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# Flower Pot Composition and Its Effect on Plant Growth

By Linus H. Jones

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The ordinary flower pot of fired clay has been the standard plant container for many years. In recent years, however, flower pots of other materials have come on the market; and of these, paper pots have received most consideration because of their economic advantages. A result of this interest has been a pronounced demand for reliable information concerning the comparative merits of different types of containers. The investigation reported in this bulletin was begun in response to this demand, and has given results which are applicable either to the production of greenhouse plants in wholesale quantities or to the growing of a single house plant.

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# FLOWER POT COMPOSITION AND ITS EFFECT ON PLANT GROWTH

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## Introduction

An investigation of the merits of several types of plant containers has revealed some interesting problems, the solution of which is of value to both the producers and users of flower pots. The standard porous clay pot, with drainage hole in the bottom, is in general use wherever plants are grown in containers. With a good potting soil, proper temperature, water, and sufficient light, the attendant in a greenhouse knows he can produce good plants in such pots. When these same plants with their containers are removed to the rooms where man works and dwells, experience indicates that the plant will lose its luxuriance and may even die. Among the excuses for failure to grow house plants may be mentioned the dryness of the air, the presence of coal gas, and a natural lack of sympathetic understanding with the plants. The paramount picture of household plants is the uncanny success of the poor people with their tin-can containers. To all appearances, these people have disobeyed all the rules of culture in that the non-porous containers with inadequate drainage are in kitchens with a great range of temperature, where coal gas is frequently present, and where the sunlight is frequently of short duration.

## The Porous Clay Flower Pot

Many examinations of house plants that are gradually dying have shown a general absence of insect pests and freedom from disease. However, when the plant is removed from its pot, it is usually quite noticeable that the porous pot itself is dry, that the upper third of the soil is wet and the lower half of the soil is powder dry. In this dry soil the roots are dead. The diagnosis from the conditions thus found is gradual death of the plant caused by a lack of moisture in the area normally occupied by the feeding roots.

An investigation of a broad nature has brought out some generalities that explain a great many failures in growing house plants. A knowledge of these factors leads to recommendations which may insure the successful home culture of plants with a minimum amount of care.

It is well known that warm air will hold more moisture than cool air. When the cool air of winter is introduced into our rooms and its temperature raised by any heating apparatus, the little moisture that it originally contained when cool is very small compared with the amount of moisture the

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<sup>1</sup> The writer is indebted to Professor A. Vincent Osmun, Head of the Department of Botany, for his keen interest in aiding in the solution of the many problems encountered in this investigation, and for his suggestions in making the results of greater service to the public.

air can retain at the raised temperature. The ratio obtained by comparing the moisture actually present with the greatest amount of moisture the air could possibly contain at a given temperature is called the *relative humidity*, with 100 per cent as the highest possible value. In the locality of Amherst, Massachusetts, the normal out-of-door relative humidities for the months of June, July, and August are respectively 74, 76, and 78 per cent (5). The driest atmosphere in North America is in Death Valley, California, where an observer has recorded a relative humidity as low as 23 per cent. This humidity is low, and yet the writer on several occasions has found the humidity of rooms in an average building to be as low as 20 per cent. In Canada, where the winter air is much cooler than in Amherst, relative humidity as low as 8 per cent has frequently been recorded (12). There has been so little work done in obtaining actual measurements of the relative humidity in homes that little information is available. Daniels (3) states it is probable that our homes have a relative humidity of 20 per cent or lower. Such a low humidity indicates an atmosphere as dry as desert air.

The effect of such a low moisture content is an atmosphere with a high evaporating power. This increased evaporating power of the air quickly takes up the moisture from the outside of the porous flower pot. The moisture lost from the pot is replaced by moisture from the soil and the process continues until both pot and soil are dry, if the soil remains in intimate contact with the pot. Usually, however, this extreme is never reached, as the daily watering of the plants provides sufficient moisture to partially replace the daily loss. As a matter of fact, practically one-half of the normal amount of water supplied may be taken up by the pot, if the pot is dry. In Table 1 are given the actual amounts of water adsorbed by dry flower pots of various sizes and also the amounts of water that constitute a normal watering for these pots.

