ Average yields were calculated for the 0, 40, 80, and 120 pound per acre rates of nitrogen only since these were the most frequently used rates. Nitrogen rates of 120 pounds or more per acre were used in all experiments.

Intermediate nitrogen rates are indicated in italics for example (30N) means 30 pounds of nitrogen for the particular experiment.

⁶ Yields at 80 and 120 pounds of nitrogen are an average of two methods of application at these three locations.

⁷ All yields given in parentheses are interpolated from yield response curves. This was done in the cases where any four rates (0, 40, 80, or 120) had been omitted from the treatments in any given experiment. Actual yields are given in tenths of a bushel and interpolated values are given in whole numbers. Average values are also rounded off to the nearest bushel.

⁸ Yields at 80, 120, and 160 pounds of nitrogen are an average of several methods of application of nitrogen as a side-dressing.

Table 2.—Frequency of Drought Periods of Specified Lengths During Critical Periods for Use of Fertilizer Nitrogen by the Corn Crop.¹

Place and period of observation	Years from 1898 to 1942 with droughts during specified periods longer than				
	14 days	21 days	28 days	35 days	42 days
Raleigh, N. C. (June 1-July 15)	No. 17	No. 3	No. 2	No. 0	No. 0
Montgomery, Ala. (June 1-July 15)	No. 21	No. 6	No. 4	No. 3	No. 2
Indianapolis, Ind. (July 1-Aug. 15)	No. 40	No. 21	No. 9	No. 6	No. 1

¹ J. A. Rigney, head, Department of Statistics, assisted in the tabulation and summary of the weather data on which this table is based. Rainfall data were obtained from Climatological Data of Weather Bureau, U. S. Department of Commerce.

Table 3.—Comparisons of Side-dressing and Plow-sole Placement of Nitrogen for Corn at Two Rates and Six Locations During 1944, 1945, and 1946.

Initials of cooperator, soil type and year	Weather conditions	Yield per acre with ¹				Least Sig. Dif. (.05)
		60 lb. N rate ²		100 lb. N rate ²		
		Side-dressed	Plow-sole	Side-dressed	Plow-sole	
1944		Bu.	Bu.	Bu.	Bu.	
JMM, Norfolk fine sandy loam	Normal	82.1**	71.4	106.9**	94.3	7.5
MGB, Lloyd clay loam	Normal for July; dry June & Aug.	48.0	46.6	50.7	52.2	6.8
1945						
WBA, Cecil clay loam	Very dry	37.7	38.8	39.2	41.6	5.9
JVT, Bladen very fine sandy loam	Very wet	79.2	77.9	76.0	82.3	6.7
HTS, Coxville fine sandy loam	Very wet	86.4	77.8	84.5	87.6	14.1
1946						
JEK, Lynchburg sandy loam	Wet	53.7	64.2	76.5	81.5	16.0
Mean, 6 locations		64.6	62.7	72.3	73.3	

¹ Uniform row application of 20-80-80 was used in 1944 and 1945 and 20-50-50 (equivalent to 500 pounds per acre of 4-10-10) in 1946. The no-nitrogen treatments at the 6 locations yielded 18.8, 18.0, 35.6, 52.3, 57.9, and 18.6 bushels per acre, respectively.

² All yields reported in this paper are adjusted to 15.5% moisture in the kernel.

"Side-dressed"—A nitrate or an ammonium and nitrate form of nitrogen was applied when corn was 2 feet high.

"Plow-sole"—An ammoniacal form of nitrogen was applied in bands on bottom of plow-furrow at turning time (1 to 4 weeks before planting).

** Highly significant.

Table 4.—Comparisons of Standard and Delayed Nitrogen Applications at Three Locations in 1944.

Soil type, initials of cooperator, and location	Yield per acre ¹		Least significant difference
	Standard method	Delayed method	
	20-80-80 in row plus 60-0-0 side-dressed	0-80-80 in row plus 80-0-0 side-dressed	
Norfolk s.l., JMM, Lumber Bridge	Bushels 82.1	Bushels 76.2	Bushels 7.5
Alamance s.l., FAA, Monroe	65.6*	58.0	7.5
Lloyd c.l., MGB, Mocksville	48.0**	38.0	6.8
Means of three locations	65.2*	57.2	..

