THE EFFECTS OF APPLYING WATER AND/OR FERTILIZER THROUGH WICKS ON THE GROWTH AND FLOWERING OF POTTED PLANTS

By

JACK DELMAR TRIPLETT, JR.

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Oklahoma State University

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Thesis Approved:

Samuel C. Wiggans
Thesis Adviser

H B. Cordner

Dean of the Graduate School

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CHAPTER I

INTRODUCTION

Careful and frequent examination is required to determine when a potted plant needs water or fertilizer. The commercial florist has an old saying, "the man with the hose determines the quality of the crop." Proper fertilization of potted plants also requires much skill and experience.

When potted plants are watered manually it is difficult to get a uniform distribution of water throughout the soil. Excessive watering may wash the fine particles down between the large particles, thus filling the pore spaces and causing compaction and poor aeration. On the other hand, too little watering causes an uneven soil moisture distribution which may result in poor plant growth.

In the latter part of the 19th century (22) sub-irrigation was first introduced into greenhouses as a means of reducing the labor required to water plants. Since then several semi-automatic watering systems such as the constant water level, wick watering, and various overhead watering devices have been designed to reduce the time and labor required to produce quality crops.

In preliminary investigations at Oklahoma State University a "Watcon" wick,[1] which was covered with black polyethylene plastic, was used to

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[1]Purchased from New Bern Nurseries, New Bern, North Carolina.

water potted plants. The results (16) using these wicks were quite promising and indicated that wick watering might be adapted to the growth of many commercially grown potted plants.

The study reported here was made to determine the feasibility of using wicks to apply both water and high analysis, soluble fertilizers to potted plants. Investigations also were made in which a nutrient-charged synthetic ion exchange compound was incorporated into the potting soil which was watered both manually and through wicks.

CHAPTER II

LITERATURE REVIEW

One of the most important components necessary for plant growth is water (18). It occurs as a part of most enzymatic and chemical reactions in plant cells. It also serves as the medium through which food and various other products are translocated from one part of the plant to another. An adequate supply of water is necessary to fill the vacuoles and to keep the tissues turgid.

Water may be taken into the plant by imbibition, osmosis, or through passive absorption (14, 18, 34). As the moisture content in the protoplasm and in the cell walls of the roots is decreased the attraction of the roots for water increases, thus resulting in imbibition of moisture. Water is absorbed by osmosis when the cell solution of the epidermal cells of the roots is more concentrated than is the external soil solution. Passive absorption occurs when water is transpired from the leaves and stems of the plant at such a rate that a suction tension is created which draws water from the roots.

Water moving through the soil is of two kinds, gravitational and capillary (10). Gravitational water is that water which moves downward as a result of the pull of gravity. It is usually not very important as far as plant growth is concerned and is present only where the quantity of water in the soil exceeds the field capacity. Capillary water is that water which moves through the soil due to the attraction of like particles

for each other. It furnishes most of the water necessary for plant growth and is represented as that quantity of water in the soil between field capacity and the permanent wilting point.

The rapidity of movement of water by capillary attraction is dependent on a number of factors, some of the most important of which are: (A) Soil Type. Post and Seeley (20) state, "The ability of soils to move water by capillarity varies with soil types and, in general, soils of organic nature appear to move the capillary water less effectively than mineral soils." (B) Directon of Water Movement. Lateral movement of capillary water is usually slower than vertical movement (36). This is thought to be partially due to the force of gravity. (C) Soil Moisture Content. In dry soils the rate of water movement is slower than in wet soils. Magisted and Breazeale (12) and Stallings (36) showed that the rate of water movement in dry soils is not sufficient to supply the needs of most plants. As the soil becomes dryer the roots have to expend a greater amount of energy to obtain moisture (12, 20, 21). On the other hand, with an increasing soil moisture content, the water film surrounding the soil particles becomes thicker and the soil moisture tension is lessened (20, 25, 34).

The capillary potential concept was first introduced in 1907 by Buckingham (2). He defined capillary potential as the gradient which is equal in magnitude to the capillary force. He assumed that the capillary force was generated by the attraction of moist soil for water. In 1922 Gardner, et al. (5) showed that the capillary potential was actually the pressure potential due to the differential pressures on either side of the liquid-gas interface in the menisci of the water film. It was first measured directly as the negative hydrastatic pressure within the water film surrounding the soil particles. In recent years, other methods of

measuring the capillary potential have been devised including the tensiometer (24, 26, 27), the pressure membrane (23), and the pressure plate (25).

In order to produce high quality potted plants, care in watering must be taken to prevent washing and packing of the soil. It is also important that the soil be thoroughly moistened without getting the foliage wet (18). Too little or too much water in the soil may have a detrimental effect on the growth and quality of the crop. Water generally is applied from overhead. Subsurface irrigation, however, may be employed under certain conditions (10, 11) although the conventional method of applying water from overhead through a hose is still widely used. Various semi-automatic watering systems have been devised in recent years to reduce the amount of hand labor required to water potted plants (10, 11, 18).

Rame (22) first reported good plant growth in 1893 when he sub-irrigated greenhouse groundbeds. In 1895, Green and Green (6) used sub-irrigation in water-tight greenhouse benches.

The sub-irrigated, semi-automatic, watering system described by Post (17) in 1939 and Seeley (29) in 1948 produces plants of the same quality as those obtained from surface watering. This system requires a water-tight bench and a means of raising and lowering the water level in the bench. Water is usually pumped into the bench until the pots are from 1/4 to 3/4 submerged. The bench is drained when the surface of the soil in the pots becomes moist. This procedure is repeated when the pots again need water. Fewer plant roots grow out of the bottoms of the pots which were watered by this method than those which are watered manually from

overhead with a hose (17).

In the constant water level system (11, 29), the surface of the water is maintained at a constant level at or just below the junction of the gravel and the pots in a water-tight bench. Surface application of liquid fertilizer can be made although an occasional leaching may be necessary. This system is efficient, and good crop quality can be obtained, but the high cost of building the water-tight benches make it uneconomical.

The copper tube method of watering (19, 29) can be used without a water-tight bench as in the sub-irrigated and the constant water level systems. In this system the water is turned on and off by means of a solenoid valve connected to a time clock (20). Since diseases can be a problem due to foliage being damp for a period of time, this system is best suited for those crops in which good lower foliage is not important such as in cut flower crops grown in benches.

The sub-irrigated (17, 20, 32), constant water level (29,32) and the copper tube semi-automatic methods (19) of watering also have been used sucessfully in cut flower benches.

Recently the "Chapin" device for watering potted plants (15) has been developed. It utilized small tubes through which water flows into the soil from the surface of each pot. Water pressure and gravity rather than capillarity are the moving forces here.

The "E-Flowmatic" watering device (1, 4) also has been used recently with good success. In this system reservoirs are spaced down the bench with small tubes running down into the pots. The plants are watered by turning on a valve for approximately 90 seconds. This system also uses water pressure and gravity rather than capillarity.

The use of wicks for watering potted plants is not new. In 1943

Post and Seeley (20) reported the successful use of wicks for watering potted plants. They stated that watering by means of a basal wick was more satisfactory for extending the usable life of plants in the house than was manual watering.

Many materials, including asbestos, clay, glass cloth, burlap, and cheesecloth, have been tested for use as wick cores since regular cotton lamp wicks conduct water too slowly and are not satisfactory for watering plants (20). In these tests it was found that wick diameter had little or no effect upon the moisture content of the soil as long as it provided proper conditions for the movement of water. The distance from the surface of the water to the surface of the soil through which the wick transports water was found to be extremely important in determining the moisture content of the soil (3, 20).

When wicks are used to water plants the soil should be thoroughly moistened by surface watering to establish capillarity both when the wicks are applied and whenever the soil has been allowed to become dry (20). When the soil is allowed to become too dry it does not readily regain the phenomena of capillarity.

Shanks (33) working with poinsettias, encountered difficulties with wick watering in field soil or mixes of field soil and various amendments. Lack of capillary movement of water in these mixtures made it necessary to add water to the pots occasionally by hand. In the peat moss or mixtures of peat moss with various amendments, or half soil and half peat moss, no hand watering was necessary. Plastic pots also helped to reduce the need for hand watering. The use of sand as an amendment to either soil or peat moss generally produced the poorest plants. The use of the half soil and half peat moss mixture as a standard treatment was as satis-

factory as any of the mixtures used. Poinsettias watered by wicks in the home remained fresh for a long period of time.

Potted chrysanthemums which were wick watered gave similar results to those obtained with poinsettias (33). It was noted that chrysanthemum plants grown in clay pots also required more supplementary watering than they did in plastic pots. Chrysanthemums kept as well in homes as poinsettias when watered only by wicks.

The proper and efficient use of fertilizer is essential to the growth of good greenhouse potted plants. Soil testing provides a means of determining the fertilizer needs of the soil. Soil tests are of three types: total analysis, partial analysis, and quick tests (13). The first two are of little value in making recommendations for greenhouse soil management practices. The quick test is rapid and better suited for use in the florist industry. The Spurway system, developed at Michigan State University by Dr. C. H. Spurway (35), or modifications of this system is most generally recommended for greenhouse use.

Soluble salts constitute the total organic and inorganic fertilizer materials that are contained in a soil at any given time (9, 10, 28, 37). The soluble salt level is obtained by diluting soil with either two or five parts distilled water and measuring the conductivity of the resulting solution with a solubridge instrument. The desired range for the solubridge reading with a one part soil to five parts water solution is between 30 and 80 (9, 10, 28, 37). Kiplinger (9) states that if the solubridge reading is continuously high, the grower is applying fertilizer too liberally or too often, the soil is not being watered heavily enough, or a combination of these factors may exist. One effect of a high solubridge reading is that it exerts a drying action on the roots which

eventually causes wilting and death of the plant. Too low a solubridge reading indicates the plant nutrients are not available in sufficient amounts to produce satisfactory plant growth.

The desired range of the soil pH varies with the type of plant which is being grown (10, 18). The optium pH level in the soil, in general, is between 6.0 and 7.0. The pH of the soil influences the nutrient availability and the amount of nutrients which are available for the plant.

The soil medium is usually deficient in one or more of the major essential nutrients, nitrogen, phosphorous, or potassium, which must be supplied from external sources. If the soil is deficient in some minor element this too must be supplied in adequate amounts for good plant growth. Fertilizers may be applied at various times in either dry or water soluble forms. The rate of fertilizer application varies with the soil medium, the time of year, the kind of crop, and the stage of growth (8, 10, 18).

Dry fertilizer may be incorporated into the soil before planting or added to the soil surface after potting and watered in. Usually a complete fertilizer, such as 5-10-5 containing 20 percent or more of the fertilizer elements, is used (10, 30). At times a single element such as phosphorus is incorporated into the soil and the other elements added after planting. The rate of fertilizer application should be determined by appropriate soil tests.

Several fertilizers available for greenhouse use are high analysis types which are readily soluble in water (10, 30). They are applied in solution form rather than as a dry material. Liquid fertilizers are not new although general usage of liquid fertilizers is relatively new. For many years growers have put manure and water in tanks and then applied the solution to the greenhouse soils (31). Until relatively recently the

use of fertilizers in liquid form for florists crops was not wide-spread. It is now the standard method, however, of applying fertilizer in most greenhouses (10). High analysis liquid fertilizers contain approximately three times as much nitrogen, phosphorus, and potash per pound of fertilizer as do the forms prepared for dry application. It is usually necessary to apply some form of calcium to the soil mixture at planting time or during the growth of the crop when needed since many high analysis soluble fertilizers do not contain an adequate amount of calcium to maintain a favorable pH (10). In general, a solution containing 1 ounce of 15-30-15, 20-10-10, or 20-20-20 per 3 gallons of water may be applied to the soil periodically at regular intervals or when a soil test indicates a need (8, 10, 18, 30).

The injection of soluble fertilizer into the water lines results in watering with a dilute concentration of fertilizer each time the soil is watered. The concentration varies with the crop as well as the time of year but, in general, it is within the range of 6-12 ounces of 20 percent nitrogen with or without other elements per 100 gallons of water (8, 10).

Recently, newer types of carriers for fertilizers have been developed such as nutrient-charged synthetic ion exchange resins. Tydex-C (7), which includes nitrogen, phosphorous, and potassium in addition to the minor elements that may sometimes be deficient in the greenhouse soils, has been used with success on many greenhouse plants. Fertilizing by the use of a nutrient-charged synthetic ion exchange compound, a "non-burning" fertilizer material, is continuous and self-regulating. As the nutrient supply in the ion exchange compound becomes depleted, additional fertlizer may be added so that only occasional fertilization will suffice if

the growing period is longer than first intended.

Handley, et al. (7) showed that when adequate exchangeable nitrogen was supplied chrysanthemum growth was at least as good as it was when liquid fertilizer was supplied overhead.

CHAPTER III

MATERIALS AND METHODS

Experiments were conducted to determine the effects of the application of water and fertilizer through wicks on the growth and flowering of potted plants of four species, chrysanthemum (Chrysanthemum morifolium), hydrangea (Hydrangea macrophylla), lily (Lillium longiflorum), and poinsettia (Euphorbia pulcherrima). The effect of a nutrient-charged synthetic ion exchange compound (Tydex-C)[2] on the growth and flowering of these species also was studied.

All experiments were conducted in the Oklahoma State University Horticulture Department greenhouse. The greenhouse was maintained at approximately a 70° to 75° F. day temperature and a 60° F. night temperature[3]. The experiments on wick placement and fertilizer application rates were conducted under a glass roof while those with Tydex-C were conducted under a translucent fiberglass roof.

The wicks used in this study are available commercially. The core of the wick is made of orlon and is covered with black polyethylene plastic.

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[2] 3.2% N, 3.5% P, 2.45% K. Supplied through the courtesty of Geo. J. Ball, Inc., West Chicago, Illinois.

[3] From November 6 to December 8 the day temperature was maintained at 65° F.

A raised, sand-filled greenhouse bench was especially prepared for use in the wick placement experiments. All of the sand was removed from the bench except a one inch layer in the bottom. An 8 mil black polyethylene plastic lining was then placed over the sand to make an open-top water-tight reservoir (Figure 1). The reservoir was filled with water containing 10 ounces of 20-20-20 fertilizer per 100 gallons of water. Algae growth was controlled by adding 10 ppm of copper sulfate. Redwood slats on which the pots were set were spaced at intervals over the reservoir. The fertilizer solution level was maintained about 2 to 3 inches below the bottom of the pots. A completely randomized design was used for these experiments.

A raised, soil-filled, greenhouse bench was used for the fertilizer application rate experiments. Small depressions which held approximately 5 gallons of liquid were dug out and lined with the black polyethylene plastic (Figure 2). The plants were placed beside the reservoirs, thus permitting the wicks to extend down into the water containing various concentrations of 20-20-20 fertilizer in solution. The solutions in the reservoirs were kept at a constant level, 1 to 2 inches below the bottoms of the pots, by adding additional solution every day. Ten ppm copper sulfate was added to the reservoirs at the start of each experiment to control algae. A randomized block design was used for these experiments.

Another raised, soil-filled greenhouse bench was utilized for experiments in which various concentrations of Tydex-C were incorporated into the soil potting mixture. Two troughs, each 8 inches wide and 4 inches deep, were dug lengthwise in the bench and lined with black polyethylene plastic. They were then filled with tap water and covered with the plastic. The pots were placed beside the troughs and the wicks inserted through

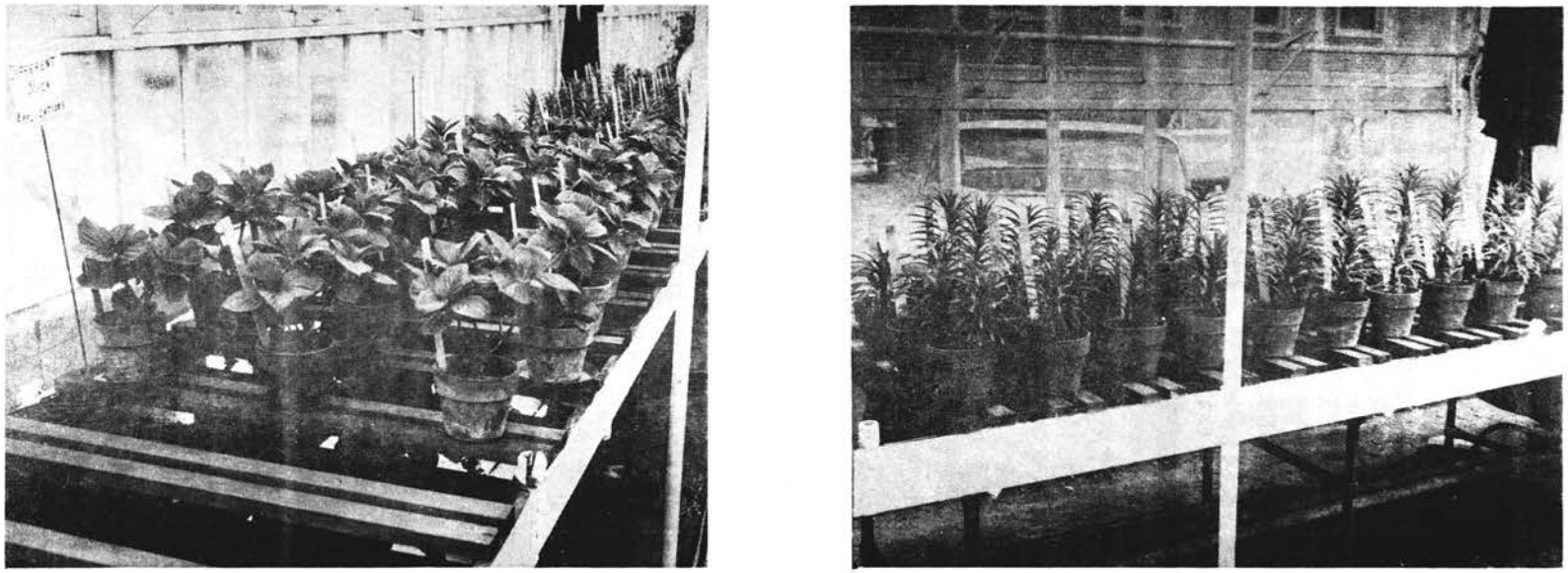


Figure 1. Placement of plants over the 200-gallon, open-top reservoir, showing hydrangeas (left) and lilies (right).