TABLE 1.—THE VOLUME OF A NORMAL WATERING OF A CLAY FLOWER POT THAT IS ADSORBED BY THE POT.

Size of pot Inches	Normal watering C. c.	Adsorbed by pot C. c.	Water avail- able for plant C. c.
3	54	25	29
4	100	57	43
5	200	86	114
6	300	132	168
7	500	163	337

If the evaporation of water from the pot plus the amount used by the plant exceeds the amount applied, there is a deficit of normal moisture in the soil. This deficit may gradually increase until the soil is entirely devoid of moisture in the lower part of the pot. When this occurs the feeding roots die and the above-soil portions of the plant die either gradually or quickly according to the nature of the plant or the rapidity with which this moisture deficit develops. The normal daily water that is applied does not evenly distribute itself throughout the soil. The attraction by the pot itself for the water causes a movement of the capillary water to the pot which usually reduces the moisture in the upper part of the soil before it has had time to penetrate the lower and drier layer of soil.

The evaporation of moisture from the outside surface area of the porous

not has a cooling effect on the soil. Experiments conducted by Jones (7) show that a difference of 20° F. may exist between the soil temperatures of a clay pot and a non-porous pot, the clay pot being the cooler. By weighing at frequent intervals, it was found that twice as much water was lost from the porous pot as from the non-porous pot. In Table 2 is shown the loss of weight from porous and non-porous three-inch flower pots and the temperature at the center of the soil mass. As the surface areas of the two types of pots were the same, the greater moisture loss in the porous pots was due to the evaporation from the outside surface of the pot itself. This double loss of moisture from the porous pots was again checked in a later phase of the investigation which brought out the fact that the porous pots required twice as much attention for watering as did the non-porous pots.

TABLE 2.—THE LOSS OF MOISTURE FROM POROUS AND NON-POROUS POTS AND THE EFFECT OF EVAPORATION ON SOIL TEMPERATURE IN THESE CONTAINERS.

Time	LOSS OF MOISTURE				SOIL TEMPERATURE			
	Porous pots		Non-porous pots		Porous pots		Non-porous pots	
	Grams	Grams	Grams	Grams	°C.	°C.	°C.	°C.
9:00 a.m.	0	0	0	0	11	11	11	11
1:30 p.m.	27.8	30.8	11.3	12.1	27	27	38	38
2:00	3.0	3.3	0.9	0.6	26	26.5	38	38
2:30	2.9	2.6	1.6	1.5	26	27	38	38
3:00	2.6	3.4	0.6	0.8	26	27	37	38
3:30	2.3	1.9	1.7	0.9	27	28	37	38
TOTAL	38.6	42.0	16.1	15.9				

However, there has been no indication that the excessive evaporation from the porous pots affects the growth of the plant from the temperature angle. There is sufficient evidence to state that the excessive evaporation ultimately leads to a water deficit in a portion of the soil and that this deficit is not made up by the daily practice of watering.

If, however, the tin can or some other non-porous container is used, there can be no adsorption of moisture by the container and hence no evaporation on the outside surface. All the water applied is evenly distributed and kept in balance throughout the soil mass. The range of moisture content is much smaller than in the porous container and the response by the plant is consequently a steady growth, if temperature and light are suited to the plant.

If porous containers are to be used in rooms where the relative humidity is low, it is advisable to keep such containers on a moist surface. This is best secured by resting them on a shallow mass of moist sphagnum moss, such as is used by florists for making funeral set pieces. The porous pot will continue to evaporate its moisture, but will replenish the loss by taking up the moisture from the moss. Standing porous pots in free water may be practised, but this method may lead to a water-soaked soil and consequent lack of aeration in the soil.

#### Paper Flower Pots

Paper flower pots may be successfully employed for growing plants, if the paper is properly impregnated with a substance that will prevent the de-

composition of the paper fibers. This water-proofing material must also be harmless to the root system, a part of which will be in direct contact with the inside wall of the pot. Because of the lack of porosity in a properly made paper flower pot, plants will frequently do better in these paper pots than in the standard clay pots.