¹ The no-nitrogen treatments at these 3 locations yielded 18.8, 33.3 and 18.0 bushels per acre, respectively.

* Significant; ** Highly significant.

Table 5.—Effect of Single Vs. Split Applications of Nitrogen Side-dressing at Four Locations in 1945 and 1946 where 25 to 35 Per Cent Above Normal Rainfall Occurred During June and July.

Soil type, initials of cooperator and location	Amount of nitrogen side-dressing applied ¹	Yield per acre ²		Least significant difference (.05)
		Time of side-dressing		
		All at knee high stage	$\frac{1}{2}$ at knee high stage $\frac{1}{2}$ at pre-tasseling	
Norfolk f.s.l., HGS, Speed	Pounds 140	Bushels 81.5	Bushels 82.4	Bushels 8.9
Coxville v.f.s.l., DHY, Raeford	60	53.6	47.0	13.4
Lynchburg s.l., JEK, Farmville	100	76.5	66.8	16.0
Norfolk s.l., JPM, Tarboro	100	117.1	101.1*	15.2
Means of 4 locations	..	82.2	74.4	N.S.

¹ 20-50-50 was applied at planting in addition to the amount of nitrogen side-dressing indicated at each location.

² The yield from the no-nitrogen treatments in the 4 experiments were 19.8, 24.5, 18.6 and 63.9 bushels per acre, respectively.

* Significant.

N.S. Non-Significant.

Table 6.—The Relationship Between the Weight of Winter Legumes Turned Under and the Corn Yield Response at Varying Levels of Nitrogen at Four Locations (Average of Two Experiments). The Same Winter Cover Treatments Have Been Continued for Four Years on Each Respective Plot and Corn Has Been Grown Each Summer.

Treatment ¹	Yield per acre (15.5% moisture)						
	Norfolk fine sandy loam (CHP and DFP), Johnston County				Norfolk sandy loam (JP) and Norfolk loamy sand (RMcB), Hoke County		
	1944	1945	1946	1947	1944	1945	1946 RMcB only
No nitrogen and no cover crop	Bu. 20.1	Bu. 10.1	Bu. 18.0	Bu. 13.2	Bu. 22.8	Bu. 14.0	Bu. 14.4
No nitrogen and a winter legume	39.7	50.1	88.6	95.8	...	25.1	53.0
Increase for legume	19.6	40.0	70.6	82.6	...	11.1	38.6
60-90 pounds ² of nitrogen and no cover crop	59.1	46.3	82.7	90.6	58.8	49.8	48.5
60-90 pounds ² of nitrogen and a winter legume ³	64.8	71.6	109.1	117.1	56.9	51.3	65.8
Increase for legume	5.7	25.3	26.4	26.5	-1.6	1.5	17.3
120-180 pounds ⁴ of nitrogen and no cover crop	73.1	73.4	106.5	112.4	70.1	66.1	65.2

¹ One ton of lime was applied at initiation of experiment and 80 pounds per acre of P_2O_5 and 80 pounds of K_2O were applied annually.

² 60 pounds of nitrogen was used in 1944 and 1945. In 1946 and 1947 the nitrogen rate was increased to 90 pounds in Johnston County and to 80 pounds in Hoke County.

³ The yields given are an average of two winter legume cover crop plots; in one 20 pounds of the nitrogen was applied to the cover crop and the balance to the corn, and in the other all of the nitrogen was applied to the corn. The winter legume yields (total top growth just before turning under) were 1,285, 1,809, 3,753, and 3,781 pounds per acre for 1944, 1945, 1946 and 1947, respectively, in Johnston County. In Hoke County 1944 through 1946 the yields were 229, 904, and 2412, respectively. The nitrogen content of tops was 3 to 4 percent. The roots contained about 1/5 to 1/10 as much total nitrogen as the tops.

⁴ 120 pounds of nitrogen was used in 1944 and 1945. In 1946 and 1947 the nitrogen rate was increased to 180 pounds in Johnston County and 160 pounds in Hoke County.