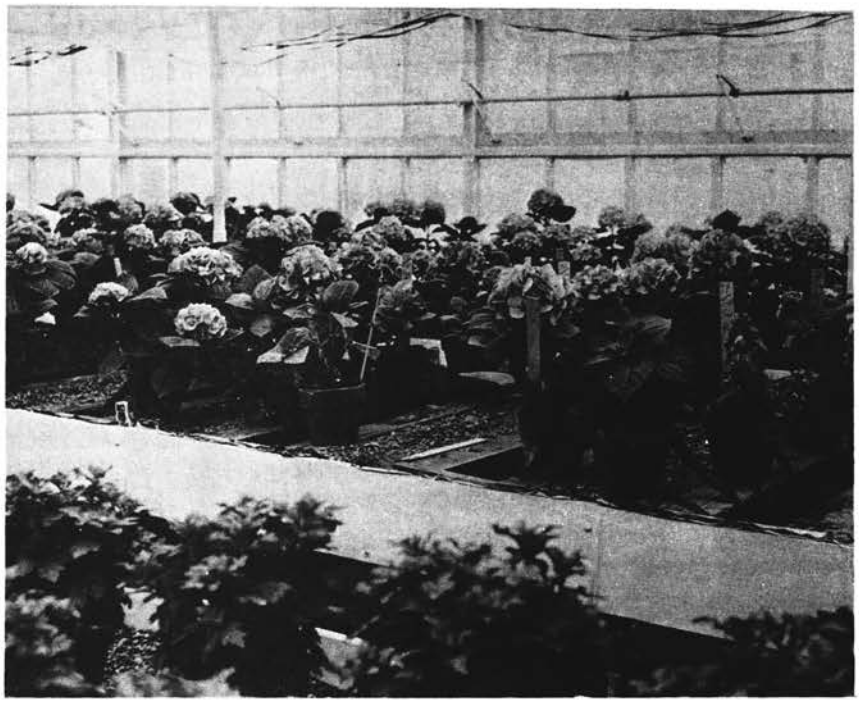


Figure 2. Wick watering of hydrangeas from 5 gallon reservoirs.

slits into the water, which was maintained at a level 1 to 1 1/2 inches below the bottom of the pots. A completely randomized design was used for these experiments.

The basic soil mixture used throughout the study consisted of equal parts of soil, sand and Canadian peat moss combined with 45 grams of hydrated lime for each cubic foot of soil mixture. The wicks were pre-soaked in tap water for several hours before being inserted into the pots.

Soil tests were made at the beginning of and at the termination of each experiment. Various observations and growth measurements were made on the plants during the course of and at the conclusion of each experiment.

Chrysanthemum (*Chrysanthemum morifolium*)

Wick Placement Experiment:

This experiment was started November 16 and terminated January 30, 76 days later. Five uniformily rooted cuttings, var. Yellow Delaware, were planted in 5½-inch clay and plastic pots. One or two wicks, 12 to 15 inches long, were placed with one end in varying locations in the pots. The other end of the wick extended from 2 to 4 inches below the surface of the solution of the reservoir containing 10 ounces of 20-20-20 fertilizer per 100 gallons of water. Pot spacing was 13 inches by 15 inches. All plants were given 4 hours of light in the middle of the night from November 16 to December 1. They were then "soft-pinched" and the supplemental light removed. There were five wick placement treatments with both the clay and plastic pots: (A) *Check*. Plants in this treatment were watered manually as needed with 10 ounces of 20-20-20 fertilizer per 100 gallons of water at every watering. (B) *One Top Wick*. About 4 inches

of the plastic sheath was peeled back from the end of the wick. The exposed core was then spread evenly over the moist soil in the pot and covered with about 1/2 inch of moist peat moss. The other end of the wick extended over the side of the pot into the reservoir. (C) Two Top Wicks. Two wicks, treated as in (B) above, were located on opposite sides of the pot. (D) One Bottom Wick (Spread). About 4 inches of the wick extended up through the hole in the bottom of the pot. The plastic sheath was peeled back about 3 inches and the exposed core spread evenly over 1/2 inch of moist peat moss on the bottom of the pot. The pot was then filled with the potting soil and another 1/4 inch of moist peat moss placed on the surface after planting. (E) One Bottom Wick (Core). About 4 inches of the wick extended up through the hole in the bottom of the pot. The plastic sheath again was peeled back about $3\frac{1}{2}$ inches, exposing the wick core. The core was immediately surrounded by the potting soil and 1/4 inch of moist peat moss placed on the surface after planting. From December 9 to December 27 all pots in treatments D and E were elevated additionally by being placed on top of $5\frac{1}{2}$-inch pots. They were then "soft-pinched" and the supplemental light removed. At the conclusion of the experiment measurements were made on plant quality, number of breaks (flowering shoots) per pot, percent of mature inflorescences, maximum plant height, above ground dry weight, and root condition (Figure 3).

Fertilizer Rate Experiment:

This experiment was started November 29 and terminated February 14, 78 days later. Five uniformly rooted cuttings, var. Yellow Delaware, were potted in $5\frac{1}{2}$-inch clay pots. All pots were given 4 hours of supplemental light in the middle of the night and watered manually with tap water from November 29 to December 13. In addition, they were watered

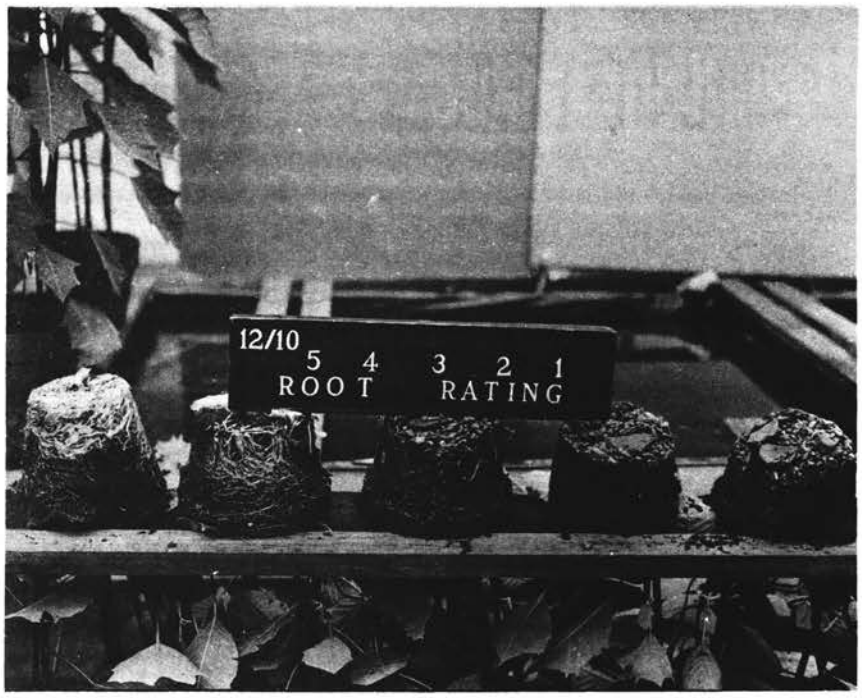


Figure 3. Roots of poinsettia plants illustrating the 5 levels of root development used as a visual standard rating in all experiments.

December 3 with a solution containing 1 ounce of 20-20-20 per 3 gallons of water. On December 13 all plants were "soft-pinched" and the supplementary light source removed. About 3 inches of a single wick was peeled back and the core spread evenly over the soil surface of each pot. It was then covered with moist peat moss. The free end of the wick extended over the side of the pot down into a 5-gallon reservoir. There were seven fertilizer treatments: (F) Check. Plants in this treatment were watered manually with tap water as needed and fertilized with a solution containing 1 ounce of 20-20-20 per 3 gallons of water every 10 days. (G) Tap Water in Reservoir Plus Manual Fertilized Check. No fertilizer was added to the reservoir, but the plants were fertilized manually with a solution containing 1 ounce of 20-20-20 in 3 gallons of water every 10 days. (H) Tap Water. No fertilizer was added to the reservoir. (I) 5 Ounces. 20-20-20 fertilizer was added to the reservoir at the rate of 5 ounces per 100 gallons of water. (J) 10 Ounces. 20-20-20 fertilizer was added to the reservoir at the rate of 10 ounces per 100 gallons of water. (K) 20 Ounces. 20-20-20 fertilizer was added at the rate of 20 ounces per 100 gallons of water. (L) 40 Ounces. 20-20-20 fertilizer was added at the rate of 40 ounces per 100 gallons of water. There were six pots per treatment. At the conclusion of the experiment the following measurements were taken: plant quality, number of breaks (flowering shoots) per pot, color and condition of foliage, maximum plant height, dry weight of inflorescences, dry weight of leaves and stems, and root condition (Figure 3).

Tydex-C Fertilizer Experiment:

This experiment was started November 2 and terminated January 24, 83 days later. Two uniformily rooted cuttings, var. Yellow Delaware, were planted in 4-inch clay pots. The plants in each of the treatments were

watered either manually or with one top wick. Two inches of the exposed wick core was spread evenly over the top of the pot, and then, covered with 1/2 inch of moist peat moss. The free end extended over the side of the pot and down into the plastic covered trough filled with tap water. The plants were "soft-pinched" November 12. There were six fertilizer treatments: (M) Check. Watered manually only and fertilized with 1 ounce of 20-20-20 fertilizer per 3 gallons of water every 10 days. (N) No Fertilizer Added. Grown in the standard potting soil mixture. (O) 0.5:19 Tydex-C. One half part Tydex-C to 19 parts of soil mixture. (P) 1:19 Tydex-C. One part of Tydex-C to 19 parts of soil mixture. (Q) 2:19 Tydex-C. Two parts of Tydex-C to 19 parts of soil mixture. (R) 4:19 Tydex-C. Four parts Tydex-C to 19 parts of soil mixture. From December 9 until January 24 all wick watered pots in treatments N, O, P, Q, and R were elevated by placing them on top of 4-inch clay pots. There were 6 pots per treatment. At the conclusion of the experiment the following measurements were taken: number of breaks (flowering shoots) per pot and the total above ground fresh weight. The date of maturity of each inflorescence also was recorded.

Hydrangea (Hydrangea macrophylla)

Dormant hydrangea plants, var. Merveille, in $5\frac{1}{2}$-inch pots, which had been maintained for approximately 2 months in a 45°F. dark cooler were obtained December 28 and immediately placed in the greenhouse. The pots in all experiments were spaced approximately 13 x 15 inches center to center.

Wick Placement Experiment:

This experiment was started December 30 and terminated March 28, 89 days later. One or two wicks, 12 to 15 inches long, were placed with one end in varying locations in the pots. The other end of the wick extending

from 2 to 4 inches below the surface of the surface of the solution in the reservoir containing 10 ounces of 20-20-20 fertilizer per 100 gallons of water. There were four wick placement treatments: (A) Check. Plants in this treatment were watered as described in chrysanthemum treatment A (page 16). (B) One Top Wick. One top wick was applied as described in chrysanthemum treatment B (page 16). (C) Two Top Wicks. Two top wicks were applied as described in chrysanthemum treatment C (page 17). (D) One Bottom Wick (Spread). The soil ball was first removed from the pots, then one bottom wick was applied as described in chrysanthemum treatment D (page 17). The soil ball was then replaced in the pot. There were six pots per treatment. About 3 weeks prior to the termination of the experiment all plants were pruned so that only the 3 best inflorescences remained. At the conclusion of the experiment measurements were made on plant quality, number of inflorescences, percent mature inflorescences, plant height, dry weight of inflorescences, dry weight of leaves and stems, and root condition (Figure 3).

Fertilizer Rate Experiment:

This experiment was started December 30 and terminated March 29, 90 days later. Two wicks were placed on opposite sides in the top of each pot. About 3 inches of the plastic sheaths were peeled back and the wick cores spread evenly over the surface. They were then covered with 1/2 inch of moist peat moss. The free ends of the wicks extended over the side of the pot down into 5-gallon reservoirs. There were seven fertilizer treatments: (F) Check. Plants in this treatment were watered as described in chrysanthemum treatment F (page 19). (G) Tap Water in Reservoir plus Manual Fertilized Check. Plants in this treatment were watered as described in chrysanthemum treatment G (page 19). From December

30 to January 19 these plants were watered with tap water only. (H) Tap Water. Watered as described in chrysanthemum treatment H (page 19). (I) 5 Ounces. Watered and fertilized as described in chrysanthemum treatment I (page 19). (J) 10 Ounces. Watered and fertilized as described in chrysanthemum treatment J (page 19). (K) 20 Ounces. Watered and fertilized as described in chrysanthemum treatment K (page 19). (L) 40 Ounces. Watered and fertilized as described in chrysanthemum treatment L (page 19). There were six pots per treatment. About 3 weeks prior to the termination of the experiment all plants were pruned so that only the 3 best inflorescences remained. At the conclusion of the experiment measurements were made on plant quality, number of inflorescences, sepal color, color and condition of foliage, maximum plant height, dry weights of inflorescences, dry weight of leaves and stems, and root condition (Figure 3).

Lily (Lilium longiflorum)

Pre-cooled 8 to 9 inch lily bulbs, var. Ace, were used. Single bulbs were potted deeply in 5½-inch clay pots and placed in the greenhouse November 29. All lily experiments were terminated March 21, 112 days later. The pots were spaced approximately 8 x 10 inches center to center.

Wick Placement Experiment:

One or two wicks, 12 to 15 inches long, were placed with one end in varying locations in the pots, and the other end from 2 to 4 inches below the surface of the reservoir containing 10 ounces of 20-20-20 fertilizer per 100 gallons of water, on November 29 or on December 22. There were four wick placement treatments for each date: (A) Check. Plants were watered as described in chrysanthemum treatment A (page 16). (B) One Top

Wick. One top wick was applied as described in chrysanthemum treatment B (page 16). (C) Two Top Wicks. Two top wicks were applied as described in chrysanthemum treatment C (page 17). (D) One Bottom Wick (Spread). One bottom wick was applied as described in chrysanthemum treatment D (page 17), and the pot then filled with potting soil. There were six pots per treatment. The pots to which wicks were applied on December 22 were watered as needed with tap water from November 29 to December 22. At the conclusion of the experiment measurements were made on number of buds per plant, foliage tip discoloration, height of die-back above soil surface, maximum plant height, above ground dry weight, and root condition (Figure 3).

Fertilizer Rate Experiment:

The bulbs were potted in the soil mixture and watered manually as needed with tap water. On December 22 about 4 inches of the plastic sheath was peeled back from the end of a single wick, the exposed core spread evenly over the moist soil surface, and then covered with 1/2 inch of moist peat moss. The free end of the wick extended over the side of the pot down into a 5-gallon reservoir. There were four fertilizer treatments: (H) Tap Water. Watered as described in chrysanthemum treatment H (page 19). (I) 5 Ounces. Watered and fertilized as described in chrysanthemum treatment I (page 19). (J) 10 Ounces. Watered and fertilized as described in chrysanthemum treatment J (page 19). (K) 20 Ounces. Watered and fertilized as described in chrysanthemum treatment K (page 19). There were 6 pots per treatment. At the conclusion of the experiment the following measurements were taken: number of buds per plant, percent open buds, foliage color, foliage tip discoloration, maximum plant height, and above ground dry weight.

Tydex-C Fertilizer Experiment:

The bulbs were planted in the various media and watered manually as needed with tap water until December 22. The exposed core of a single wick was then spread evenly over the top of each pot and covered with 1/2 inch of moist peat moss. The other end of the wick extended over the side of the pot and down into the trough filled with tap water. There were five fertilizer treatments: (M) Check. Watered and fertilized as described in chrysanthemum treatment M (page 20). (N) No Fertilizer: Grown in the same soil mixture as described in chrysanthemum treatment N (page 20). (O) 5:19 Tydex-C. Grown in the same soil mixture as described in treatment O (page 20). (P) 1:19 Tydex-C. Grown in the same soil mixture as described in chrysanthemum treatment P (page 20). (Q) 2:19 Tydex-C. Grown in the same soil mixture as described in chrysanthemum treatment Q (page 20). There were 6 pots per treatment. At the conclusion of the experiment the following measurements were taken: number of buds per plant, foliage color, height of die-back above soil surface, maximum plant height, above ground dry weight, and root condition (Figure 3).

Poinsettia (Euphorbia pulcherrima)

Wick Placement Experiment:

This experiment was started October 5 and terminated December 10, 66 days later. Rooted cuttings, var. Indianapolis Red, which were potted in $2\frac{1}{2}$-inch pots and had been under long day photoperiod conditions were purchased and placed in the greenhouse September 27. Three uniform plants with an average height of about 12 cm were potted in both 6-inch clay and plastic pots on October 5. All pots were then watered with a solution containing 1 teaspoonful of "Panodrench" per 3 gallons of water after potting.

One or two wicks 12 to 15 inches long were placed with one end in varying locations in the pots. The other end extended from 2 to 4 inches below the surface of the reservoir which contained 10 ounces of 20-20-20 fertilizer per 100 gallons of water. The pots were spaced 13 x 15 inches center to center. There were five treatments: (A) Check. Watered and fertilized as described in chrysanthemum treatment A (page 16). (B) One Top Wick. One top wick applied as described in chrysanthemum treatment B (page 16). (C) Two Top Wicks. Two top wicks applied as described in chrysanthemum treatment C (page 17). (D) One Bottom Wick (Spread). One bottom wick applied as described in chrysanthemum treatment D (page 17). (E) One Bottom Wick (Core). One bottom wick applied as described in chrysanthemum treatment E (page 17). There were six pots per treatment. At the conclusion of the experiment measurements were made on bract diameter, bract area, increase in plant height, root condition (Figure 3), and "house-life". (Number of days plant kept at room temperature until 2 of the 3 plants in the pot were not attractive).