In cooperation with an industrial concern in Massachusetts<sup>2</sup>, a thorough investigation has been made of what the requirements of a paper pot should be to insure proper growth of plants. Growers who were using paper pots, water-proofed with paraffin, claimed that poor growth was obtained in these pots because of an acid condition in the soil resulting from a lack of aeration through the wall of the pot. That this premise probably is not well-founded is shown by the fact that plants grown in glass containers have proved to be superior to plants grown in porous containers. In Figure 3 are shown tomato, pepper, and calendula plants growing in porous pots (clay) and extremely non-porous containers (jelly glasses). Figure 3 also shows the poor growth obtained in pots made of paraffined paper. It is quite evident that the lack of porosity in the paper pot is not a factor that hinders normal growth. Sufficient aeration of the soil may be obtained easily through the surface in the same way that aeration occurs in the field and forest.

Since porosity is not a factor, attention was directed to the soil temperature as affected by the materials used in making plant containers (7). The cooling effect by evaporation from a porous pot was sufficient to maintain a soil temperature 20° F. lower than that of a glass container. The temperature of the soil in a glass container followed closely the fluctuations of temperature of the air of the greenhouse. The temperature of the soil mass in a paper pot lagged about 3° F. behind the soil temperature of the glass container.

TABLE 3.—TEMPERATURES OF SOIL MASS IN THREE-INCH PLANT CONTAINERS OF DIFFERENT COMPOSITION.

Time	Standard pot °F.	Paper pot °F.	Peat pot °F.	Fiber pot °F.	Glass tumbler °F.
8:30 a.m.	64	67	64	65	68
9:00	77	82	73	73	82
9:30	83	91	79	79	93
10:00	85	95	82	84	99
10:30	85	99	84	86	102
11:00	85	100	84	88	104
11:30	86	100	84	90	105
12:00 m.	86	102	85	90	105
12:30 p.m.	85	102	84	90	105
1:00	85	102	85	91	105
1:30	86	102	86	91	105
2:00	86	102	86	91	105
2:30	86	102	86	91	105
3:00	86	102	86	91	105
3:30	86	102	86	91	105
4:00	86	102	86	91	105
4:30	86	103	86	91	105

In Table 3 is given the half-hourly readings of soil temperatures obtained from a few types of plant containers. The paper pot, in a warm greenhouse,

<sup>2</sup> Bird and Son, East Walpole, Massachusetts.

did have a soil temperature considerably higher than that of a porous pot. However, no experimental evidence could be obtained which would indicate any effect on plant growth. Tomato plants in clay, paper, and glass containers grown in a night air temperature of 80° F. were larger than a similar series grown at a temperature of 60° F., but the relative differences between the plants in the various containers in the same series remained the same. Furthermore, the soil temperature in the paper pot was more like that of the glass containers, yet plants in the glass containers were frequently better than those in clay pots and the plants in the paper pots were poorer than those in the clay pots. These results indicate that the soil-temperature factor is as unimportant as the porosity factor so far as it applies to growth in paper pots.

The habit of growth in the paraffined paper pots was quite similar to growth obtained when a nutrient deficiency exists. The leaves of the plant turned to a yellow green and became stiff. New leaves grew slowly and remained small. These plants resembled plants that have been exposed to very cool temperatures or have been put on a ration of a reduced quantity of water. These practices, i. e., cool temperature and little water, are used in the method of "hardening-off" plants either to hold them back in growth or to prepare them for the more rigorous life of field culture. However, the root system was very much unlike the strong root systems of plants that have been hardened-off. The ball of roots with soil was not present. The roots were very few and showed little tendency to branch. This absence of a fibrous root system on the outside of the soil mass was not due to lack of moisture on the outside of the potted soil. The paper pot soon became quite moist and in many cases was penetrated by roots that were working downward on the outside of the pot. Numbers 11 and 12 in Figure 1 show the poor root systems of plants grown in plain paper and paraffined paper pots. Numbers 16 and 17 are plants grown in clay and glass containers, showing excellent root systems.



Fig. 1.—Calendula Plants, 40 days in 4-inch containers.

No. 11, plain paper pot; 12, paraffined paper pot; 13, 14, 15, Bakelite varnishes on paper pots; 16, clay; 17, pint size glass fruit jar.