Table 7.—Effect of Nitrogen Application on the Stover to Grain Ratio Under Good Moisture Conditions at Two Locations in 1946.

Pounds of nitrogen applied per acre	Stover to grain ratio ¹	
	Norfolk sandy loam Raeford (DHY)	Norfolk fine sandy loam Princeton (DFP)
0	2.83	3.30
40	1.15	...
80	1.11	...
9094
120	.97	...
160	.93	...
18078

¹ Weight of stover produced divided by the weight of corn grain produced. The grain yields at DHY were 22.8, 52.1, 81.7, 100.5, and 102.3 bushels per acre, respectively. The grain yields at DFP were 11.6, 77.2, and 102.7 bushels per acre, respectively.

Table 8.—Effect of Varying Plant Stands on the Yield and Total Weight of All Ears on the Plant at Low, Medium, and Adequate Nitrogen Applications Under Fair to Good Soil Moisture Conditions.

Plants per acre (number)	Equiv. plant spacing in a 3.5 foot row	Low nitrogen (20 lb. N/A)		Medium nitrogen (70 lb. N/A)		Adequate nitrogen (120-170 lb. N/A)	
		Yield per acre ¹	Total ear weight per plant ²	Yield per acre ³	Total ear weight per plant ²	Yield per acre ⁴	Total ear weight per plant ²
4,000	Inches 37.4	Bushels 39	Pounds .67	Bushels 58	Pounds 1.00	Bushels 63	Pounds 1.07
7,000	21.4	39	.38	73	.71	84	.82
10,000	15.0	41	.28	71	.49	92	.63
13,000	11.5	36	.19	73	.39	92	.48

¹ Average of 3 hybrids from an experiment (CFT) on a Norfolk sandy loam soil, Raeford. Fertilization—500 lb. per acre of 4-10-10 with no nitrogen side-dressing.

² Total ear weight per plant refers to the average ear weight multiplied by the average number of ears per plant.

³ Average of 3 locations (CFT, JSJ, and CPK) where 70 pounds of nitrogen was applied.

⁴ Average of 6 experiments where adequate nitrogen was used. The rate applied varied from 120 to 170 pounds per acre.

Table 9.—Effect of Plant Population and Straw Mulch on the Percentage of the Yield on One-Eared, Two-Eared, and Three-Eared Plants and the Average Ear Size of Each, Under a High Fertility Level and Good Moisture Conditions on a Cecil Loam at Wake Forest in 1947.

Plants per acre (number)	Yield per acre	Yield produced on—			Weight per ear on—							Av. ears per plant
		One- eared plants	Two- eared plants	Three- eared plants	One- eared plants	Two-eared plants		Three-eared plants			Av. of all ears	
						Top ear	2nd ear	Top ear	2nd ear	3rd ear		
	Bu.	%	%	%	Lb.	Lb.	Lb.	Lb.	Lb.	Lb.	Lb.	No.
4,600	80.0	2.4	52.0	44.6	0.47	0.62	0.54	0.57	0.51	0.26	0.48	2.48
7,800	111.6	3.2	75.1	21.6	0.55	0.56	0.45	0.57	0.51	0.21	0.47	2.05
11,500	126.3	11.3	83.8	4.9	0.51	0.49	0.35	0.52	0.41	0.18	0.42	1.78
11,500 + 2.5 tons straw mulch	139.1	12.3	83.2	4.5	0.52	0.51	0.39	0.50	0.47	0.24	0.46	1.80

Table 10.—Effect of Phosphoric Acid Application on Corn Yields in Experiments Conducted During 1944-46.