Fertilizer Rate Experiment:

This experiment was started October 8 and terminated December 15, 68 days later. Uniform cuttings, var. Indianapolis Red, were obtained from stock plants and rooted under intermittant mist in $2\frac{1}{2}$-inch clay pots August 25. All plants were given 4 hours of supplementary light in the middle of the night until October 5. Two uniform plants, about 11 cm. tall, were potted October 8 in $5\frac{1}{2}$-inch clay pots. The plants were watered with a solution containing 1 teaspoonful of "Panodrench" per 3 gallons of water. All pots were watered through one or two wicks, 12 to 15 inches long, placed in the top of each pot. About 4 inches of the plastic sheath was peeled back and the exposed core spread evenly over soil surface of each

pot. It was then covered with moist peat moss. The free end of the wick extended over the side of the pot down into a 5-gallon reservoir. There were six treatments: (G) Tap Water in Reservoir plus Fertilizer Applied Manually. All plants were fertilized manually as described in chrysanthemum treatment G (page 19). (H) Tap Water. Watered as described in chrysanthemum treatment H (page 19). (I) 5 Ounces. Watered and fertilized as described in chrysanthemum treatment I (page 19). (J) 10 Ounces. Watered and fertilized as described in chrysanthemum treatment J (page 19). (K) 20 Ounces. Watered and fertilized as described in chrysanthemum treatment K (page 19). (L) 40 Ounces. Watered and fertilized as described in chrysanthemum treatment L (page 19). There were 3 pots per treatment. At the conclusion of the experiment the following measurements were taken: bract diameter, bract area, increase in plant height, root condition (Figure 3) and reflectometer reading (measure of reflection - low numbers indicate dark green color and high numbers indicate light green color) on the upper surface of the top and third from the bottom leaves of the plant.

Tydex-C Fertilizer Experiment:

This experiment was started October 25 and terminated December 21, 57 days later. Cuttings, var. Indianapolis Red, were taken from stock plants and rooted as in the fertilizer rate application experiment above. They were watered and fertilized as needed until October 25 when two plants, 17 cm. tall, were potted in $5\frac{1}{2}$-inch clay pots. After the plants were potted they were watered in with 1 teaspoonful of "Panodrench" per 3 gallons of water. The pots in each treatment were watered either manually or with wicks. About 4 inches of a single wick was exposed and spread over the top of the pot. It was then covered with 1/2 inch of moist peat moss.

The free end of the wick extended over the side of the pot and down into the trough filled with water. There were six treatments: (M) Check. Watered and fertilized as described in chrysanthemum treatment M (page 20). (N) No Fertilizer Added. Grown in the same soil mixture as described in chrysanthemum treatment N (page 20). (O) 0.5:19 Tydex-C. Grown in the same soil mixture as described in chrysanthemum treatment O (page 20). (P) 1:19 Tydex-C. Grown in the same soil mixture as described in chrysanthemum treatment P (page 20). (Q) 2:19 Tydex-C. Grown in the same soil mixture as described in chrysanthemum treatment Q (page 20). (R) 4:19 Tydex-C. Grown in the same soil mixture as described in chrysanthemum treatment R (page 20). There were six pots per treatment. At the conclusion of the experiment the following measurements were taken: bract diameter, increase in plant height, root condition (Figure 3), and reflectometer reading on the upper surface of the top and third from the bottom leaves of each plant.

CHAPTER IV

RESULTS

Chrysanthemum (*Chrysanthemum morifolium*)

Wick Placement Experiment:

The data in Table I (See Appendix) show the effects of manual and wick watering in both clay and plastic pots on plant quality, number of breaks (flowering shoots) per pot, percent mature inflorescences, maximum plant height, above ground dry weight and root condition. Figure 4 shows the effect of wick placement in potted chrysanthemums, var. Yellow Delaware.

The best average plant quality resulted when the plants were watered and fertilized through two top wicks. The poorest plants were in the one top wick treatments. There was no appreciable difference between clay and plastic pots in the quality of plants produced.

More breaks were obtained from plants in pots which were watered and fertilized through two top wicks or one bottom wick (core) than in any other treatment. There was an over-all average of 1.5 more breaks per pot in the plastic pots.

All inflorescences in the two top wicks treatments were mature at the termination of the experiment, January 31. However, only 61 percent of the inflorescences in the manually watered treatments were mature by this time. The type of pot used made little difference in the date of inflorescence maturity.

The two top wicks treatments produced the tallest average plants while

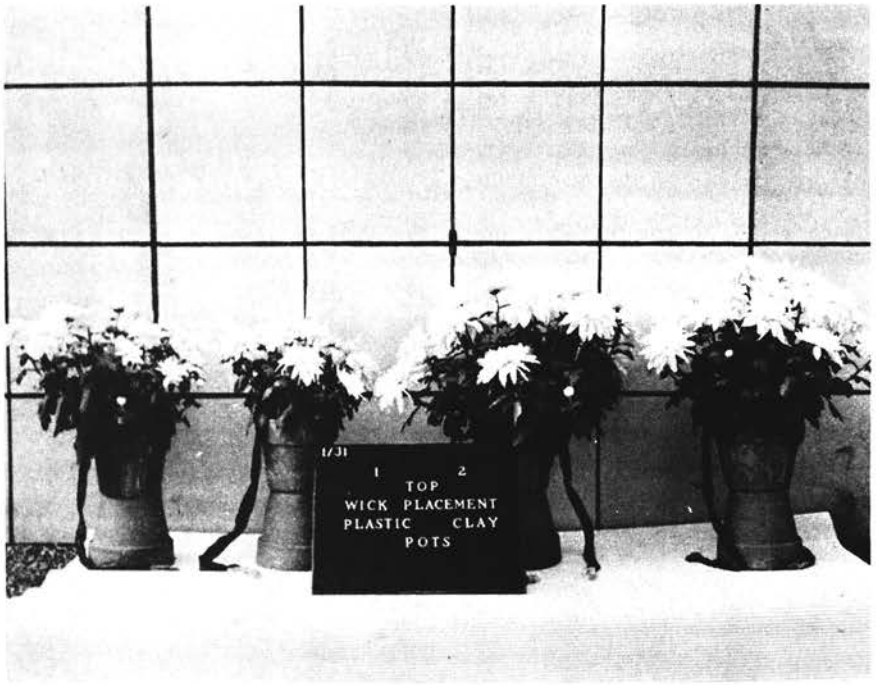


Figure 4. Wick placements in potted chrysanthemums, var. Yellow Delaware. Left to right: one top wick, plastic pot; one top wick, clay pot; two top wicks, plastic pot; two top wicks, clay pot.

those which were watered and fertilized manually were shortest. Again the type of pot used made no apparent difference in the average over-all plant height.

The average dry weight of the above ground plant parts was greatest in the two top wicks treatments and least in the manually watered and fertilized and the one top wick treatments. There was a slight increase in the average above ground dry weight of plants grown in clay pots over those in plastic pots.

The most desirable root condition occurred in the two top wicks treatments and the least in the one top wick treatments. The plants grown in clay pots showed the best over-all root condition.

Fertilizer Rate Experiment:

The data in Table II (See Appendix) show the effects of various concentrations of 20-20-20 fertilizer applied manually or through a single top wick on plant quality, total number of breaks (flowering shoots) per pot, color and condition of foliage, maximum plant height, dry weight of inflorescences, dry weight of leaves and stems, and root condition.

The best average plant quality occurred in the pots which were both watered and fertilized manually, watered with wicks and fertilized manually, or both watered and fertilized by wicks with 10 ounces of 20-20-20 fertilizer per 100 gallons of water. The poorest average plant quality occurred in the wick watered non-fertilized treatment.

There were from 16.0 to 18.5 breaks per pot in all treatments except the non-fertilized treatment which produced an average of only 10.8 breaks per pot.

The color and condition of foliage was satisfactory in all treatments for the wick watered plants except those receiving 0 or 5 ounces of 20-20-20

fertilizer.

The maximum average plant height was obtained in the 10 ounce 20-20-20 fertilizer treatment. The shortest plants were in the non-fertilized treatment.

The greatest average total dry weights of both the inflorescences and of the leaves and stems occurred in plants which were wick watered with 10 ounces of 20-20-20 fertilizer. The average dry weights of both the inflorescences and of the leaves and stems were least in the non-fertilized treatment.

There was a marked decrease in the average root condition as the fertilizer concentration was increased particularly with the wick watered treatments containing 10, 20, or 40 ounces of 20-20-20 fertilizer.

Tydex-C Fertilizer Experiment:

The data in Table III (See Appendix) show the effects of various concentrations of Tydex-C in the soil mixture, watered manually or with one top wick per pot, on the total number of breaks (flowering shoots) per pot, date of maturity, and above ground fresh weight. Figure 5 shows the effect of different concentrations of Tydex-C in the soil, watered with one top wick in 4-inch pots, on the growth and flowering of chrysanthemums, var. Yellow Delaware.

The plants receiving no Tydex-C or 20-20-20 applied manually had the most breaks. Over-all treatments, plants which received Tydex-C or which were fertilized manually were mature at the end of the experiment. In general, plants which were watered manually matured from 2 to 3 days earlier than those which were watered through wicks.

The greatest average above ground fresh weight of plants occurred in the pots which were watered and fertilized manually. Manual watering

Figure 5. The effects of different concentrations of Tydex-C in the soil, watered with one top wick in 4-inch pots, on the growth and flowering of chrysanthemums, var. Yellow Delaware. Left: (left to right) 20-20-20 check, 0, 1/2, and 1.0 times recommended rate of Tydex-C. Right: (left to right) 20-20-20 check, 0, 2, and 4 times recommended rate of Tydex-C. (Recommended rate of Tydex-C is 1 part to 19 parts soil mixture.)

caused a greater fresh weight increase over-all treatments than did wick watering. As the ratio of Tydex-C to soil mixture decreased there was a corresponding average over-all fresh weight decrease.

Hydrangea (*Hydrangea macrophylla*)

Wick Placement Experiment:

The data in Table IV (See Appendix) show the effects of manual and wick watering on plant quality, number of inflorescences, percent mature inflorescences, plant height, dry weight of inflorescences, dry weight of leaves and stems, and root condition.

The best average plant quality occurred when the plants were watered and fertilized through the bottom wick (spread). The poorest average plant quality was in plants which were watered and fertilized through one top wick.

There was no appreciable difference in the average number of inflorescences per plant between the manually watered, the two top wicks, or the single bottom wick treatments. In the one top wick treatment the average number of inflorescences per plant was approximately 2.5.

The inflorescences of plants in the two top wicks and one bottom wick treatments were 78 and 84 percent mature, respectively, at the termination of the experiment. On the other hand the inflorescences of the plants in the one top wick treatment were only 11 percent mature at this time.

The average plant height of the mature hydrangeas was not materially affected by any of the treatments.

The average dry weights of the inflorescences and of the leaves and stems were greatest in plants in the one bottom wick (spread) treatment. They were least in plants grown in the one top wick treatment.

The average root condition of all plants was good except those grown in the one top wick treatment.

Fertilizer Rate Experiment:

The data in Table V (See Appendix) show the effects of various concentrations of 20-20-20 fertilizer, applied manually or through two top wicks, on plant quality, number of inflorescences, sepal color, color and condition of foliage, maximum plant height, dry weight of inflorescences, dry weight of leaves and stems, and root condition. The effects of different concentrations of 20-20-20 fertilizer in the reservoir watered with two top wicks, on the growth and flowering of hydrangeas, var. Merveille is shown in figure 6.

The average plant quality was best in plants which were watered through wicks with solutions of 5 and 10 ounces of 20-20-20, watered and fertilized manually or watered through wicks and fertilized manually. The poorest plant quality occurred in the wick watered treatments containing 0 and 40 ounces of 20-20-20 fertilizer.

With most treatments the average number of inflorescences per plant was approximately 3.0. The 0 and 20 ounces of 20-20-20 treatments, however, produced only 1.5 and 2.0 inflorescences per plant, respectively.

A clear pink sepal color occurred in plants which were watered and fertilized manually or watered through wicks with 20 or 40 ounces of 20-20-20 in 100 gallons of water. A clear blue color occurred only in the sepals of plants which were watered with tap water alone.

The average color and condition of foliage of plants was excellent with all but the 0 and 40 ounces 20-20-20 treatments.

The tallest plants occurred in the 5 ounce 20-20-20 treatment. Plant height in the 40 ounce 20-20-20 treatment was markedly shorter than

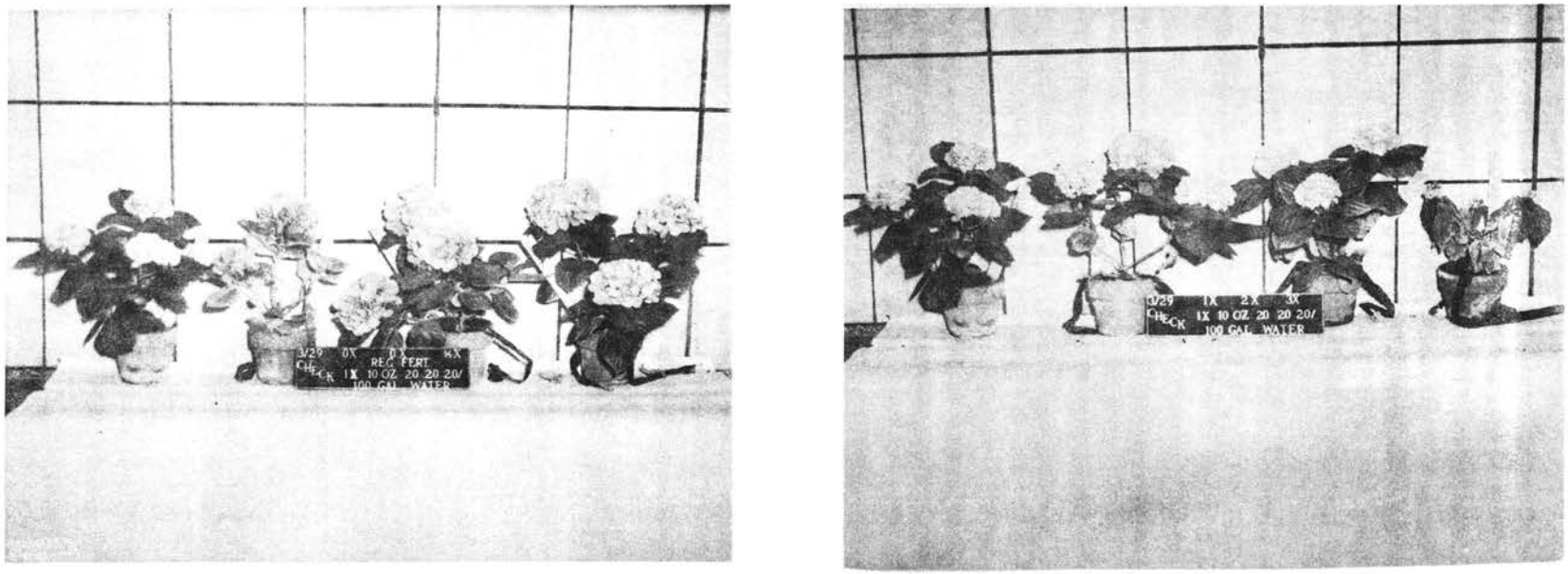


Figure 6. The effects of different concentrations of 20-20-20 fertilizer in the reservoir, watered with two top wicks, on the growth and flowering of hydrangeas, var. Merveille. Left: (left to right) 20-20-20 check, 0, 0 fertilizer in reservoir plus 20-20-20 check, and 1/2 times recommended rate. Right: (left to right) 20-20-20 check, 1, 2, and 4 times recommended rate. The 3X in right picture should read 4X. (Recommended rate is 10 ounces of 20-20-20 per 100 gallons of water in the reservoir.)

in any other treatment.

The greatest average dry weight of inflorescences occurred in the treatments which were watered through wicks and fertilized manually or watered and fertilized through wicks with 5, 10, or 20 ounces of 20-20-20 while the least was in plants given the 0 and 40 ounces of 20-20-20.

The average dry weight of leaves and stems was greatest in the 5, 10, and 20 ounce 20-20-20 treatments and in the manually watered and fertilized treatment. The smallest average stem and leaf dry weights occurred in the wick watered plants which received no added fertilizer.

The best average root condition was obtained in plants in the wick watered and manually fertilized, 5 ounce, and 10 ounce 20-20-20 treatments. The poorest average root condition occurred in plants in the 40 ounce 20-20-20 treatment.

Lily (*Lilium longiflorum*)

Wick Placement Experiment:

The data in Table VI (See Appendix) show the effects of both manual and wick watering and time of wick application on the number of buds per plant, foliage tip discoloration, height of die-back above the soil surface, maximum plant height, above ground dry weight and root condition of Ace lilies.

The various methods of watering resulted in little difference in the average number of buds per plant. There also was very little difference between the two dates of wick placement in relation to the average number of buds per plant.

Neither date of wick application nor wick location made any appreciable difference in the average amount of foliage tip discoloration.

Plants in the one top wick treatment applied November 29 had the most leaf die-back, while those in the two top wicks treatment applied December 22 had the least. The over-all average die-back was somewhat greater for the plants in which wicks had been applied to the pots at the start of of the experiment, November 29.

The tallest plants were obtained in the two top wicks treatments and the shortest in the manually watered treatment. The over-all average plant height was slightly greater when the wicks were applied at the start of the experiment, November 29.

The average above ground plant dry weight was greatest in the two top wicks and one bottom wick treatments and the least in the manually watered treatment. The over-all average above ground dry weight was greatest in plants in which the wicks were placed in the pots on November 29.

The most desirable root condition was in the two top wicks treatments. The poorest average root condition occurred in the manually watered treatment. Date of wick application made little difference over-all treatments in the average root condition.

Fertilizer Rate Experiment:

The data in Table VII (See Appendix) show the effects of various concentrations of 20-20-20 fertilizer applied through one top wick on the number of buds per plant, percent open buds, foliage color, foliage tip discoloration, maximum plant height, and above ground dry weight. Figure 7 shows the effects of different concentrations of 20-20-20 fertilizer in the reservoir watered with one top wick, on the growth and flowering of lilies, var. Ace.

The greatest number of buds per plant were obtained in the 5 ounce

Figure 7. The effects of different concentrations of 20-20-20 fertilizer in the reservoir, watered with one top wick, on the growth and flowering of lilies, var. Ace. Left to right: 0, 1/2, 1, and 2 times recommended rate. (Recommended rate is 10 ounces of 20-20-20 fertilizer per 100 gallons of water in the reservoir.)

20-20-20 treatment while the fewest buds occurred in the 0 and 20 ounce treatments.

The percent of open buds per plant was greatest in the 5 and 10 ounce 20-20-20 treatments. The 0 and 20 ounce treatments had the fewest open buds per plant at the termination of the experiment.

As the concentration of 20-20-20 was increased the foliage color increased with the maximum foliage color occurring in plants grown in the 10 and 20 ounce treatments.

Increasing concentrations of 20-20-20 caused an increase in the average foliage tip discoloration.

The average maximum plant height was decreased as the concentration of 20-20-20 increased with the shortest plants occurring in the 10 and 20 ounce treatments.

The average above ground plant dry weight was greatest in plants in the 5 ounce 20-20-20 treatment and the least in the 20 ounce treatment.