The leaves of the plants were strikingly similar to leaves on plants suffering from a lack of available nitrogen. Tomato plants in clay and paper pots were given an application of an ammonium sulfate solution (1 ounce to 1 gallon) when the plants in the paper pots had apparently stopped growing.

Check pots of both clay and paper were left untreated. Three days after this application the plants in the treated paper pots showed a darker green color and were soon quite superior to the plants in the paper pots to which no ammonium sulfate had been added. The plants in the clay pots which received ammonium sulfate showed a trace of improvement over the untreated pots, but the difference was marked only by darker green foliage. In Table 4 is shown the height of the plants, thirty days after the application of the ammonium sulfate solution.

TABLE 4.—HEIGHT OF TOMATO PLANTS IN FOUR-INCH PAPER AND CLAY FLOWER POTS, THIRTY DAYS AFTER AN APPLICATION OF AMMONIUM SULFATE SOLUTION

PAPER POTS		CLAY POTS	
Ammonium sulfate series	Check series	Ammonium sulfate series	Check series
<i>Inches</i>	<i>Inches</i>	<i>Inches</i>	<i>Inches</i>
22	13	23	22
22	13	26	28
24	14	26	25
25	11	26	23
22	15	18	25
<b>Average 23</b>	<b>13</b>	<b>24</b>	<b>25</b>

On the same day that the plants were measured, they were photographed (Figure 2).



Fig. 2.—Nitrogen Deficiency in Paper Pots.

Ammonium sulfate solution applied to pots marked N, two weeks after seedlings were set. Photographed 30 days after nitrogen was applied.

The nitrogen applied to the paper pots, even after the plants were checked in growth, was sufficient to bring the plants to a height practically equal to that of the plants in clay pots. That there was sufficient nitrogen in the soil when the seedling tomatoes were potted is shown by the fact that the clay pots receiving the ammonium sulfate solution produced no better plants than were obtained in clay pots to which no nitrogen had been added.

In practically every case the loss of green color by the foliage of the plants was preceded by a softening of the pot, indicating that decomposition of the pot had started. Heavier coatings of paraffin prolonged the stiffness of the pot, thereby insuring good growth of the plants for a longer period than was possible in the paper pots protected with a light coating of paraffin. That the decomposition of the paper fibers is indirectly the cause of the nitrogen deficiency is substantiated by the results of many investigators who have studied the effect of decomposing cellulose on plant growth. This investigation, in its latter phase, indicates that when the paper fibers are so well protected that decomposition is impossible, no nitrogen deficiency will occur. The direct cause of the shortage of available nitrogen is the superior ability of the soil micro-organisms, producing the decomposition, to assimilate the nitrogen of the soil in competition with the plant.

In this case, the mass of soil was practically surrounded by decomposable cellulose. The literature on the effect of decomposing cellulose on plant growth is concerned with cellulose incorporated in the soil. However, as the paper soon becomes water-soaked and evaporates water from its outside surface, the cellulose truly becomes a constituent of the soil, and it is not improbable that the same or similar processes of cellulose decomposition are involved. It must also be kept in mind that when decomposition of the pot has reached the point where the pot becomes water-soaked, this area acts as an evaporating surface and there would be a movement of the soil solution to this area. Furthermore, the feeding roots are close to the inside surface of the pot, the very region where microbial activity is the highest and where there would be the greatest competition for nutrients of the soil.

The recent work of Collison and Conn (2) confirms the explanation of earlier investigators, i. e., "that the presence of highly carbonaceous material stimulates the activities of micro-organisms which compete with the plants for the available nitrogen and in that way cause a nitrogen shortage in the medium." Of these investigators may be mentioned Krüger and Schneidewind (10) (11) who first proposed the theory. Pfeiffer and Lemmermann (13) decided that the micro-organisms used the nitrogen as a necessary food for their existence. Kellerman and Wright (8) came to a similar conclusion when they created a state of malnutrition in citrous seedlings by addition of cellulose to the soil. Hill (6) studied the length of time that cellulose depressed the nitrate content of a soil. Doryland (4) and Rahn (14) concluded that the supply of soil nitrogen may be utilized by the micro-organisms to the extent that it may become a limiting factor to their activities. Allison (1) makes an application of the nitrogen-carbon ratio which has the approximate constant of 1:10 in humid regions. When this ratio is widened by the introduction of a highly carbonaceous substance there is an increased activity of micro-organisms to narrow the new ratio in the process of which the relatively small amount of nitrogen is tied up in the protein substance of the organisms. This nitrogen may be utilized over and over again by these organ-



isms and is not available for plants until the ratio approaches the 1:10 constant.