Year	Soil type, initials of cooperator and location	Soluble phosphorus (per acre) ¹		Yield per acre			
		Top soil	Sub-soil	N-P-K ² plots	N-O-K ² plots	Increase due to phosphoric acid applica.	Least Signif. Dif.
		Lb.	Lb.	Bu.	Bu.	Bu.	Bu.
1944	Piedmont Lloyd c.l., MGB, Mocksville ³	Trace		50.7	43.1	7.6	6.8
1944	Alamance s.l., FAA, Monroe ³	Trace		65.6	55.1	10.5	7.5
1945	Alamance s.l., JSB, Monroe ³	14		57.8	42.1	15.7	8.3
1945	Lloyd c.l., WBA, Mocksville ³	28		39.2	32.9	6.3	5.9
1946	Lloyd c.l., GWM, Advance ³	41		74.5	62.8	11.7	6.0
1946	Alamance s.l., HCS(S), Monroe ³	82	28	109.4	86.0	23.4	12.6
1946	Alamance s.l., HCS(N), Monroe ³	78	9	104.0	97.7	6.3	N.S.
1945	Coastal Plain Coxville s.l., HTS, Ayden ³	169		93.4	78.9	14.5	14.1
1945	Dunbar s.l., REF, Smithfield ³	110		74.7	53.8	20.9	17.6
1944	Norfolk s.l., JMMC, Lumber Bridge ⁴	366		106.9	102.0	4.9	
1945	Norfolk s.l., HCS, Speed ⁴	266		81.5	81.2	.3	
1945	Bladen v.f.s.l., JVT, Bethel ⁴	248		81.4	84.5	-3.1	
1945	Coxville v.f.s.l., DHY, Raeford ⁴	101		64.8	57.2	7.6	
1946	Norfolk s.l., JPMc, Tarboro ⁴	202	41	117.1	111.5	5.6	

¹ Soluble phosphorus in soil determined by the Truog method (0.002 normal H₂SO₄)

² Plots designated "N-O-K" received fertilizers containing adequate nitrogen and potash but no phosphoric acid. Plots designated "N-P-K" received fertilizer containing adequate amounts of nitrogen, phosphoric acid, and potash. The fertilization included 500 pounds per acre of 4-16-16 in 1944 and 1945 and 4-10-10 in 1946 applied in bands at planting and 100 to 180 pounds per acre of nitrogen side-dressing.

³ Previous crops included corn, small grain, soybeans, lespedeza and other lightly fertilized crops.

⁴ Previous crops included cotton, tobacco, or potatoes which are usually heavily fertilized.

Table 11.—The Effect of Potash Application on Corn Yields in Experiments Conducted During 1944-46.

Year	Soil type, initials of cooperator and location	K ₂ O per acre		Yield per acre			
		Top soil	Sub-soil	N-P-K ¹ plots	N-P-O ¹ plots	Inc. due potash (K ₂ O) applica.	Least Signif. Dif.
		Lb.	Lb.	Bu.	Bu.	Bu.	Bu.
1945	Coastal Plain Coxville f.s.l., HTS, Ayden ²	103		93.4	62.0	31.4	14.1
1945	Coxville v.f.s.l., DHY, Raeford ³	38		64.8	48.8	16.0	13.4
1945	Dunbar s.l., REF, Smithfield ²	82	47	74.7	33.2	41.5	17.6
1946	Lynchburg s.l., JEK, Farmville ²	54	47	88.5	66.7	21.8	16.0
1944	Norfolk f.s.l., JMMc, Lumber Bridge ³	273		106.9	100.5	6.4	N.S.
1945	Norfolk f.s.l., Speed ³	102		81.5	76.7	4.8	N.S.
1945	Bladen v.f.s.l., JVT, Bethel ²	235		81.4	77.1	4.3	N.S.
1946	Norfolk s.l., JPMc, Tarboro ³	85	94	117.1	107.5	9.6	N.S.
1946	Piedmont Alamance s.l., HCS(S), Monroe ²	53	24	109.4	94.0	15.4	12.6
1946	Lloyd c.l., GWM, Advance ³	158		74.5	62.2	12.3	6.0
1944	Lloyd c.l., MGB, Mocksville ²	198		50.7	49.4	1.3	N.S.
1944	Alamance s.l., FAA, Monroe ²	169		65.6	61.6	4.0	N.S.
1945	Alamance s.l., JSB, Monroe ²	310		57.8	55.6	2.2	N.S.
1945	Lloyd c.l., WBA, Mocksville ²	207		39.2	39.0	0.2	N.S.
1946	Alamance s.l., HCS(N), Monroe ²	54	46	104.0	96.9	7.1	N.S.

¹Plots designated "N-P-O" received fertilizer containing adequate nitrogen and phosphoric acid, but no potash.