Tydex-C Fertilizer Experiment

The data in Table VIII (See Appendix) show the effects of various concentrations of Tydex-C in the soil mixture watered with one top wick on the number of buds per plant, foliage color, height of die-back above soil surface, maximum plant height above pot, above ground dry weight, and root condition. The effects of different concentrations of Tydex-C in the soil watered with one top wick, on the growth and flowering of lilies, var. Ace is shown in figure 8.

The greatest number of buds was obtained from plants in the 0.5:19 Tydex-C treatment while the fewest occurred in the non-fertilized (0:19) treatment.

Plants in the manually watered and fertilized treatment had the best

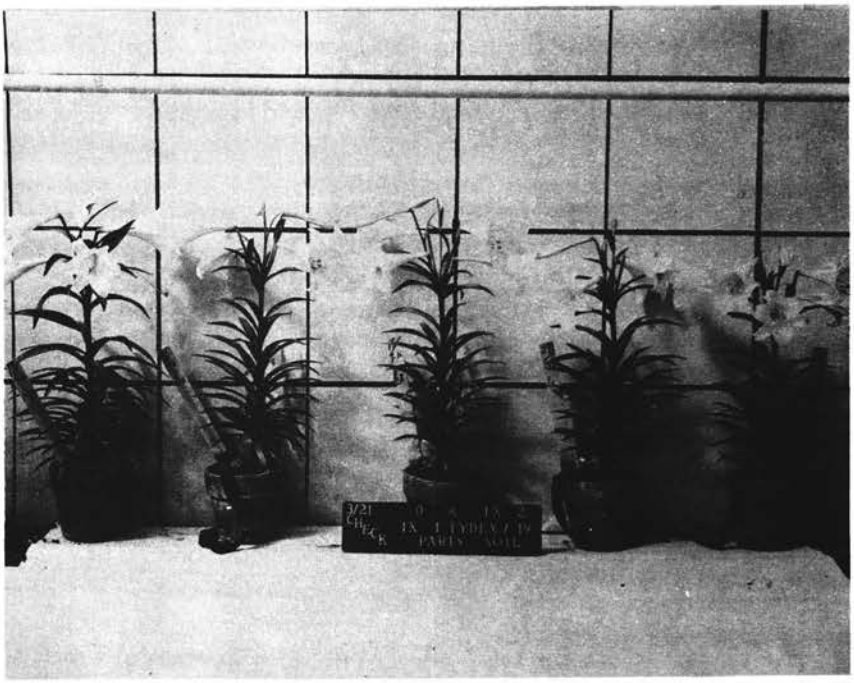


Figure 8. The effects of different concentrations of Tydex-C in the soil, watered with one top wick, on the growth and flowering of lilies, var. Ace. Left to right: 20-20-20 check, 0, 1/2, 1, and 2 times recommended rates of Tydex-C. (Recommended rate of Tydex-C is 1 part to 19 parts soil mixture.)

foliage color while those in the 0:19 treatment showed the poorest foliage color. The different ratios of Tydex-C in the soil made little difference in average foliage color.

The least average die-back occurred in plants which were manually watered and fertilized while the most occurred in the 0:19 Tydex-C treatment.

The 0.5:19 Tydex-C treatment produced the tallest plants. The shortest plants occurred in the 2:19 Tydex-C treatment.

The greatest average above ground plant dry weight was obtained in the 0.5:19 Tydex-C and in the manually watered and fertilized treatments.

The best average root condition occurred in the manually watered and fertilized treatment while the poorest was in the 0.5:19 treatment.

Poinsettia (*Euphorbia pulcherrima*)

Wick Placement Experiment:

The data in Table IX (See Appendix) show the effects of manual and wick watering in clay and plastic pots on bract diameter, bract area, increase in plant height, root condition, and "house life". In figure 9 the effects of different wick placements and number of wicks on the growth and flowering of poinsettias, var. Indianapolis Red are shown.

The average bract diameter was greatest in plants watered through one top wick, two top wicks, or one bottom wick (spread). The smallest average bract diameter occurred in plants in the manually watered treatments. There was no over-all difference in the average bract diameter between plants growing in clay and plastic pots.

Plants in the two top wicks treatments had the greatest average bract area while the smallest bract area occurred in plants which were

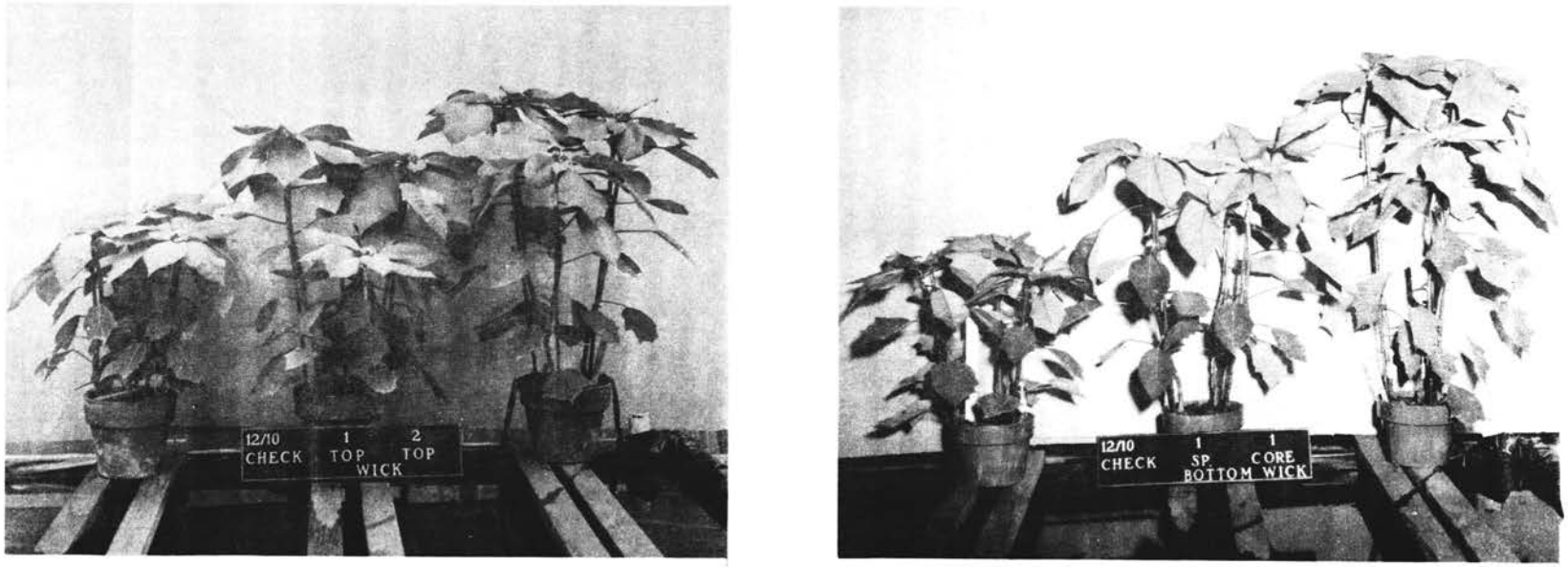


Figure 9. The effects of different wick placements on number of wicks on the growth and flowering of poinsettias, var. Indianapolis Red. Reservoir contains 10 ounces of 20-20-20 per 100 gallons of water. Left: (left to right) 20-20-20 check, 1 top wick, and two top wicks in clay pots. Right: (left to right) 20-20-20 check, 1 bottom wick (spread), and 1 bottom wick (core) in plastic pots.

manually watered. There was no appreciable difference in the average bract area between plants grown in clay or plastic pots.

The bottom wick (core) treatments resulted in the greatest average over-all increase in plant height. Plant height was least in the manually watered and one top wick treatments. The average over-all increase in plant height was slightly greater in plants grown in plastic pots. The effects of one top wick or two top wicks on the uniformity of plant height in clay and plastic pots is shown in figure 10.

The best average root condition occurred in pots grown in the one top wick treatments. The poorest occurred in the bottom wick (core) treatments. The over-all average root condition was best in plants grown in clay pots.

The two top wicks treatments produced plants which had the longest average "house life". The manually watered treatments lasted the fewest number of days after the test was completed. There was no appreciable difference, however, in average "house life" between plants grown in clay and plastic pots.

Fertilizer Rate Experiment:

The data in Table X (See Appendix) show the effects of various concentrations of 20-20-20 applied through one or two top wicks on bract diameter, bract area, increase in plant height, root condition, and reflectometer reading on the upper surface of the top and third from the bottom leaf of each plant. In figure 11 the effects of different concentrations of 20-20-20 fertilizer in the reservoir, watered by one or two top wicks, on the growth and flowering of poinsettias, var. Indianapolis Red are shown.

The average bract diameter was greatest in the plants receiving 10

Figure 10. The effects of one top wick (left) and two top wicks (right) on the uniformity of poinsettia plant height in clay and plastic pots, respectively, left to right.

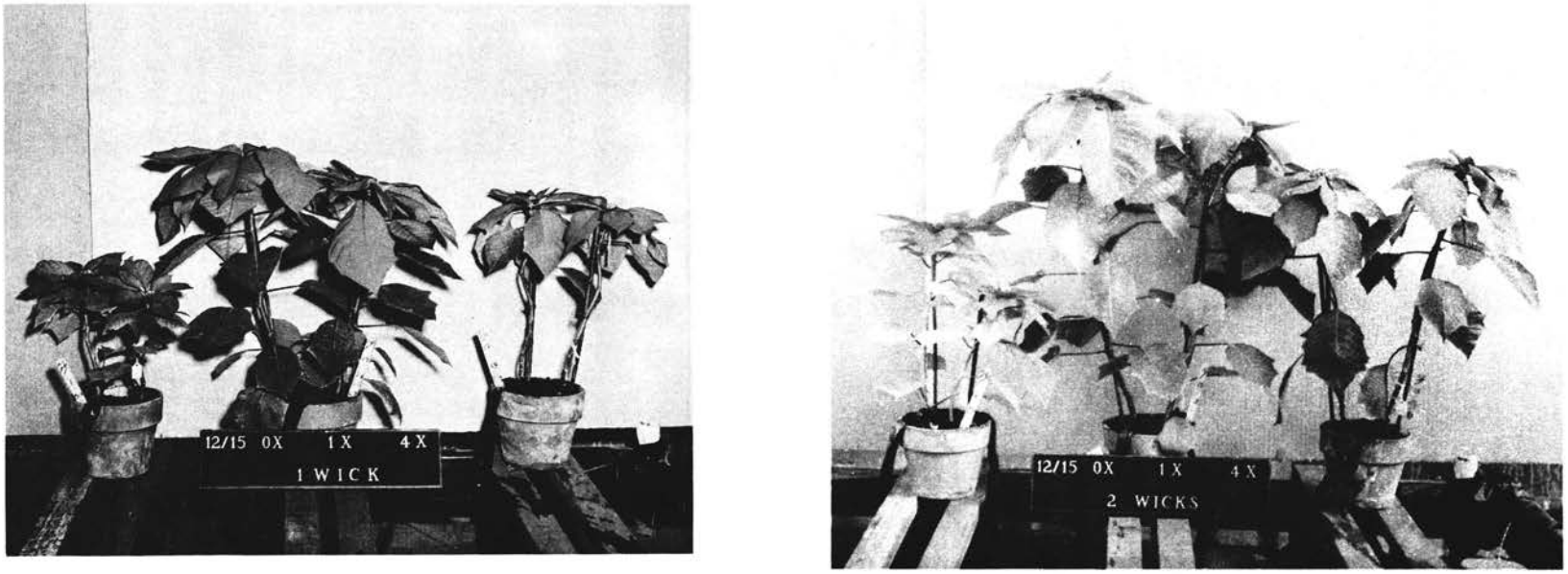


Figure 11. The effects of different concentrations of 20-20-20 fertilizer in the reservoir, watered by one or two top wicks, on the growth and flowering of poinsettias, var. Indianapolis Red. Left: (left to right) 0, 1, and 4 times recommended rate, applied through one wick. Right: (left to right) 0, 1, and 4 times recommended rate, applied through two top wicks. (Recommended rate is 10 ounces of 20-20-20 per 100 gallons of water in the reservoir.)

ounces of 20-20-20 through wicks. Plants which received no fertilizer had the smallest average bract diameter. There was very little difference in the average bract diameter between plants in the one or the two top wicks treatments.

The average bract area was greatest in plants which were wick watered and fertilized manually or were given 10 ounces of 20-20-20 through wicks. The method of watering caused very little difference in the average bract area.

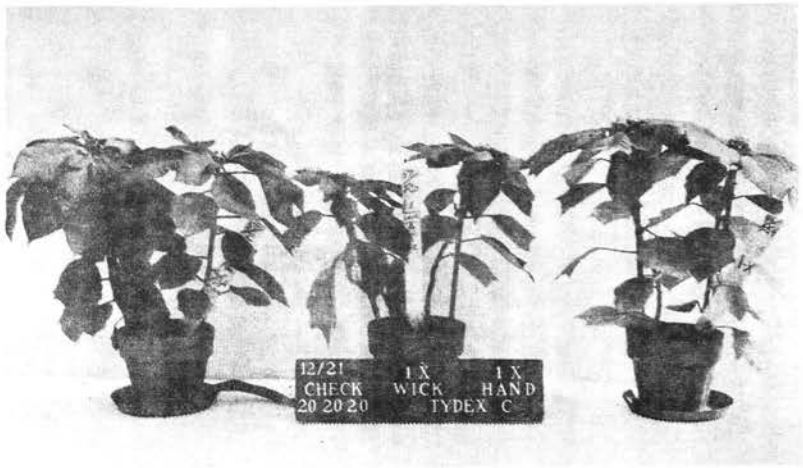
The greatest average plant height increase was obtained in the 10 and 20 ounce 20-20-20 treatments. The shortest plants were in the non-fertilized treatments. Over-all fertilizer treatments, plants with two top wicks had the greatest average increase in plant height.

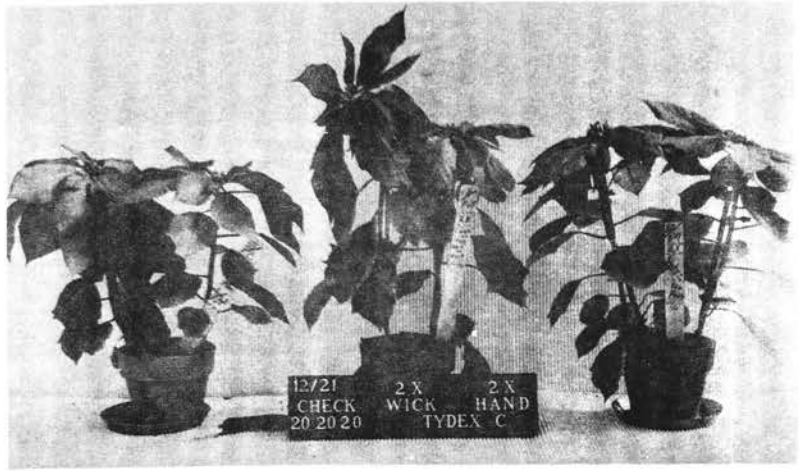
The best root condition was obtained in the 0, 5, or 10 ounce treatments. High fertilizer concentrations produced plants with poor roots. In general, over-all fertilizer treatments, the two top wicks produced the best average root conditon.

As the concentration of the 20-20-20 was increased there was a darker green color as evidenced by a lower reflectance from both the top and third from the bottom leaves.

Tydex-C Fertilizer Experiment:

The data in Table XI (See Appendix) show the effects of various concentrations of Tydex-C in the soil mixture watered manually or through one top wick per pot on bract diameter, increase in plant height, root condition, and reflectometer reading on the upper surface of the top and third from the bottom leaves of each plant. Figure 12 shows the effects of different concentrations of Tydex-C in the soil mixture, watered manually or with one top wick, on the growth and flowering of poinsettias,





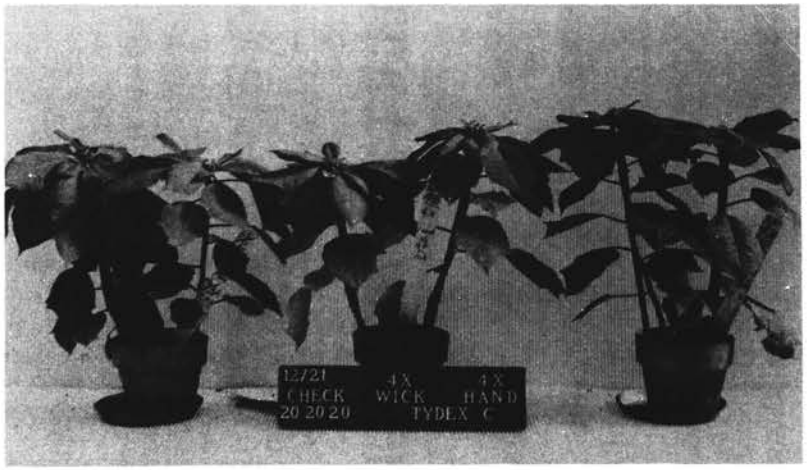


Figure 12. The effects of different concentrations of Tydex-C in the soil mixture, watered manually or with one top wick, on the growth and flowering of poinsettias, var. Indianapolis Red. Upper left: (left to right) 20-20-20 check and wick and manually watered with recommended rate of Tydex-C in the soil. Upper right: (left to right) 20-20-20 check and wick and manually watered with 2 times recommended rate of Tydex-C in the soil. Lower left: (left to right) 20-20-20 check and wick and manually watered with 4 times recommended rate of Tydex-C in the soil. (Recommended rate of Tydex-C is 1 part to 19 parts of soil mixture.)

var. Indianapolis Red.

The greatest average bract diameter occurred in the plants in the 2:19 and 4:19 Tydex-C treatments. The smallest average bract diameter was in the plants in the 0:19 Tydex-C treatments. There was very little difference over all treatments between manual and wick watering in average bract diameter.

The tallest plants were in the 2:19 Tydex-C and in the manually watered and fertilized treatments. The shortest plants occurred in the 0:19 Tydex-C treatments. There was no over-all difference in the average plant height increase between manually and wick watered plants.

Method of watering and the ratio of Tydex-C to the soil mixture made little difference in the average root condition.

As the ratio of Tydex-C to soil was increased there was less reflectance from both the top and third from the bottom leaves, thus indicating a darker green color.