The work of Viljoen and Fred (15) in which wood and wood pulp cellulose were used shows a harmful effect on plants. These investigators agree that the harmful effect was due to the need for nitrogen by the organisms decomposing the cellulose. As the paper pots are of this form of cellulose, there is no doubt that the same processes were taking place.

Knott and Jeffries (9)<sup>3</sup> also working with paper flower pots made actual determinations of nitrate present in the soil. Their data show that in the process of decomposing the cellulose, the nitrate nitrogen of the soil had been reduced six-sevenths. Their recommendation that the effect of nitrate deficiency may be overcome by periodic applications of a nitrate solution is in agreement with the data of Table 4 in this paper.

Knott and Jeffries (9) recommend the treating of paper bands or pots with wax, asphalt, or other chemicals. The rate of decomposition will then be reduced and there will be less danger of nitrate starvation.

The effect of a nitrogen deficiency can be overcome by applications of available nitrogen. It was the purpose of the writer, however, not to remedy the effect, but to remove the cause. It was reasoned that a paper pot in which the fibers are so well protected that decomposition can not occur should grow as good plants as those grown in glass containers.

Many different materials were used<sup>4</sup>, some of which gave a partial degree of protection. Substances, which usually protect wood and are subjected to wide fluctuations of temperature and moisture, could not withstand the inroads of the weathering processes taking place in the humid atmosphere of the soil, a soil with a slight acid reaction, and replete with biochemical processes set up by the micro-organisms of the soil.

Inasmuch as any water-proofing material would decrease the porosity of the paper pot, the trend of pot composition would be to approach a structure that resembled glass. Hence, in all tests, glass containers as well as clay flower pots were used as checks. If glass produced poorer plants than those grown in clay pots, the practicability of the results would be doubtful.

The materials used for water-proofing were given careful consideration. Combinations of treatments were made, including inside and outside surfaces and treatments before and after the pots were formed. Special grades of paraffin, sodium silicate, lacquer, varnish, Bakelite varnish, cellophane, and asphalt were used. Pots were provided with plant nutrients and also chemicals toxic to organisms (mercuric chloride and copper sulfate) incorporated in the paper before the coatings were applied.

Tomato and calendula seedlings were used as indicator plants as they grow fairly rapidly and the leaves quickly turn yellow when a nitrogen deficiency exists. As the testing progressed and many of the treatments to the paper were eliminated, the final test was carried out with geranium plants in four-inch pots. The geranium grows slowly and did not become pot-bound

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<sup>3</sup> The program of testing paper pots with various water-proofing materials was well advanced before the publication of the good work done by Knott and Jeffries.

<sup>4</sup> The writer is indebted to Mr. E. L. Connolly of Bird & Son for the treated paper pots and to the Bakelite Corporation for furnishing this laboratory with three Bakelite varnishes.

in the course of the five-month period when this test of durability of the pots was under way.

When the fibers of the pot were properly water-proofed with a substance that had some degree of permanence, it was found that as good plants could be grown in the paper pots as in the glass containers; and the latter in turn were frequently superior to plants grown in the standard clay pots. The results of such a test are shown in Figure 1.

The Bakelite-treated paper gave excellent results as measured in growth. This substance is not adaptable to the machinery used in treating this particular paper, but it served to demonstrate the improvement obtained in paper pots when the fibers are properly protected from decomposing organisms.