Plots designated "N-P-K" received fertilizers containing amounts of nitrogen, phosphoric acid and potash. The fertilization included 500 pounds per acre of 4-16-16 in 1944 and 1945 and 4-10-10 in 1946 applied in bands at planting and 100 to 180 pounds of nitrogen per acre as a side-dressing.

²Previous crops included corn, small grain, soybean, lespedeza and other lightly fertilized crops.

³Previous crops included cotton, tobacco, or potatoes which are usually heavily fertilized.

Table 12.—The Effect of Mulch Upon Yields of Adequately Fertilized Corn Under Droughty Conditions and Conditions of Normal to Above Normal Rainfall During 1944 to 1947.

Year	Initials of cooperator and soil type and location	Yield per acre		
		No mulch ¹	Mulch ¹	Increase due to mulch
	Dry conditions	Bu.	Bu.	Bu.
1944	MGB, Lloyd clay loam, Mocksville	57.3	85.3	28.0**
	FAA, Alamance silt loam, Marshville	70.8	88.5	17.7**
1945	WBA, Lloyd clay loam, Mocksville	39.2	52.2	13.0**
	JSB, Alamance silt loam, Monroe	57.8	75.3	17.5**
	BTB, Davidson clay loam, Advance	53.0	65.3	12.3**
1946	OWM, Lloyd clay loam, Advance	74.5	92.0	17.5**
1947	CES(A), Cecil clay loam, Raleigh	49.9	94.9	45.0**
	CES(L), Cecil clay loam, Raleigh	75.5	92.5	17.0**
	Average of 8 experiments	59.8	80.8	21.0
	Good moisture conditions			
1944	JMMc, Norfolk fine sandy loam, Lumber Bridge	100.0	100.9	0.9
1945	JVT, Bladen very fine sandy loam, Bethel	81.4	91.0	9.6**
	HGS, Norfolk very fine sandy loam, Speed	81.5	88.3	6.8
1946	JPMc, Norfolk sandy loam, Tarboro	117.1	116.5	-0.6
	HCS(N), Alamance silt loam, Monroe	104.0	110.0	6.0
	HCS(S), Alamance silt loam, Monroe	109.4	108.3	-1.1
	JSJ, Norfolk sandy loam, Raeford	83.6	91.7	8.1
	CPK, Norfolk fine sandy loam, Selma	80.8	85.8	5.0
1947	WWH(A), Cecil loam, Wake Forest	126.3	139.2	12.9*
	WWH(L), Cecil loam, Wake Forest	118.9	125.2	6.3
	Average of 10 experiments	100.3	105.7	5.4

¹ The "mulch" and "no mulch" plots received the same fertilization in any given comparison. Different rates were used at various locations, but the amount was never less than 120-50-50, which was considered to be adequate at the given locations. The mulch was applied just after the last cultivation when the corn was knee high. The wheat straw was the most common material used although pine needles and mulch paper was used in a few cases.
* - significant; ** - highly significant.

Table 13.—The Effect of Straw Mulch upon Soil Temperature and Moisture Readings on a Lloyd Clay Loam on July 5, July 17, and August 25, 1944.

Fertilizer and straw treatment ¹	Depth of meas.	July 5 ²		July 17 ²	August 25 ²	
		Soil temp. °F	Soil moist. %	Soil moist. %	Soil temp. °F	Soil moist. %
120-80-80	In.	122			115	
	½					
	0-2		3.9	6.8		7.1
120-80-80 + 3 tons straw mulch per acre	2-4		9.0	14.4		10.5
	½	84			79	
	0-2		7.3	18.4		18.9
	2-4		9.8	22.4		18.6

¹ 120-80-80 refers to pounds per acre of nitrogen-phosphoric acid-potash. The applications were split with 100-60-60 on the plow-sole and 20-20-20 in the row at planting. The straw mulch was applied just after the corn was "laid by" at knee high stage on June 16.

² Soil moisture and temperature readings are an average of two replicates where the two treatments occurred adjacent to each other. Temperature readings were taken in mid-afternoon during bright sunshine, when air temperature was about 95° F.

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