Soil Test Results

Wick Placement Experiments:

The data in Tables XII and XIII (See Appendix) show the effects of wick placement and type of pot on the pH and soluble salt content, respectively, of soil samples taken at the termination of the chrysanthemum, hydrangea, lily, and poinsettia experiments. The pH of the soil in both clay and plastic pots was lowest in the bottom wick and highest in the top wick treatments at the termination of all wick placement experiments. The soil pH was lower in the plastic than in the clay pots. Soil pH was lower in all treatments at the termination than at the beginning of the experiments. In general, the soluble salt content was slightly higher in

the top wick than in the bottom wick treatments. Soluble salt content also was higher in plastic than in clay pots. The soluble salt content was higher at the termination of the experiments than at the beginning of the experiment in all treatments.

Fertilizer Rate Experiments:

The data in Tables XIV and XV (See Appendix) show the effects of applying 20-20-20 fertilizer by different watering methods on the pH and soluble salt content, respectively, of soil samples taken at the termination of the chrysanthemum, hydrangea, lily, and poinsettia experiments. In general, there was little difference in the one and two top wicks treatments. The top half of the soil in the pots, generally, had a lower pH than the bottom half. As the rate of 20-20-20 fertilizer increased the over-all pH was lowered. The pH of the soil was lower at the termination than at the beginning in each experiment. As the fertilizer concentration applied through wicks was increased the soluble salt content of the soil also was increased. Generally the top half of the soil in the pot had a higher soluble salt content than the lower half. At the termination of each of the experiments the potting media in the 10, 20, and 40 ounce 20-20-20 treatments contained a much higher soluble salt content than at the beginning of the experiments.

Tydex-C Fertilizer Experiments:

The data in Tables XVI and XVII (See Appendix) show the effects of different concentrations of Tydex-C in the soil mixture, watered manually or through one top wick, on the pH and soluble salt content, respectively, of soil samples taken at the start and termination of the chrysanthemum, lily and poinsettia experiments. The pH was decreased as the ratio of

Tydex-C to soil mixture was increased at the start of the experiment. In general, the pH of the soil containing Tydex-C was higher at the termination of the experiments than at the beginning. There was little difference in pH over-all treatments between manual and wick watering. As the ratio of Tydex-C in the soil mixture at the start of each experiment was increased, the soluble salt content of the soil also was increased. At the termination of each experiment there was little difference between Tydex-C treatments or between manual and wick watering in the soluble salt content in the soil.

CHAPTER V

DISCUSSION AND CONCLUSION

The production of high quality greenhouse potted plants presents many and varied problems to the grower. One of the most important factors is the proper and timely application of both water and fertilizer to the crop. With the ever increasing expense needed for maintenance and the decreasing semi-skilled labor supply available for such jobs it has become necessary for the successful grower to devise many new labor saving devices.

This study was concerned primarily with the use of wicks as a means of watering and fertilizing potted plants, from time of potting until maturity. Various placements of wicks in the pots were used to convey water and liquid fertilizer to the potting media. Apparently there was a more even distribution of water in the soil when the two top wicks treatment was used since the plant height was most uniform in the two top wicks poinsettia and chrysanthemum pots, containing 3 and 5 plants, respectively. When a single top wick treatment was used the poinsettia and chrysanthemum plants opposite the wick were usually shorter at maturity, and the soil immediately surrounding those plants seemed to be drier. The lack of uniformity in plant height with the different wick treatments was less noticeable in plastic pots than in the more porous clay pots. Also the rather poor root condition of the plants grown in plastic pots could be accounted for by the wetter soil which contained a higher soluble

salt content.

A different type of culture is generally employed with the growth of hydrangeas than with chrysanthemums or poinsettias. The soil ball immediately surrounding the base of hydrangeas roots must be kept wet, thus it was anticipated that the type of wick watering treatment which produced quality plants would vary. The bottom wick treatments, which brought the greatest amount of moisture into immediate contact with the roots gave the highest quality hydrangea plants while quality chrysanthemum and poinsettia plants were produced with the two top wicks treatment.

Lily plant growth was not appreciably different in any of the various wick treatments. This apparent lack of response to various wick placements perhaps can best be explained by the fact that lilies appear to grow well in a low fertility soil or in one which may be somewhat dry.

It was possible to produce high quality plants by utilizing dilute solutions of liquid fertilizer applied continuously through wicks. Fairly low concentrations, 5 or 10 ounces of 20-20-20 per 100 gallons of water, were sufficient for good growth of all four species. Increasing the concentration of 20-20-20 in the reservoir to 20 or 40 ounces per 100 gallons of water, however, caused considerable burning or wilting and dying of the foliage. This was particularly true with hydrangeas. Apparently the lowering of the pH and the accumulation of excess soluble salts caused a toxic condition in the growing medium.

There apparently was not a proper balance of nitrogen and phosphorus in the liquid fertilizer used for lilies. According to Laurie, Kiplinger, and Nelson (10) lilies grow best when a sufficient supply of nitrogen is available to the plant. Too much phosphorous in relation to other nutrients present may cause some leaf scorch. Phosphorous should be used

sparingly, and then, only in phosphorous deficient soils.

In general, higher quality chrysanthemum plants were produced on the hand watered than on the wick watered media containing various concentrations of a nutrient-charged synthetic ion exchange compound. There was no appreciable difference in the quality of manual and wick watered lily and poinsettia plants. Apparently the wick watered plants in the 4-inch pot received too much water for the small tender chrysanthemum rooted cuttings which they contained. On the other hand neither the lily bulb nor the poinsettia cutting showed any visible injury caused by an excess of water being present.

Nutrients were readily released from the ion exchange compound when the pots were either manually or wick watered. This was true in each of the experiments containing Tydex-C since there was a lower soluble salt content at the termination than at the beginning of each experiment. Increasing the ratio of Tydex-C in the soil medium to more than 1 part Tydex-C to 19 parts soil mixture with chrysanthemum and lily and to more than 2 parts Tydex-C to 19 parts soil mixture with poinsettia had no appreciable effect on bloom date, amount of blooming, or foliage color and condition. Regardless of the type of watering system employed there apparently was little difference in the time of nutrient release from the synthetic ion exchange compound. Nitrogen appeared to be a limiting factor for high quality plant growth in soils containing low concentrations of Tydex-C.

CHAPTER VI

SUMMARY

The study reported herein was concerned with the use of wicks to convey water and fertilizer to potted chrysanthemum, hydrangea, lily, and poinsettia plants. The wicks, made of orlon, were encased in a black plastic sheath to reduce evaporation. Various wick placements, kinds of pots, and kinds and rates of fertilizer were studied.

The highest quality chrysanthemums and poinsettias were grown in the two top wicks per pot treatment. High quality hydrangeas were produced in the one bottom wick (spread) treatment. Neither wick placement nor time of wick application had any appreciable effect on the type of lily plants produced. A single top wick failed to supply enough moisture to the soil to maintain high quality plant growth when the surface of the soil in the pot was more than eight inches above the surface of the water in the reservoir. This effect was particularly noticeable in the chrysanthemum and poinsettia experiments in which there was more than one plant per pot.

Plants in clay pots, in general, required more water than those grown in plastic pots. This was especially noticeable in the manually watered check treatments.

A sufficient quantity of 20-20-20 liquid fertilizer was conveyed from the reservoir through the wick into the potting medium to produce satisfactory plant growth. The concentration of fertilizer needed for

optimum plant growth varied, however, with the species grown. Increasing concentrations of 20-20-20 in the reservoir lowered the pH and raised the soluble salt content of the potting medium.

A nutrient-charged synthetic ion exchange compound, Tydex-C, was incorporated into the potting medium and watered either manually or by one top wick. In general, there was little difference in plant growth between manual and wick watering. Nitrogen appeared to be a limiting factor for high quality plant growth in soils containing less than 2 parts Tydex-C to 19 parts soil mixture.

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APPENDIX

TABLE I

THE EFFECTS OF MANUAL AND WICK WATERING IN CLAY AND PLASTIC POTS ON THE GROWTH AND FLOWERING OF CHRYSANTHEMUM MORIFOLIUM, VAR. YELLOW DELAWARE. ALL WATER SUPPLIED TO PLANTS CONTAINED 10 OUNCES OF 20-20-20 PER 100 GALLONS OF WATER. (TEST STARTED 11/16/60, COMPLETED 1/31/61.)

Measurements	Pot No.	Watered Manually		Wick Placement								Average	
				1 Top-Spread		2 Top-Spread		1 Bottom-Spread		1 Bottom-Core			
		Clay	Plastic	Clay	Plastic	Clay	Plastic	Clay	Plastic	Clay	Plastic	Clay	Plastic
Plant Quality (1 = poor, --- 5 = excellent)	1	2.5	3.0	1.0	1.5	5.0	5.0	4.0	4.0	3.5	5.0		
	2	2.5	2.5	3.0	1.0	5.0	5.0	3.5	4.0	2.5	5.0		
	3	3.5	2.5	3.0	2.5	5.0	4.5	3.0	3.0	2.5	4.0		
	4	3.0	2.5	2.0	1.0	5.0	4.5	3.5	3.5	3.0	4.0		
Average		2.9	2.6	2.3	1.5	5.0	4.8	3.5	3.6	2.9	4.5	3.3	3.4
Treatment Average		2.8		1.9		4.9		3.6		3.7			
Total Number of Breaks per Pot	1	17	15	17	18	18	19	18	20	19	18		
	2	16	13	9	17	18	22	13	20	17	20		
	3	14	15	9	19	18	17	16	17	18	19		
	4	16	14	17	21	20	17	20	19	18	17		
Average		15.8	14.3	13.0	18.8	18.5	18.8	16.8	19.0	18.0	18.5	16.4	17.9
Treatment Average		15.1		15.9		18.7		17.9		18.3			
Percent Mature Inflorescence 1/31/61 ($1\frac{1}{4}$" dia. or more)	1	35	80	29	78	100	100	72	75	68	94		
	2	44	77	100	76	100	100	85	85	71	85		
	3	57	73	100	84	100	100	81	76	61	95		
	4	63	57	100	81	100	100	90	79	78	65		
Average		50	72	82	80	100	100	82	79	70	85	76.8	83.2
Treatment Average		61		81		100		81		78			

TABLE I (Continued)

Measurements	Pot No.	Watered Manually		Wick Placement								Average	
				1 Top-Spread		2 Top-Spread		1 Bottom-Spread		1 Bottom-Core			
		Clay	Plastic	Clay	Plastic	Clay	Plastic	Clay	Plastic	Clay	Plastic	Clay	Plastic
Maximum Plant Height Above Pot (cm)	1	23	20	19	23	27	31	22	27	26	25		
	2	20	17	22	20	29	27	22	28	21	21		
	3	23	17	24	27	28	29	18	22	18	27		
	4	22	20	17	21	30	29	24	27	25	23		
Average		22.0	18.5	20.5	22.8	28.5	29.0	21.5	26.0	22.5	24.0	23.0	24.1
Treatment Average		20.3		21.7		28.8		23.8		23.3			
Total Above Ground Dry Weight per Pot (gm)	1	14.15	13.30	17.60	19.25	27.90	30.10	17.85	25.10	25.00	19.25		
	2	11.85	10.95	12.75	13.20	29.50	34.80	14.85	23.10	13.90	23.45		
	3	14.25	13.65	13.15	21.25	27.75	25.15	13.35	17.50	15.35	24.70		
	4	14.45	11.70	14.80	19.32	27.35	29.45	17.25	19.35	17.75	23.40		
Average		13.68	12.40	14.58	18.26	28.13	29.88	15.83	21.26	18.00	22.70	18.04	20.90
Treatment Average		13.04		16.42		29.01		18.55		20.35			
Root Condition (1 = poor, --- 5 = excellent)	1	4.0	1.0	2.0	1.5	3.5	3.0	5.0	3.0	5.0	2.5		
	2	3.5	1.5	3.0	1.5	3.5	2.5	5.0	3.5	4.0	3.5		
	3	5.0	1.5	2.0	1.5	3.5	1.5	2.0	3.5	3.5	2.5		
	4	3.0	1.5	1.5	1.0	3.0	3.0	4.5	4.5	4.0	3.5		
Average		3.9	1.4	2.1	1.4	3.4	2.5	4.1	3.6	4.1	3.0	3.5	2.4
Treatment Average		2.7		1.8		3.0		3.9		3.6			

TABLE II

THE EFFECTS OF DIFFERENT CONCENTRATIONS OF 20-20-20 APPLIED MANUALLY AND THROUGH WICKS ON THE GROWTH AND FLOWERING OF CHRYSANTHEMUM MORIFOLIUM, VAR. YELLOW DELAWARE[a]. (TEST STARTED 12/13/60, COMPLETED 2/14/61.)

Measurements	Pot No.	Watered Manually	Watered by One Top Wick				
		Fertilized Overhead with 1 Ounce per 3 Gallons Water Every 10 Days	Fertilized Through Wicks				
			Ounces Per 100 Gallons of Water				
			0	5	10	20	40
Plant Quality (1 = poor, ... 5 = excellent)	1	4.0	4.5	1.5	3.0	4.0	3.0	3.0
	2	5.0	4.0	1.5	3.5	4.5	4.0	3.5
	3	5.0	4.0	1.5	3.0	4.0	4.5	4.0
	4	5.0	5.0	2.0	4.0	4.0	4.0	4.0
	5	5.0	4.0	1.0	3.0	5.0	4.0	5.0
	6	5.0	4.0	2.0	4.0	5.0	4.0	3.5
Average		4.8	4.3	1.6	3.4	4.4	3.9	3.8
Total Number of Breaks per pot	1	23	19	10	15	16	11	15
	2	15	14	11	18	18	18	17
	3	20	17	11	15	16	19	16
	4	15	20	12	20	21	19	16
	5	18	17	10	19	19	14	18
	6	20	18	11	17	21	15	14
Average		18.5	17.5	10.8	17.3	18.5	16.0	16.0
Color and Condition of Foliage (1 = poor, ... 5 = excellent)	1	5	4	2	3	5	5	5
	2	5	5	2	3	5	5	4
	3	5	4	2	4	5	5	4
	4	5	4	2	3	5	5	4
	5	5	4	2	3	5	5	4
	6	5	4	2	3	5	5	4
Average		5.0	4.2	2.0	3.5	5.0	5.0	4.2

[a] 5 Plants per 5½ Inch Pot.

TABLE II (Continued)

Measurements	Pot No.	Watered Manually	Watered by One Top Wick				
		Fertilized Overhead with 1 Ounce per 3 Gallons Water Every 10 Days	Fertilized Through Wicks				
			Ounces Per 100 Gallons of Water				
			0	5	10	20	40
Maximum Plant Height Above Pot (cm)	1	19	23	13	17	24	18	20
	2	22	24	16	20	25	21	22
	3	20	22	16	18	24	21	17
	4	19	22	17	20	21	22	18
	5	22	21	13	19	25	21	24
	6	24	20	17	20	25	23	19
Average		21.0	22.0	15.3	19.0	24.0	21.0	20.0
Total Dry Weight of Inflorescences (gm)	1	10.20	9.90	2.41	7.22	9.58	4.22	4.35
	2	8.55	7.12	3.00	8.02	10.39	6.28	5.53
	3	9.30	7.46	2.45	7.10	10.00	8.80	5.80
	4	7.90	11.68	3.11	10.00	11.05	8.44	6.67
	5	8.75	10.46	2.08	8.22	11.81	8.35	8.12
	6	9.83	7.60	3.23	9.15	11.72	7.65	5.33
Average		9.09	9.04	2.71	8.29	10.76	7.29	5.97
Total Dry Weight of Leaves and Stems (gm)	1	15.82	17.50	7.50	10.55	13.28	12.00	11.60
	2	11.92	14.75	9.82	12.02	14.80	13.15	12.68
	3	14.88	15.92	8.30	11.30	15.85	11.65	15.65
	4	10.28	16.55	7.90	12.85	15.32	13.11	12.40
	5	14.80	13.58	5.85	11.25	16.85	13.15	14.72
	6	14.20	12.65	10.25	12.80	16.77	14.65	11.57
Average		13.65	15.16	8.27	11.80	15.48	12.95	13.10

TABLE II (Continued)

Measurements	Pot No.	Watered Manually	Watered by One Top Wick				
		Fertilized Overhead with 1 Ounce per 3 Gallons Water Every 10 Days	Fertilized Through Wicks				
			Ounces Per 100 Gallons of Water				
			0	5	10	20	40
Root Condition (1 = poor, ... 5 = excellent)	1	5.0	5.0	5.0	3.0	3.0	1.5	1.5
	2	4.5	5.0	5.0	3.5	2.5	2.0	1.5
	3	4.5	4.0	5.0	2.5	1.5	2.0	1.0
	4	5.0	4.5	4.5	3.5	2.5	1.5	1.0
	5	4.0	4.0	5.0	3.0	3.0	2.0	1.0
	6	5.0	4.0	4.5	3.5	3.5	2.0	1.0
Average		4.7	4.4	4.8	3.2	2.7	1.8	1.2

TABLE III

THE EFFECTS OF DIFFERENT CONCENTRATIONS OF TYDEX - C IN THE SOIL MIXTURE, WATERED MANUALLY OR WITH ONE TOP WICK PER POT[a/] ON THE GROWTH AND FLOWERING OF CHRYSANTHEMUM MORIFOLIUM, VAR. YELLOW DELAWARE.
(TEST STARTED 11/2/60, COMPLETED 1/24/61.)