It was further learned that a properly coated paper disc in the bottom of a paper pot improved the growth of plants. These discs serve to prevent the roots from passing through the cracks in the base of the pot. These cracks result from the folding of certain parts in forming the bottom of the pot. Of the 10 best growing pots in a series of 40, 3 were of glass, 5 were of paper with double coatings of varnish or lacquer and with discs, 1 was of paper coated with Bakelite, and 1 of paper with a double coating of lacquer. It is possible that the discs, by making a more solid bottom, prevent the leaching out of certain nutrients, particularly nitrogen. If the paper pots are set on beds of soil, sand, or cinders, these discs prevent the penetration of the roots into such a moist medium. If the discs are not present, the pots must be lifted frequently to break off these roots, otherwise the major part of the root system will get into the moist bench and be lost when the plant is moved to a new location.

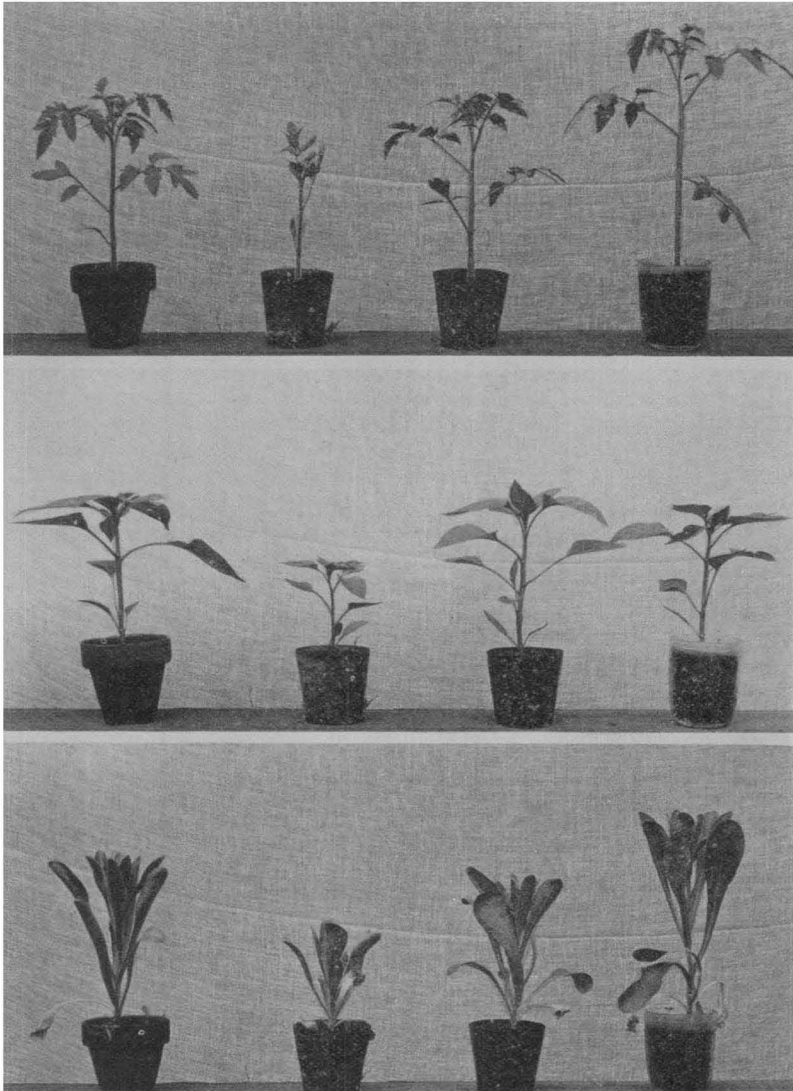
The most practical paper pot was one in which the fibers were impregnated and bound together with asphalt. In subsequent tests with several different plants, this paper pot has proved capable of growing as good plants as are produced in clay pots. In Figure 3 are shown the results obtained with tomato, pepper, and calendula plants growing in three-inch pots of clay, paraffined paper, asphalt paper, and jelly glasses.

The asphalt paper pot may be profitably used by amateur plant growers who do not have greenhouse facilities. Commercial growers may find these pots of value for the last transplanting as the plants are then potted for shipping, thus eliminating the extra weight and breakage that would occur if clay pots were used.

#### Glass Containers as Flower Pots

The use of glass or vitreous materials in making flower pots, has a practical value. These containers promote good growth of plants in atmospheres of low humidity. In homes, offices, and arid areas of the country, such plant containers conserve the moisture in the soil, retain all the nutrients, and considerably reduce the time necessary for the care of plants.

The prevailing idea that flower pots must be porous is quite erroneous. In practically all laboratories, where plants are grown under controlled conditions, non-porous containers of metal or crockware are employed and no question has ever been raised that the lack of porosity of the container has vitiated the results of the experimental work. Unlike the porous pot, the glass container can not evaporate moisture on the outside surface. Unless care is exercised in watering, there is grave danger that the soil will be flooded by over-watering; but this may be guarded against by potting the plant with



**Fig. 3.—Seedlings of Tomato (26 days), Pepper (39 days), and Calendula (43 days).**

**Left to right, 3-inch pots of clay, paraffined paper, asphalted paper, and jelly glasses.**

sufficient soil so that very little volume is left above the surface of the soil that can be filled with water. In glass containers, soils that are wet to the touch need no water; if they are barely moist, water may be added. Though a drainage hole is not necessary, it may be helpful in case free water gathers in the soil. In a period of three months in a greenhouse, plants in glass containers required less than half as much water as those in clay pots. With house plants, the difference would be wider.

In Figures 1 and 3 are shown experiments with various types of pots; including glass. The glass containers in these photographs did not have drainage holes, yet glass produced plants as good as those grown in other containers, or better.

In order to demonstrate that glass containers were productive beyond the vegetative phase of the plant, an experiment was prolonged through the blossoming stage with calendulas. The plants were in 4-inch clay pots, 4-inch Bakelite-varnished paper pots, and pint glass fruit jars (holding the same volume of soil as a 4-inch pot). The plants in the fruit jars produced more flowers than those in any other type of container, as is shown in Table 5.

TABLE 5.—THE EFFECT OF THE TYPE OF PLANT CONTAINER ON THE PRODUCTION OF BLOOMS FROM CALENDULA PLANTS.

Type of pot	Pots Number	Blooms Number	Average blooms per pot Number
Bakelite paper	3	7	2.33
Clay	3	4	1.33
Pint glass jars	3	11	3.66

There are many forms of glassware that may be adapted to the growing of plants. Cheap glass tumblers and jelly glasses may be used for small plants. The ornate jardiniere may be better used as a plant container than as a means to hide a clay pot.

### Rubber Flower Pots

In the course of the investigation, tests were conducted with a new type of flower pot made of rubber.<sup>5</sup> The saucer is attached, and a drainage hole enters the saucer from the side of the pot at the base. Careful tests indicated that the pots contained no substance harmful to the plants.

Some of the pots were coated with a Bakelite varnish; some with asphalt. The remaining pots were not coated, thus allowing the roots of the plant to come in direct contact with the rubber. All produced plants that compared favorably with plants in glass and clay pot containers.

Figure 4 illustrates the results in the rubber pots as compared with clay pots. Maidenhair fern was used as an indicator plant. The plants were grown in an office window and were practically equal when potted, 50 days before the photograph was made. At the time of photographing, the larger number of old and new fronds in the rubber pots indicated that the plants in these pots were the more thrifty. In Table 6 is given the count of old, new, and total fronds of each pot. The rubber pots are slightly flexible and the two in the photograph have been in use for over a year without any sign of deterioration.

<sup>5</sup> Manufactured by the Fisk Rubber Company, Chicopee Falls, Massachusetts.

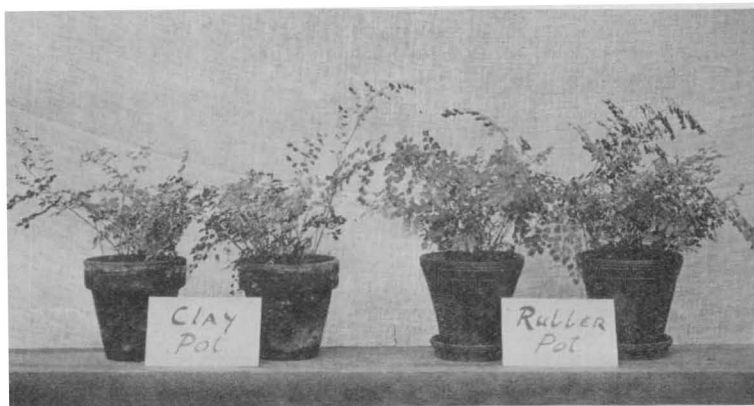


Fig. 4.—Maidenhair Fern in Rubber and Clay Flower Pots.