Measurement	Pot No.	Fertilized Every 7 Days With 1 oz. 20-20-20 per 3 gal. of Water	Ratio of Tydex-C to Soil Mixture										Average of Tydex-C	
			0:19		0.5:19		1:19		2:19		4:19			
		Manual	Wick	Manual	Wick	Manual	Wick	Manual	Wick	Manual	Wick	Manual	Wick	Manual
Total Number of Breaks per Pot	1	7	4	3	6	7	4	6	5	7	6	7		
	2	8	3	5	5	8	6	7	8	8	5	7		
	3	9	4	6	6	8	Died	8	5	8	5	7		
	4	7	2	5	6	7	Died	6	5	8	7	5		
	5	8	6	2	7	6	6	8	4	8	4	7		
	6	8	5	4	6	8	9	Died	6	6	9	7		
Average		7.8	4.0	4.2	6.0	7.3	6.3	7.0	5.5	7.5	6.7	6.7	5.7	6.5
Treatment Average			4.1		6.7		6.7		6.5		6.7			
Date All Flowers In Pot Were Mature ($1\frac{1}{4}$" dia. or more)	1	1/17	[b/]	1/23	1/23	1/17	[b/]	1/17	1/23	1/20	[b/]	1/17		
	2	1/17	[b/]	[b/]	1/23	1/20	[b/]	1/17	1/20	1/17	1/23	1/12		
	3	1/17	1/23	1/20	1/23	1/23	Died	1/20	1/17	1/20	1/17	1/20		
	4	1/12	1/23	[b/]	1/23	1/20	Died	1/23	[b/]	1/17	1/17	1/13		
	5	1/12	[b/]	[b/]	1/20	1/20	1/20	1/20	1/20	1/17		1/20		
	6	1/12	[b/]	[b/]	1/20	1/20	1/20	Died	1/20	1/17	1/17	1/12		
Total Above Ground Fresh Weight Per Pot (gms)	1	73.1	13.7	13.1	60.9	61.4	31.7	102.9	85.0	117.6	49.4	133.1		
	2	108.1	3.5	27.0	28.8	86.7	38.8	101.8	72.7	109.5	77.1	118.6		
	3	113.1	16.9	63.8	45.7	68.8	Died	88.0	69.5	98.7	113.1	103.3		
	4	127.5	13.5	18.4	38.5	94.3	Died	80.4	49.5	102.0	109.7	89.3		
	5	123.7	27.9	5.5	28.1	47.0	73.7	66.7	69.4	127.0	33.9	103.0		
	6	124.3	18.3	16.4	38.8	84.0	90.2	Died	78.8	88.1	121.0	111.8		
Average		111.6	15.6	24.0	40.1	73.7	58.6	88.0	70.8	107.2	87.0	109.9	54.4	80.6
Treatment Average			19.8		56.9		73.3		89.0		98.5			

[a/] 2 Plants per 4 inch pot.

[b/] Not mature at end of test.

TABLE IV

THE EFFECTS OF MANUAL AND WICK WATERING ON THE GROWTH AND FLOWERING OF *HYDRANGEA MACROPHYLLA*, VAR. MERVEILLE. ALL WATER APPLIED TO PLANTS CONTAINED 10 OUNCES OF 20-20-20 PER 100 GALLONS OF WATER. (TEST STARTED 12/30/60, COMPLETED 3/28/61.)

Measurements	Pot No.	Watered Manually	Wick Placement		
			1 Top-Spread	2 Top-Spread	1 Bottom-Spread
Plant Quality (1 = poor,... 5 = excellent)	1	3.5	2.5	3.5	4.0
	2	4.0	1.0	4.5	5.0
	3	4.0	2.0	4.5	5.0
	4	4.0	3.0	4.0	4.5
	5	3.0	Blind	4.0	5.0
	6	2.0	4.0	3.0	5.0
Average		3.4	2.5	3.9	4.8
Number of Inflorescences	1	2	1	3	3
	2	3	2	3	3
	3	3	3	3	3
	4	3	3	3	3
	5	3	Blind	3	3
	6	3	3	3	3
Average		2.8	2.4	3.0	3.0
Percent Mature Inflorescences (75% or more of sepals fully expanded)	1	0	0	100	67
	2	67	0	67	100
	3	100	0	100	100
	4	67	0	100	67
	5	0	0	100	67
	6	100	67	0	100
Average		56	11	78	84

TABLE IV (Continued)

Measurements	Pot No.	Watered Manually	Wick Placement		
			1 Top-Spread	2 Top-Spread	1 Bottom-Spread
Maximum Plant Height Above Pot. (cm)	1	27	28	23	26
	2	27	24	30	33
	3	27	26	28	30
	4	24	22	34	24
	5	23	21	22	26
	6	22	27	20	33
Average		25.0	24.7	26.2	28.7
Dry Weight of Inflorescences (gm)	1	.67	.01	4.12	3.20
	2	3.40	.25	4.15	7.50
	3	5.08	.53	4.20	6.38
	4	2.20	1.32	5.90	3.96
	5	1.50	Blind	2.75	5.42
	6	3.70	1.85	2.00	11.60
Average		2.76	.66	3.85	6.34
Dry Weight of Stems and Leaves (gms)	1	10.25	8.63	9.38	10.92
	2	11.60	5.05	12.92	15.42
	3	9.20	7.62	11.42	14.40
	4	9.50	8.60	13.40	9.50
	5	8.02	7.22	9.62	12.00
	6	10.00	8.95	7.22	18.40
Average		9.76	7.67	10.66	13.44

TABLE IV (Continued)

Measurements	Pot No.	Watered Manually	Wick Placement		
			1 Top-Spread	2 Top-Spread	1 Bottom-Spread
Root Condition (1 = poor, ... 5 = excellent)	1	4.5	1.5	4.5	5.0
	2	4.0	1.0	5.0	5.0
	3	4.0	1.0	4.0	5.0
	4	4.0	2.0	5.0	5.0
	5	4.5	1.0	4.0	5.0
	6	5.0	3.0	4.5	5.0
Average		4.3	1.6	4.5	5.0

TABLE V

THE EFFECTS OF DIFFERENT CONCENTRATIONS OF 20-20-20 APPLIED MANUALLY AND THROUGH WICKS ON THE GROWTH AND FLOWERING OF HYDRANGEA MACROPHYLLA, VAR. MERVEILLE. (TEST STARTED 12/30/60, COMPLETED 3/29/61.)

Measurements	Pot No.	Watered Manually	Watered by Two Top Wicks					
		Fertilized Overhead With 1 Ounce per 3 Gallons Water Every 10 Days		Fertilized Through Wicks				
				Ounces Per 100 Gallons of Water				
				0	5	10	20	40
Plant Quality (1 = poor, ... 5 = excellent)	1	3.5	—	2.0	5.0	4.5	3.0	1.0
	2	4.5	4.0	2.0	5.0	4.5	4.0	1.0
	3	5.0	3.5	3.0	5.0	5.0	2.5	1.0
	4	4.5	4.0	1.0	5.0	4.5	2.0	1.0
	5	4.5	5.0	2.0	5.0	4.5	4.0	1.0
	6	4.0	5.0	1.5	4.0	5.0	1.0	1.0
Average		4.3	4.3	1.9	4.8	4.7	2.8	1.0
Number of Inflorescences Per Pot	1	3	—	1	3	3	1	3
	2	3	3	2	3	3	3	3
	3	3	3	3	3	3	2	3
	4	2	2	Blind	3	3	3	3
	5	3	3	2	3	3	3	3
	6	2	3	1	2	3	Blind	3
Average		2.67	2.80	1.50	2.83	3.00	2.00	3.00
Sepal color (1 = Clear Blue, 4 = Clear Pink)	1	4	—	1	2	3	4	Wilted
	2	4	3	1	2	3	4	Wilted
	3	4	2	1	2	3	4	Wilted
	4	4	3	Blind	2	3	4	Wilted
	5	4	2	1	2	3	4	Wilted
	6	4	2	1	2	3	Blind	Wilted
Average		4.0	2.4	1.0	2.0	3.0	4.0	Wilted

TABLE V (Continued)

Measurements	Pot No.	Watered Manually	Watered by Two Top Wicks				
		Fertilized Overhead With 1 Ounce per 3 Gallons Water Every 10 Days	Fertilized Through Wicks				
			Ounces Per 100 Gallons of Water				
			0	5	10	20	40
Color and Condition of Foliage (1 = poor, ... 5 = excellent)	1	4.0	1.5	5.0	4.5	4.0	1.0
	2	4.0	2.0	5.0	5.0	4.5	1.0
	3	5.0	2.0	5.0	5.0	4.0	1.0
	4	5.0	1.0	5.0	4.5	3.5	1.0
	5	4.5	1.5	5.0	5.0	4.0	1.0
	6	5.0	1.5	5.0	5.0	4.5	1.0
Average		4.6	1.6	5.0	4.8	4.1	1.0
Maximum Plant Height Above Pot (cm)	1	22	28	33	32	22	20
	2	30	26	32	29	30	20
	3	28	27	34	32	32	18
	4	29	24	35	29	27	18
	5	23	30	33	33	30	22
	6	26	21	27	29	24	24
Average		26.3	26.0	33.3	30.7	27.8	20.3
Dry Weight of Inflorescences (gms)	1	4.40	3.05	11.30	8.75	.15	1.92
	2	5.05	3.55	10.30	6.25	5.35	1.50
	3	4.25	6.68	6.17	11.05	14.55	.45
	4	5.20	Blind	8.40	7.10	4.75	1.45
	5	5.90	3.80	6.35	5.25	5.55	1.00
	6	1.35	1.12	3.60	9.30	Blind	.78
Average		4.35	3.03	7.65	7.95	6.07	1.18

TABLE V (Continued)

Measurements	Pot No.	Watered Manually	Watered by Two Top Wicks				
		Fertilized Overhead With 1 Ounce per 3 Gallons Water Every 10 Days	Fertilized Through Wicks				
			Ounces Per 100 Gallons of Water				
			0	5	10	20	40
Dry Weight of Leaves and Stems (gms)	1	11.00	9.90	14.70	14.40	12.80	8.20
	2	15.00	6.45	14.40	15.35	16.12	10.78
	3	16.12	9.08	11.50	14.22	14.18	7.15
	4	18.45	6.12	10.77	16.75	15.05	10.15
	5	11.35	5.00	14.02	15.00	13.78	8.05
	6	11.80	7.25	16.42	14.40	13.35	10.25
Average		13.95	7.30	13.63	15.02	14.21	9.10
Root Condition (1 = poor, ... 5 = excellent)	1	4.0	4.5	5.0	4.5	1.5	1.0
	2	4.0	4.0	5.0	5.0	3.0	1.0
	3	4.0	4.0	5.0	5.0	3.0	1.0
	4	4.0	2.0	5.0	5.0	3.0	1.0
	5	3.0	4.0	4.5	3.0	4.0	1.5
	6	5.0	3.0	4.5	5.0	2.0	1.5
Average		4.0	3.6	4.8	4.6	2.8	1.2

TABLE VI

THE EFFECTS OF DIFFERENT WICK PLACEMENTS APPLIED (A) AT TIME OF BULB PLANTING (11/29/60) AND (B) WHEN THE SHOOTS WERE ½ INCH ABOVE POT LEVEL (12/22/60) ON THE GROWTH AND FLOWERING OF LILIUM LONGIFLORUM, VAR. ACE. ALL WATER APPLIED TO PLANTS CONTAINED 10 OUNCES OF 20-20-20 PER 100 GALLONS OF WATER (TEST STARTED 11/29/60, COMPLETED 3/21/61.)

Measurements	Pot No.	Watered Manually	Wick Placement						Average	
			1 Top-Spread		2 Top-Spread		1 Bottom-Spread		Wick Placement Treatments	
		(A)	(A)	(B)[a]	(A)	(B)[a]	(A)	(B)[a]	(A)	(B)[a]
Number of Buds per Plant	1	4	5	4	4	7	5	7		
	2	4	5	5	5	5	7	4		
	3	4	6	5	5	7	5	4		
	4	5	5	6	4	6	5	3		
	5	4	5	5	4	5	3	5		
	6	6	5	3	4	2	3	4		
Average		4.5	5.2	4.7	4.3	5.3	4.7	4.5	5.1	4.6
Treatment Average			5.0		4.8		4.6			
Foliage Tip Discoloration (1 = severe 5 = none)	1	4.0	3.0	3.5	4.0	3.5	3.5	4.5		
	2	3.0	3.0	3.0	3.0	2.5	3.5	2.5		
	3	4.0	3.5	2.0	4.0	2.5	3.0	3.0		
	4	3.0	3.0	4.0	3.0	4.5	4.0	3.5		
	5	4.0	4.0	3.0	3.5	4.0	3.0	3.5		
	6	3.0	3.0	3.0	3.5	4.0	3.5	3.0		
Average		3.5	3.3	3.1	3.5	3.5	3.4	3.3	3.4	3.3
Treatment Average			3.2		3.5		3.4			

[a] Watered manually with tap water, till placed on wicks (12/22/60).

TABLE VI (Continued)

Measurements	Pot No.	Watered Manually	Wick Placement						Average Wick Placement Treatments	
			1 Top-Spread		2 Top-Spread		1 Bottom-Spread			
		(A)	(A)	(B)[a]	(A)	(B)[a]	(A)	(B)[a]	(A)	(B)[a]
Height of Die-Back Above Soil Surface (cm)	1	4	4	4	1	3	1	2		
	2	5	7	5	0	3	3	2		
	3	1	5	1	0	3	0	3		
	4	3	5	4	6	2	4	4		
	5	4	3	1	3	0	3	5		
	6	0	1	2	5	0	7	3		
Average		2.8	4.2	2.8	2.5	1.8	3.0	3.2	3.2	2.6
Treatment Average			3.5		2.2		3.1			
Maximum Plant Height Above Pot (cm)	1	50	51	62	58	56	50	57		
	2	57	57	54	50	55	50	39		
	3	56	49	46	71	67	60	55		
	4	50	54	52	60	61	58	62		
	5	46	60	51	59	47	56	71		
	6	47	64	40	61	50	63	60		
Average		51.0	55.8	50.8	61.5	56.0	56.2	57.3	57.8	54.7
Treatment Average			53.3		58.8		55.8			
Above Ground Dry Weight Per Pot (gm)	1	14.50	17.56	14.70	22.58	21.38	17.75	26.20		
	2	15.50	19.97	14.46	19.00	19.10	25.65	14.35		
	3	19.58	16.13	16.82	29.53	21.62	22.50	21.80		
	4	14.92	17.54	17.40	23.50	21.32	19.78	18.38		
	5	12.45	15.51	16.71	23.15	18.18	11.28	22.22		
	6	17.20	22.55	10.90	18.07	12.88	23.54	20.78		
Average		15.69	18.21	15.17	22.64	19.08	20.08	20.62	20.31	18.29
Treatment Average			16.69		20.86		20.35			

TABLE VI (Continued)

Measurement	Pot No.	Watered Manually	Wick Placement						Average Wick Placement Treatments	
			1 Top-Spread		2 Top-Spread		1 Bottom-Spread			
		(A)	(A)	(B)[a]	(A)	(B)[a]	(A)	(B)[a]	(A)	(B)[a]
Root Condition (1 = poor, ... 5 = excellent)	1	2.5	3.0	4.5	4.5	4.0	2.5	5.0		
	2	3.0	3.5	3.5	4.0	4.0	4.0	3.5		
	3	2.5	3.0	4.0	5.0	3.0	4.0	2.0		
	4	3.0	3.0	4.0	3.5	4.0	3.5	4.5		
	5	2.0	2.5	3.5		4.5	2.5	4.0		
	6	4.5	4.0	3.0	3.5	5.0	5.0	3.0		
Average		2.9	3.2	3.8	4.1	4.1	3.6	3.7	3.6	3.9
Treatment Average			3.5		4.1		3.7			

TABLE VII

THE EFFECTS OF DIFFERENT CONCENTRATIONS OF 20-20-20 IN 100 GALLONS OF WATER, APPLIED BY MEANS OF ONE TOP WICK, ON THE GROWTH AND FLOWERING OF LILIUM LONGIFLORUM, VAR. ACE. (TEST STARTED 12/22/60, COMPLETED 3/21/61.)

Measurements	Pot No.	Concentration in Ounces			
		0	5	10	20
Number of Buds Per Plant	1	4	5	5	5
	2	5	5	4	3
	3	3	6	5	4
	4	3	5	5	3
	5	3	5	4	4
	6	3	5	3	4
Average		3.5	5.2	4.3	3.8
Percent Open Buds (3/21/61)	1	80	100	100	83
	2	100	100	100	60
	3	60	75	100	67
	4	75	83	100	75
	5	60	100	100	80
	6	75	83	75	100
Average		75	90	96	76

TABLE VII (Continued)

Measurements	Pot No.	Concentration in Ounces			
		0	5	10	20
Foliage Color (1 = yellow, ... 3 = yellow-green, 5 = dark green)	1	3	4	5	5
	2	3	4	5	5
	3	3	4	5	5
	4	3	4	5	5
	5	3	3	5	5
	6	3	4	5	5
Average		3.0	3.8	5.0	5.0
Foliage Tip Discoloration (1 = severe, 5 = none)	1	5.0	4.5	4.5	2.5
	2	5.0	4.0	4.5	4.0
	3	5.0	4.0	5.0	3.0
	4	5.0	4.5	3.5	3.0
	5	5.0	4.0	3.5	4.0
	6	4.5	4.0	4.0	2.0
Average		4.9	4.2	4.2	3.1

TABLE VII (Continued)

Measurements	Pot No.	Concentration in Ounces			
		0	5	10	20
Maximum Plant Height Above Pot (cm)	1	61	50	43	51
	2	49	49	47	48
	3	58	47	29	35
	4	51	48	41	41
	5	58	62	50	44
	6	51	45	46	37
Average		54.7	50.2	42.7	42.7
Above Ground Dry Weight Per Pot (gm)	1	20.38	20.55	20.02	19.62
	2	17.98	19.92	20.68	20.25
	3	20.95	22.38	13.46	16.60
	4	17.05	17.00	14.62	15.30
	5	19.60	20.92	18.46	16.30
	6	15.40	17.70	16.40	13.50
Average		18.56	19.74	17.27	16.92

TABLE VIII

THE EFFECTS OF DIFFERENT CONCENTRATIONS OF TYDEX-C FERTILIZER IN THE SOIL, USING ONE TOP WICK FOR WATER APPLICATION, ON THE GROWTH AND FLOWERING OF LILIUM LONGIFLORUM, VAR. ACE. (TEST STARTED 11/29/60, COMPLETED 3/21/61.)

Measurements	Pot No.	Watered Manually	1 Top Wick Per Pot[1/]			
		Fertilized with 1 oz. 20-20-20 per 3 gal. Water Every 10 Days for 30 Days.	Ratio of Tydex-C To Soil			
			0:19	0.5:19	1:19	2:19
Number of Buds per Plant	1	5	4	7	4	6
	2	5	6	6	5	6
	3	5	5	6	6	3
	4	6	4	6	4	4
	5	5	5	5	5	7
	6	4	3	6	5	6
Average		5.0	4.5	6.0	4.8	5.3
Foliage Color (1 = Yellow .... 3 = Yellow Green 5 = Dark Green)	1	5	3	3	4	3
	2	5	3	4	3	4
	3	5	3	4	4	4
	4	5	3	3	4	4
	5	5	3	4	4	4
	6	5	4	4	3	3
Average		5.0	3.2	3.7	3.7	3.7
Height of Die-Back Above Soil Surface (cm)	1	4	4	5	4	3
	2	2	5	4	4	1
	3	2	6	4	5	2
	4	0	5	4	3	1
	5	0	4	2	3	4
	6	0	6	4	5	2
Average		1.3	5	3.8	4.0	2.2

TABLE VIII (Continued)

Measurements	Pot No.	Watered Manually	1 Top Wick Per Pot[1/]			
		Fertilized with 1 oz. 20-20-20 per 3 gal. Water Every 10 Days for 30 Days.	Ratio of Tydex-C To Soil			
			0:19	.5:19	1:19	2:19
Maximum Plant Height Above Pot. (cm)	1	50	48	59	50	51
	2	48	59	55	52	47
	3	44	51	53	46	47
	4	52	48	60	44	44
	5	50	50	52	47	50
	6	56	49	51	52	40
Average		50.0	50.8	55.0	48.5	46.5
Above Ground Dry Weight Per Pot (gms)	1	18.72	18.50	23.52	18.20	17.50
	2	21.00	21.25	24.30	18.45	18.80
	3	23.50	16.71	20.20	20.30	13.70
	4	23.45	17.05	22.05	17.40	19.12
	5	21.36	20.92	19.04	20.60	26.05
	6	19.50	16.70	19.80	18.62	18.20
Average		21.25	18.52	21.54	18.92	18.89
Root Condition (1 = poor, ... 5 = excellent	1	4.5	5.0	2.0	3.5	2.0
	2	5.0	4.0	4.0	4.0	3.0
	3	3.5	4.5	4.0	4.0	3.0
	4	5.0	3.0	4.0	3.0	5.0
	5	4.0	3.0	1.5	4.0	4.5
	6	4.5	5.0	3.0	3.5	3.0
Average		4.4	4.1	3.1	3.7	3.4

[1/] Watered manually 11/29/60 to 12/22/60. Individual wick applied to each pot 12/22/60.

TABLE IX

THE EFFECTS OF MANUAL AND WICK WATERING IN CLAY AND PLASTIC POTS ON THE GROWTH AND FLOWERING OF EUPHORBIA PULCHERRIMA, VAR. INDIANAPOLIS RED. ALL WATER SUPPLIED TO PLANTS CONTAINED 10 OUNCES OF 20-20-20 PER 100 GALLONS OF WATER. (TEST STARTED 10/5/60, COMPLETED 12/10/60.)

Measurements	Pot No.	Watered Manually		Wick Placement								Average	
				1 Top-Spread		2 Top-Spread		1 Bottom-Spread		1 Bottom-Core			
		Clay	Plastic	Clay	Plastic	Clay	Plastic	Clay	Plastic	Clay	Plastic	Clay	Plastic
Bract Diameter (cm)	1 A	33.0	27.5	28.5	35.0	28.5	27.5	41.0	34.0	35.5	38.0		
	B	32.5	28.5	28.0	30.5	29.5	31.0	43.5	33.0	31.5	27.5		
	C	34.5	30.0	34.0	44.0	40.0	27.5	25.5	34.0	37.5	38.0		
	2 A	28.0	22.0	39.5	30.5	39.5	33.0	27.0	29.0	24.5	27.5		
	B	33.0	29.5	42.0	35.5	37.5	42.5	38.0	33.0	33.0	44.0		
	C	36.0	29.0	30.0	34.0	36.5	26.0	45.5	29.0	28.0	25.5		
	3 A	36.5	26.5	34.5	32.5	36.0	40.5	30.0	39.5	29.0	43.0		
	B	31.0	28.5	27.5	34.0	33.5	37.0	33.0	36.0	29.0	43.0		
	C	36.5	28.0	22.5	39.0	37.5	36.5	32.0	40.5	17.0	28.0		
	4 A	25.0	30.5	33.5	42.0	21.0	41.0	42.5	32.5	27.5	37.5		
	B	30.5	28.0	27.0	41.5	25.5	26.5	37.5	23.5	39.0	30.5		
	C	26.5	26.5	36.5	22.0	36.0	28.5	39.0	34.5	31.0	38.5		
	5 A	———	21.5	31.5	29.0	32.0	43.0	30.5	36.0	28.5	24.5		
	B	———	15.0	37.5	33.5	37.0	30.0	37.0	35.0	30.0	26.5		
	C	———	27.0	33.0	39.0	32.5	33.5	35.0	42.5	31.5	30.5		
	6 A	35.5	29.5	25.0	37.5	41.0	42.0	———	37.0	36.0	34.5		
	B	27.0	30.0	41.0	41.0	42.0	34.5	———	40.0	35.5	33.0		
	C	30.0	30.0	37.0	33.0	40.5	43.0	———	28.5	37.5	41.0		
Average		31.7	27.2	32.7	35.2	34.8	34.6	35.8	34.3	31.2	33.9	33.2	33.0
Treatment Average		29.5		34.0		34.7		35.1		32.6			

TABLE IX (Continued)

Measurements	Pot No.	Watered Manually		Wick Placement								Average	
				1 Top-Spread		2 Top-Spread		1 Bottom-Spread		1 Bottom-Core			
		Clay	Plastic	Clay	Plastic	Clay	Plastic	Clay	Plastic	Clay	Plastic	Clay	Plastic
Bract Area (cm^2)	1 A	625.0	312.5	356.0	562.5	625.0	625.0	712.5	687.5	794.0	550.0		
	B	407.0	375.0	400.0	472.0	806.0	331.0	869.0	912.5	894.0	381.0		
	C	419.0	431.0	706.0	1069.0	1087.5	300.0	287.5	912.5	900.0	806.0		
	2 A	456.0	219.0	800.0	406.0	919.0	919.0	250.0	562.5	406.0	706.0		
	B	562.5	500.0	925.0	544.0	975.0	1075.0	560.5	537.5	381.0	1200.0		
	C	362.5	531.0	550.0	687.5	856.0	425.0	794.0	656.0	300.0	407.0		
	3 A	775.0	375.0	637.5	712.5	1062.5	1150.0	562.5	956.0	475.0	1125.0		
	B	537.5	469.0	244.0	725.0	587.5	1100.0	562.5	562.5	256.0	1275.0		
	C	437.5	406.0	356.0	869.0	650.0	812.5	456.0	1094.0	200.0	531.0		
	4 A	362.5	400.0	550.0	731.0	237.5	1287.5	1375.0	462.5	537.5	1006.0		
	B	325.0	469.0	550.0	1125.0	812.5	487.5	662.5	212.5	975.0	694.0		
	C	337.5	344.0	706.0	312.5	875.0	675.0	719.0	425.0	719.0	1112.0		
	5 A	____	275.0	512.5	237.5	706.0	1119.0	344.0	625.0	462.5	587.5		
	B	____	156.0	500.0	581.0	675.0	612.5	781.0	750.0	500.0	587.5		
	C	____	400.0	525.0	875.0	1031.0	475.0	925.0	1206.0	525.0	769.0		
	6 A	481.0	356.0	382.0	750.0	944.0	837.5	____	344.0	944.0	700.0		
	B	462.5	406.0	1219.0	962.5	1119.0	706.0	____	925.0	737.5	794.0		
	C	434.5	437.5	931.0	625.0	1237.5	825.0	____	337.5	968.5	637.5		
Average		465.7	381.2	602.8	680.4	844.8	764.6	657.4	676.0	609.7	770.5	636.1	654.6
Treatment Average		423.5		641.6		804.7		666.7		690.1			

TABLE IX (Continued)

Measurements	Pot No.	Watered Manually		Wick Placement								Average	
				1 Top-Spread		2 Top-Spread		1 Bottom-Spread		1 Bottom-Core			
		Clay	Plastic	Clay	Plastic	Clay	Plastic	Clay	Plastic	Clay	Plastic	Clay	Plastic
Increase in Plant Height (cm)	1 A	21.0	17.0	15.0	23.5	32.0	30.5	36.5	38.0	46.5	42.5		
	B	16.0	22.5	21.0	23.0	37.5	17.0	31.0	36.0	46.5	46.0		
	C	17.0	17.0	39.5	41.0	39.0	17.5	6.5	33.0	51.0	52.0		
	2 A	23.5	19.0	33.5	11.0	34.5	17.0	34.5	36.5	36.0	34.5		
	B	13.0	23.0	27.0	10.5	26.0	35.0	55.0	38.5	53.0	47.0		
	C	17.0	29.5	13.0	30.5	38.5	19.0	42.5	40.5	35.5	32.5		
	3 A	21.0	14.5	36.5	12.0	41.5	43.5	33.5	53.0	25.0	47.0		
	B	19.0	24.0	19.5	28.0	39.0	37.0	36.0	33.0	12.5	48.0		
	C	14.5	19.0	8.0	33.0	30.0	40.5	26.0	41.0	4.5	35.0		
	4 A	9.5	18.0	11.5	35.0	17.0	52.0	49.0	43.5	35.5	49.5		
	B	15.5	18.0	7.5	38.5	42.5	42.5	19.5	42.5	43.5	38.5		
	C	13.0	20.5	15.0	7.5	39.0	30.0	36.5	38.5	38.5	50.5		
	5 A	Hail	15.5	24.5	15.0	38.5	52.0	28.0	37.0	11.5	48.0		
	B	Hail	14.5	11.0	21.5	35.0	26.0	41.0	47.5	14.0	39.5		
	C	Hail	17.5	27.0	34.5	41.0	30.0	45.5	53.0	14.5	44.0		
	6 A	17.0	13.0	7.5	33.5	34.0	44.5	___	30.0	42.5	45.5		
	B	14.0	21.0	31.5	24.5	40.5	32.5	___	30.0	47.5	44.4		
	C	21.5	14.0	32.0	14.5	46.0	41.0	___	15.5	56.0	40.0		
Average		16.8	18.8	21.1	24.3	36.2	33.7	34.7	38.2	34.1	43.6	28.6	31.7
Treatment Average		17.8		22.7		35.0		36.5		38.9			

TABLE IX (Continued)

Measurements	Pot No.	Watered Manually		Wick Placement								Average	
				1 Top-Spread		2 Top-Spread		1 Bottom-Spread		1 Bottom-Core			
		Clay	Plastic	Clay	Plastic	Clay	Plastic	Clay	Plastic	Clay	Plastic	Clay	Plastic
Root Condition (1 = poor, ... 5 = excellent)	1	3.0	2.0	4.5	3.5	3.5	2.0	4.5	1.0	1.0	4.0		
	2	4.0	2.0	4.5	2.5	3.5	2.0	5.0	3.0	2.5	4.5		
	3	4.5	2.5	4.0	3.0	4.0	2.5	2.0	5.0	1.0	4.5		
	4	3.0	2.0	4.5	3.0	4.0	2.5	4.5	1.0	2.5	2.0		
	5		3.5	3.5	2.0	4.0	4.0	2.5	3.5	1.5	1.0		
	6	4.0	1.0	4.5	2.5	4.5	3.0		1.0	3.0	4.0		
Average		3.7	2.2	4.3	2.8	3.9	2.7	3.7	2.4	1.9	3.3	3.5	2.7
Treatment Average		3.0		3.6		3.3		3.1		2.6			
"Home Life" (days)	1	7	20	19	17	20	20	15	16	18	19		
	2	8	0	15	15	18	16	19	18	8	19		
	3	6	19	18	16	18	19	15	16	18	17		
	4	7	3	16	15	18	18	20	0	8	8		
	5		19	16	18	19	18	19	14	18	16		
	6	8	18	17	16	21	24		8	19	19		
Average		7.2	13.2	16.8	16.2	19.0	19.2	17.6	12.0	14.8	16.3	15.1	15.4
Treatment Average		10.2		16.5		19.1		14.8		15.6			

TABLE X

THE EFFECTS OF DIFFERENT CONCENTRATIONS OF 20-20-20 APPLIED MANUALLY AND THROUGH WICKS ON THE GROWTH AND FLOWERING OF EUPHORBIA PULCHERRIMA, VAR. INDIANAPOLIS RED. ALL PLANTS WATERED BY ONE OR TWO TOP WICKS. (TEST STARTED 10/8/60, COMPLETED 12/15/60.)

Measurement	Pot No.	Fertilized Overhead With 1 Ounce per 3 Gallons Water Every 10 Days		Fertilized Through Wicks										Average	
				Ounces per 100 Gallons of Water											
				0		5		10		20		40			
		1	2	1	2	1	2	1	2	1	2	1	2	1	2
Bract Diameter (cm)	1 A	27.5	39.5	20.5	27.0	37.0	34.5	40.0	36.5	32.5	35.0	25.0	36.0		
	B	41.0	41.0	23.5	29.5	32.0	41.0	44.0	36.0	34.0	28.0	25.5	33.0		
	2 A	32.5	38.0	32.0	24.0	34.5	37.5	30.0	49.5	36.0	41.5	26.0	35.0		
	B	37.0	38.0	27.5	25.0	34.0	32.0	41.5	58.5	40.0	38.0	25.5	36.0		
	3 A	43.0	37.5	26.5	18.0	30.0	30.5	44.0	46.0	41.5	29.5	32.0	36.0		
	B	44.0	39.0	24.5	24.5	37.0	35.5	33.0	44.5	42.5	33.0	31.5	36.0		
Average		37.5	38.8	25.8	24.7	34.1	35.2	38.8	45.2	37.8	34.2	27.6	35.3	33.6	35.6
Treatment Average		38.2		25.3		34.7		42.0		36.0		31.5			
Bract Area (cm^2)	1 A	506.5	994.0	206.0	343.5	687.5	550.0	825.0	593.5	800.0	744.0	456.0	900.0		
	B	1181.0	987.5	306.0	269.0	500.0	562.5	1169.0	556.5	812.5	500.0	456.0	744.0		
	2 A	525.0	769.0	537.5	281.0	544.0	750.0	375.0	1144.0	806.0	944.0	406.0	875.0		
	B	931.0	800.0	319.0	281.0	775.0	737.5	1056.5	1219.0	831.0	625.0	394.0	900.0		
	3 A	956.5	756.0	406.5	250.5	525.0	525.0	962.5	1143.5	919.0	581.0	100.0	694.0		
	B	1181.0	787.5	375.0	331.0	869.0	456.0	487.5	1050.0	1006.5	537.5	494.0	531.0		
Average		880.2	849.0	358.3	292.7	650.1	596.9	812.5	951.1	862.4	655.3	384.3	774.0	658.0	686.5
Treatment Average		864.6		325.5		623.5		881.8		758.9		579.2			

TABLE X (Continued)

Measurement	Pot No.	Fertilized Overhead With 1 Ounce per 3 Gallons Water Every 10 Days		Fertilized Through Wicks										Average	
				Ounces per 100 Gallons of Water											
				0		5		10		20		40			
		1	2	1	2	1	2	1	2	1	2	1	2	1	2
Increase in Plant Height (cm)	1 A	11.0	27.0	5.0	8.0	16.0	12.0	24.0	37.5	36.5	36.5	23.5	34.5		
	B	26.5	22.0	6.0	10.0	24.0	26.5	30.0	28.5	28.0	28.5	31.5	26.0		
	2 A	12.0	23.5	20.5	17.0	25.5	18.5	23.0	47.0	26.0	50.0	20.5	35.0		
	B	26.0	23.5	17.0	25.0	21.5	29.5	43.0	42.0	25.0	48.5	21.0	33.0		
	3 A	25.0	35.0	11.5	15.0	11.5	28.0	35.5	39.0	33.0	34.4	22.0	32.0		
	B	37.5	31.0	13.5	22.0	27.5	21.0	21.0	50.0	36.0	44.0	25.5	28.5		
Average		23.0	27.0	12.3	16.2	21.0	22.6	29.4	40.7	30.8	40.3	24.0	31.5	23.4	29.7
Treatment Average		25.0		14.3		21.8		35.1		35.6		27.8			
Root Condition (1 = poor, .. 5 = excellent)	1	1.0	4.0	3.5	1.5	2.5	4.5	4.0	1.5	1.0	1.0	1.0	2.0		
	2	1.0	2.0	2.5	5.0	2.5	3.0	2.5	5.0	3.0	3.5	1.0	3.5		
	3	1.0	2.5	3.0	4.5	3.5	2.0	3.5	2.0	3.5	1.0	1.0	1.0		
Average		1.0	2.8	3.0	3.7	2.8	3.2	3.3	2.8	2.5	1.8	1.0	2.2	2.3	2.8
Treatment Average		1.9		3.4		3.0		3.1		2.2		1.6			

TABLE X (Continued)

Measurement	Pot No.	Fertilized Overhead With 1 Ounce per 3 Gallons Water Every 10 Days		Fertilized Through Wicks										Average	
				Ounces per 100 Gallons of Water											
				0		5		10		20		40			
		1	2	1	2	1	2	1	2	1	2	1	2	1	2
Reflectometer Readings on Top and Third From Bottom Leaves at Different Dates (Ave. of 6 Plants-2 Plants Per Pot)															
11/3	T	10.6	11.4	14.1	18.8	8.9	10.3	10.2	11.8	8.0	9.4	6.7	8.6	9.8	11.7
	B	11.9	16.2	18.5	13.5	10.5	11.6	12.3	11.7	9.6	11.7	9.1	11.3	12.0	12.7
11/17	T	8.5	10.2	11.6	12.4	10.2	10.1	8.0	7.4	8.0	7.1	6.8	7.8	8.9	9.2
	B	10.9	14.3	14.9	13.1	11.5	12.3	10.8	10.2	11.4	10.5	9.0	12.6	11.4	12.2
12/1	T	8.3	7.8	10.7	11.7	8.5	8.4	6.4	7.1	6.7	7.4	8.5	7.1	8.2	8.3
	B	9.6	9.7	12.4	12.1	10.0	8.8	9.1	9.3	8.0	8.1	10.2	7.3	9.9	9.2
12/15	T	7.7	7.8	10.3	10.5	9.1	8.7	6.7	6.4	7.3	8.9	7.9	7.6	8.2	8.3
	B	8.9	9.3	13.2	10.9	10.8	9.3	8.8	8.2	9.5	7.0	—	7.3	10.2	8.7
Average	T	8.8	9.3	11.7	13.4	9.2	9.4	7.8	8.2	7.5	8.2	7.5	7.8		
	B	10.3	12.4	14.8	12.4	10.7	10.5	10.3	9.9	9.6	9.3	9.4	9.6		
Treatment Average	T	9.1		12.6		9.3		8.0		7.9		7.7			
	B	11.4		13.6		10.6		10.1		9.5		9.5			