TABLE 6.—LIVING FRONDS OF MAIDENHAIR FERNS, FIFTY DAYS IN CLAY AND RUBBER FLOWER POTS.

	Clay pots		Rubber pots	
	No. 1 <i>Number</i>	No. 2 <i>Number</i>	No. 1 <i>Number</i>	No. 2 <i>Number</i>
Good fronds	24	23	56	31
New fronds	6	3	18	19
Total living fronds	30	26	74	50

### Discussion

The type of pot, porous or non-porous, determines the method of culture to be used. The standard clay, porous flower pot, employed by the commercial grower, does not produce good plants in dwelling houses. In order to use this pot successfully, it must be kept on a bed of moist material so that the evaporated water may be replaced from outside the pot instead of from the moisture within the pot. Thus, a pot may be porous or vitreous without any injury occurring to the plant if cultural practices are adapted to the type of pot. The non-porous pot is adaptable to the requirements of house and office culture of ornamental plants, and may even be used by the commercial grower with special advantage if plants are to be shipped.

The porous pot may be made non-porous by filling the pores with paint, or similar preparations. The non-porous containers may be made of waterproofed fibers, glass, any vitreous material, or any synthetic substance that can be poured into a mould or stamped out, as metal. It should be kept in mind, however, that there should be no soluble chemical in the substance of the pot that will be harmful to plants. Should there be decomposable materials in the pot, nitrogen deficiency would probably occur.

### Summary

An investigation has been made of the effect of flower pot composition on plant growth. Flower pots are either porous or non-porous. This character of porosity in any pot determines the cultural practice to be followed for good growth. The porous pot, because of its evaporating surface, allows the soil to dry out unless a means is provided for the pot itself to take up moisture from some outside source. The porous pot, when dry, can adsorb one-half the normal daily application of water given to 3, 4, 5, and 6-inch sizes, and one-third the amount given to a 7-inch pot. The evaporation of moisture from the outside surface of the pot has a cooling effect on the soil; but this cooling of the soil has no effect on plant growth. About twice as much water is lost from a porous pot by evaporation as from a non-porous pot in the same period of time.

The relative humidity of houses and offices is so low during the heating months of the year that the evaporating power of the air frequently dries out the lower half of the mass of soil in a clay or porous pot. The roots in this section, therefore, are killed, weakening the plant so that it gradually dies. The moisture deficit caused by the excessive evaporation is seldom made up by the daily watering of plants.

Paper pots, properly protected from the activities of micro-organisms, will produce as good growth as can be obtained in glass or clay pots. However, if decomposition is in progress, the organisms make use of the available nitrogen in the soil and the plant suffers from nitrogen starvation. This nitrogen deficiency may be overcome by the addition of available nitrogen to the soil in excess of what can be utilized by the micro-organisms.

The method of testing, with a variety of materials for water-proofing paper fibers, is described. Better growth was obtained by the use of a disc in the bottom of the paper pot used in the experiments. This disc served to prevent the leaching of nutrients and also aided in the retention of the root system within the pot.

The most practical paper pot was one in which the fibers were impregnated and bound together with asphalt. These paper pots produced plants equal to those grown in glass and clay pots.

Glass containers may be used successfully for plants. With a glass pot, or any non-porous pot, care must be taken not to over-water the soil. Compared with the watering of porous pots, the frequency for watering a non-porous pot may be cut in half. There should be more soil in a non-porous pot than in a porous pot to prevent excessive applications of water. Glass containers are particularly valuable for the home and office, or in atmospheres with a low humidity. They conserve the moisture, which is evenly distributed in the soil of the container.

Rubber flower pots represent a type of non-porous pot moulded from a synthetic substance. These pots produced good plants and are more permanent and less breakable than glass or clay pots.

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