TABLE XI

THE EFFECTS OF DIFFERENT CONCENTRATIONS OF TYDEX-C IN THE SOIL MIXTURE, WATERED MANUALLY OR WITH ONE TOP WICK PER POT, ON THE GROWTH AND FLOWERING OF *EUPHORBIA PULCHERRIMA*, VAR. INDIANAPOLIS RED.
(TEST STARTED 10/25/60, COMPLETED 12/21/60)

Measurement	Pot No.	Fertilized Every 7 Days With 1 oz. 20-20-20 Per 3 gal. of Water	Ratio of Tydex-C to Soil Mixture										Average of Tydex-C	
			0:19		0.5:19		1:19		2:19		4:19			
		Manual	Wick	Manual	Wick	Manual	Wick	Manual	Wick	Manual	Wick	Manual	Wick	Manual
Bract Diameter (cm)	1 A	33.0	21.0	27.5	38.0	32.0	33.0	35.5	26.0	32.0	40.0	37.5		
	B	34.5	24.5	29.0	30.0	32.5	15.5	41.0	30.5	35.0	32.5	37.5		
	2 A	38.5	23.5	28.5	31.0	31.0	24.0	34.0	30.5	36.0	34.0	37.0		
	B	41.5	25.0	28.5	34.0	24.5	28.5	32.0	31.5	29.5	31.0	34.5		
	3 A	36.0	30.5	27.5	27.5	32.5	27.5	37.5	42.5	40.0	34.5	32.5		
	B	35.0	19.5	27.0	30.0	32.0	31.0	38.0	35.5	36.0	38.0	34.5		
	4 A	27.0	25.0	27.0	34.5	35.0	30.5	36.0	37.5	35.0	22.5	37.0		
	B	30.0	26.0	27.0	26.0	24.5	28.0	34.5	39.5	35.0	29.0	32.0		
	5 A	31.5	27.0	28.5	33.5	34.0	40.5	37.0	37.0	38.0	35.0	30.5		
	B	36.5	27.0	20.5	24.0	33.5	28.0	36.0	34.0	35.0	33.5	32.5		
	6 A	31.5	30.0	27.5	33.5	30.0	34.0	37.0	38.0	35.5	46.0	34.0		
	B	27.0	38.0	22.5	35.0	28.0	16.0	34.5	37.5	34.0	41.5	37.5		
Average		33.5	26.4	26.8	31.4	30.0	28.0	36.1	35.0	35.1	34.8	34.8	31.1	32.7
			26.6		30.7		32.1		35.1		34.8			
Increase In Plant Height (cm)	1 A	19.5	5.0	7.5	16.5	12.5	13.5	12.5	17.0	17.0	16.0	17.5		
	B	14.0	7.5	8.5	11.0	11.5	5.0	15.0	12.0	15.5	15.0	21.5		
	2 A	16.5	6.0	8.5	15.0	13.5	14.0	15.5	25.5	19.5	15.5	11.0		
	B	17.0	7.0	16.0	13.0	10.0	9.0	14.0	12.5	6.5	20.5	15.0		
	3 A	13.0	7.0	13.5	9.0	14.0	9.0	17.5	15.5	19.0	12.0	11.0		
	B	14.0	11.0	10.0	6.5	11.5	9.0	15.0	21.0	19.0	11.0	13.5		
	4 A	13.0	9.5	8.5	13.5	15.0	18.0	13.5	17.5	13.0	13.5	17.0		
	B	16.5	8.0	6.0	9.0	5.0	13.0	13.0	20.0	13.0	19.5	10.0		
	5 A	17.0	7.5	9.5	15.5	14.0	17.0	11.0	21.0	4.0	13.0	9.0		
	B	14.0	9.0	7.0	7.5	14.0	13.5	10.0	15.5	15.5	10.5	11.5		
	6 A	16.5	15.5	10.5	10.5	18.0	12.5	13.5	20.0	15.5	19.0	12.5		
	B	21.5	8.0	5.5	11.5	19.0	6.0	16.0	21.0	13.0	17.0	11.0		
Average		16.0	8.4	9.3	11.5	13.2	11.6	13.9	18.2	14.2	15.2	13.4	13.0	12.8
Treatment Average			8.9		12.4		12.8		16.2		14.3			

TABLE XI (Continued)

Measurement	Pot No.		Fertilized Every 7 Days With 1 oz. 20-20-20 Per 3 gal. of Water	Ratio of Tydex-C to Soil Mixture										Average of Tydex-C	
				0:19		0.5:19		1:19		2:19		4:19			
			Manual	Wick	Manual	Wick	Manual	Wick	Manual	Wick	Manual	Wick	Manual	Wick	Manual
Root Condition	1		3.5	3.0	5.0	3.5	4.0	1.5	3.5	3.5	4.5	4.0	3.0		
(1 = poor, ...	2		4.0	2.5	4.5	1.5	2.0	2.5	3.0	3.0	3.5	4.0	3.5		
5 = excellent)	3		2.5	3.5	4.5	3.0	4.0	3.0	2.0	4.0	3.5	3.5	4.5		
	4		1.0	3.0	5.0	3.0	4.5	2.5	4.5	3.5	3.0	3.0	2.5		
	5		4.0	1.5	4.0	3.0	5.0	3.5	4.0	3.0	3.0	3.0	2.0		
	6		1.0	4.0	3.0	4.0	4.0	3.5	4.0	4.0	4.0	4.0	3.0		
Average			2.7	2.9	4.3	3.0	3.9	2.8	3.5	3.5	3.6	3.6	3.1	3.2	3.7
Treatment Average				3.6		3.5		3.2		3.6		3.4			
Reflectometer	11/3	T	10.9	10.8	9.8	8.6	9.5	8.7	8.5	8.8	8.4	8.9	9.3	9.2	9.1
Readings on Top		B	11.5	10.3	10.0	10.1	10.9	8.7	10.5	10.2	9.8	10.0	10.8	9.9	10.4
and Third From	11/17	T	8.8	12.8	14.8	10.6	9.4	10.5	9.4	9.3	10.3	10.5	9.3	10.7	10.6
Bottom Leaves at		B	11.4	13.2	16.7	12.7	11.1	11.0	12.4	14.4	13.6	12.8	11.4	12.8	13.0
Different Dates	12/1	T	7.9	12.7	14.8	10.2	9.5	10.5	8.8	8.7	8.5	10.3	9.4	10.5	10.2
(Ave. of 6 Plants-		B	10.5	13.2	15.4	11.4	12.4	11.8	11.3	11.7	11.6	12.3	11.9	12.1	12.5
2 Plants Per Pot)	12/15	T	8.3	12.3	12.5	9.7	10.3	10.3	9.0	8.6	8.2	9.8	9.2	10.1	9.8
		B	9.5	12.7	12.2	11.9	12.2	10.9	10.5	10.4	10.3	10.2	11.2	11.2	11.3
Average		T	9.0	12.2	13.0	9.8	9.7	10.0	8.9	8.9	8.9	9.9	9.3		
		B	10.7	12.4	13.6	11.5	11.7	10.6	11.2	11.7	11.3	11.3	11.3		
Treatment Average		T		12.6		9.8		9.5		8.9		9.6			
		B		13.0		11.6		10.9		11.5		11.3			

TABLE XII

THE EFFECTS OF MANUAL AND WICK WATERING IN CLAY AND PLASTIC POTS ON THE pH OF SOIL SAMPLES TAKEN AT THE TERMINATION OF THE CHRYSANTHEMUM, HYDRANGEA, LILY AND POINSETTIA EXPERIMENTS.

Treatment	Type Of Pot	pH			
		Chrysanthemum[a]	Hydrangea[a]	Lily[a]	Poinsettia[b]
Manually Watered and Fertilized	Clay	5.4	5.7	5.4[c]	6.1
	Plastic	5.0	—	—	6.0
		—	—	—	—
One Top Wick	Clay	5.9	6.5	5.8[c] 5.7[d]	6.4
	Plastic	5.6	—	—	6.4
		—	—	—	—
Two Top Wicks	Clay	5.8	6.1	5.2[c] 5.2[d]	—
	Plastic	5.4	—	—	6.0
		—	—	—	—
One Bottom Wick (spread)	Clay	4.8	5.0	4.9[c] 5.2[d]	5.5
	Plastic	4.8	—	—	5.0
		—	—	—	—
One Bottom Wick (core)	Clay	5.1	—	—	5.9
	Plastic	4.5	—	—	5.6
		—	—	—	—
Average	Clay	5.4	5.8	5.3[c/e] 5.4[d]	6.0
	Plastic	5.1	—	—	5.8
		—	—	—	—

[a] Soil test at start of experiment was pH 6.6, solubridge 23.
[b] Soil test at start of experiment was pH 6.8, solubridge 42.
[c] Placed on experiment 11/29.
[d] Placed on experiment 12/22.
[e] Does not include manually watered and fertilized check.

TABLE XIII

THE EFFECTS OF MANUAL AND WICK WATERING IN CLAY AND PLASTIC POTS ON THE SOLUBLE SALT CONTENT OF SOIL SAMPLES TAKEN AT THE TERMINATION OF THE CHRYSANTHEMUM, HYDRANGEA, LILY AND POINSETTIA EXPERIMENTS.

Treatment	Type Of Pot	Soluble Salts (solubridge, 1:5 dilution)			
		Chrysanthemum[a]	Hydrangea[a]	Lily[a]	Poinsettia[b]
Manually Watered	Clay	36	60	36[c]	41
	Plastic	79	—	—	34
		—	—	—	—
One Top Wick	Clay	28	58	48[c] 37[d]	45
	Plastic	55	—	—	60
		—	—	—	—
Two Top Wicks	Clay	40	60	65[c] 42[d]	60
	Plastic	84	—	—	80
		—	—	—	—
One Bottom Wick (spread)	Clay	37	85	44[c] 37[d]	41
	Plastic	55	—	—	64
		—	—	—	—
One Bottom Wick (core)	Clay	39	—	—	42
	Plastic	72	—	—	66
		—	—	—	—
Average	Clay	36	66	52[c/e] 39[d/e]	46
	Plastic	69	—	—	61
		—	—	—	—

[a] Soil test at start of experiment was pH 6.6, solubridge 23.
[b] Soil test at start of experiment was pH 6.8, solubridge 42.
[c] Placed on experiment 11/29.
[d] Placed on experiment 12/22.
[e] Does not include manually watered and fertilized check.

TABLE XIV

THE EFFECTS OF VARIOUS CONCENTRATIONS OF 20-20-20 FERTILIZER AND DIFFERENT METHODS OF WATERING ON THE pH OF SOIL SAMPLES TAKEN AT THE TERMINATION OF THE CHRYSANTHEMUM, HYDRANGEA, LILY, AND POINSETTIA EXPERIMENTS.

Treatment	Number Of Wicks	pH			
		Chrysanthemum[a]	Hydrangea[a]	Lily[a]	Poinsettia[b]
Manually Watered and Fertilized		6.0[c] 6.0[d]	5.2 —	— —	— —
Watered by Wicks Fertilized Manually	1	5.3[c] 5.9[d]	— —	— —	5.9[c] 6.3[d]
	2	— —	6.2 —	— —	6.2[c] 7.0[d]
Watered, No Fertilizer Added	1	6.0[c] 6.2[d]	— —	6.0 —	5.8[c] 6.6[d]
	2	— —	6.3 —	— —	6.9[c] 7.1[d]
5 oz. 20-20-20 per 100 Gallons Water In Reservoir	1	6.1[c] 6.5[d]	— —	5.9 —	6.3[c] 6.9[d]
	2	— —	6.4 —	— —	6.1[c] 7.1[d]
1 oz. 20-20-20 per 100 Gallons Water In Reservoir	1	5.5[c] 6.5[d]	— —	5.7 —	6.0[c] 6.7[d]
	2	— —	6.2 —	— —	5.5[c] 6.4[d]
20 oz. 20-20-20 per 100 Gallons Water In Reservoir	1	4.9[c] 6.0[d]	— —	5.3 —	6.5[c] 6.2[d]
	2	— —	5.2 —	— —	5.0[c] 5.6[d]
40 oz. 20-20-20 per 100 Gallons Water In Reservoir	1	5.5[c] 5.9[d]	— —	— —	6.1[c] 5.6[d]
	2	— —	5.0 —	— —	5.3[c] 5.9[d]

[a] Soil test at start of experiment was pH 6.6 solubridge 23.
[b] Soil test at start of experiment was pH 6.8 solubridge 42.
[c] Sample from top ½ of pot.
[d] Sample from bottom ½ of pot.

TABLE XV

THE EFFECTS OF VARIOUS CONCENTRATIONS OF 20-20-20 FERTILIZER AND DIFFERENT METHODS OF WATERING ON THE SOLUBLE SALT CONTENT OF SOIL SAMPLES TAKEN AT THE TERMINATION OF THE CHRYSANTHEMUM, HYDRANGEA, LILY, AND POINSETTIA EXPERIMENTS.

Treatment	Number Of Wicks	Soluble Salts (solubridge, 1:5 dilution)			
		Chrysanthemum[a]	Hydrangea[a]	Lily[a]	Poinsettia[b]
Manually Watered and Fertilized		32[c] 34[d]	48 —	— —	— —
Watered by Wicks Fertilized Manually	1	28[c] 40[d]	— —	— —	31[c] 26[d]
	2	— —	50 —	— —	25[c] 18[d]
Watered, No Fertilizer Added	1	30[c] 26[d]	— —	24 —	19[c] 22[d]
	2	— —	39 —	— —	20[c] 27[d]
5 oz. 20-20-20 per 100 Gallons Water In Reservoir	1	40[c] 18[d]	— —	42 —	27[c] 44[d]
	2	— —	60 —	— —	33[c] 29[d]
10 oz. 20-20-20 per 100 Gallons Water In Reservoir	1	62[c] 39[d]	— —	32 —	51[c] 34[d]
	2	— —	80 —	— —	56[c] 54[d]
20 oz. 20-20-20 per 100 Gallons Water In Reservoir	1	96[c] 67[d]	— —	64 —	62[c] 88[d]
	2	— —	152 —	— —	71[c] 110[d]
40 oz. 20-20-20 per 100 Gallons Water In Reservoir	1	175[c] 110[d]	— —	— —	155[c] 118[d]
	2	— —	220 —	— —	120[c] 130[d]

[a] Soil test at start of experiment was pH 6.6 solubridge 23.
[b] Soil test at start of experiment was pH 6.8 solubridge 42.
[c] Sample from top ½ of pot.
[d] Sample from bottom ½ of pot.

TABLE XVI

THE EFFECTS OF DIFFERENT RATIOS OF TYDEX-C TO SOIL MIXTURE, WATERED MANUALLY OR THROUGH ONE TOP WICK, ON THE pH OF THE SOIL SAMPLE TAKEN AT THE START AND THE TERMINATION OF THE CHRYSANTHEMUM, LILY, AND POINSETTIA EXPERIMENTS.

Treatment	Method Of Watering	pH					
		Start			Termination		
		Chrysanthemum	Lily	Poinsettia	Chrysanthemum	Lily	Poinsettia
Watered And Fertilized Manually With 20-20-20		6.6	6.6	6.6	5.3	5.6	5.6
No Fertilizer Added	Manual	6.6		6.6	6.4		7.1
	Wick	6.6	6.6	6.6	7.1	6.0	6.6
0.5:19	Manual	5.1		5.6	6.1		6.5
	Wick	5.1	5.9	5.6	6.9	5.9	6.2
1:19	Manual	5.2		5.4	6.0		6.5
	Wick	5.2	5.2	5.4	6.6	5.4	5.8
2:19	Manual	4.5		5.3	5.7		5.8
	Wick	4.5	4.2	5.3	5.7	4.8	5.2
4:19	Manual	3.7		4.5	4.9		4.8
	Wick	3.7		4.5	4.9		4.8
Average[a/]	Manual	5.0		5.5	5.8		6.1
	Wick	5.0	5.5	5.5	6.2	5.5	5.7

[a/] Does not include the watered and fertilized manually treatment.

TABLE XVII

THE EFFECTS OF DIFFERENT RATIOS OF TYDEX-C TO SOIL MIXTURE, WATERED MANUALLY OR THROUGH ONE TOP WICK, ON THE SOLUBLE SALT CONTENT OF THE SOIL SAMPLE TAKEN AT THE START AND THE TERMINATION OF THE CHRYSANTHEMUM, LILY, AND POINSETTIA EXPERIMENTS.

Treatment	Method Of Watering	Soluble Salts (solubridge, 1:5 dilution)					
		Start			Termination		
		Chrysanthemum	Lily	Poinsettia	Chrysanthemum	Lily	Poinsettia
Watered And Fertilized Manually With 20-20-20		23	23	19	27	28	21
No Fertilizer Added	Manual	23		19	25		16
	Wick	23	23	19	16	25	24
0.5:19	Manual	34		30	27		17
	Wick	34	40	30	24	23	21
1:19	Manual	54		42	32		16
	Wick	54	54	42	20	17	25
2:19	Manual	75		60	24		21
	Wick	75	80	60	22	24	26
4:19	Manual	101		85	29		31
	Wick	101		85	38		40
Average[a/]	Manual	57		47	27		20
	Wick	57	49	47	24	22	27

[a/] Does not include the watered and fertilized manually treatment.

VITA

Jack Delmar Triplett, Jr.

Candidate for the Degree of

Master of Science

Thesis: THE EFFECTS OF APPLYING WATER AND/OR FERTILIZER THROUGH WICKS ON THE GROWTH AND FLOWERING OF POTTED PLANTS

Major Field: General Horticulture

Biographical:

Personal Data: Born August 7, 1937, at Brownsville, Texas, the son of Jack D. and Rachel B. Triplett.

Education: Attended elementary school at El Jardin School, located in Cameron Co., Texas; attended High School at El Jardin High School and Brownsville High School located in Cameron Co., Texas; graduated from Lenapah High School, Lenapah, Oklahoma in 1955; received a Bachelor of Science degree from the Oklahoma State University, with a major in Field Crops in 1959; fulfilled requirements for a teaching certificate in Vocational Agriculture at Oklahoma State University in 1960; completed requirements for the Master of Science degree in August, 1961.

Professional experience: Part time self employed farmer from 1952 to 1961; teaching assistantship with Oklahoma State University Horticulture Department 1960 to 1961.

Member of: Horticulture Club, Agronomy Club, Collegiate FFA, Oklahoma Vocational Association, American Vocational Association, and American Society of Horticulture Science.