AN ANALYSIS OF POINSETTIA TREE PRODUCTION, KEEPING QUALITY, AND INTERCROPPING OF 11.4 CM (4½ IN) POT POINSETTIAS

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER I

INTRODUCTION AND LITERATURE REVIEW

Euphorbia pulcherrima Willd., the poinsettia, belongs to the family Euphorbiaceae or spurge family. Other members of this family include scarlet plume, *E. fulgens*; snow-on-the-mountain, *E. marginata*; crown of thorns, *E. splendens*; *E. ephithymoides*, known commonly as *E. polycroma* and many other succulents (4).

The poinsettia was cultivated by the Aztecs of Mexico in ancient times and is native to the area near Taxco. This plant was first introduced in the United States by Joel Robert Poinsett, the first U.S. ambassador to Mexico. Robert Buist, a horticulturalist, was the first to propagate the poinsettia for sale in 1828 (13,17).

Paul Ecke Poinsettias, Encinitas, California, (5) outlined a schedule for producing a "Poinsettia Table Tree" having an overall height of 71-91 cm (28-36 in), utilizing the 'Gutbier's V-14 Glory' cultivar. The schedule for the California and Florida areas was: pan rooted cutting, May 15; first pinch, August 10; second pinch, September 15; and full bloom, December 15. For the Ohio-Wisconsin areas, the suggested first and second pinch dates were August 1 and September 5, respectively.

Virginia Zrebiec, Paris Fracasso, and Harry Tayama of Ohio State University (21) reported on the production of double-pinched and single-pinched "mini-poinsettia trees" in 17.8 cm (7 in) pots starting with rooted cuttings June 24 and July 22, respectively. These trees finished 63.5 cm (25 in) and 55.8 cm (22 in) above the pot rim in December. The double-pinched plant was considered more attractive, but required the extra month to produce.

'Brilliant Diamond', 'V-14 Glory', and 'Top White' cultivars were grown as trees by P. Allen Hammer and Terri Kirk (9). 'V-14 Glory' was found to be the best cultivar as a tree for height, color, form, and sturdiness. The schedule for producing the trees was: cuttings potted, May 20; first pinch, July 31; lower leaves removed, August 21; second pinch, September 3; lights on, September 16; and lights off, September 26.

In the 1981 poinsettia trial at Oklahoma State University, 'V-14 Glory' poinsettia trees were grown on the following schedule: pan rooted cuttings in 19 cm (7½ in) pots, May 28; first pinch, August 10; second pinch, September 15, growth retardant spray, October 15; transplant to 25 cm (10 in) pot, November 12; full bloom, December 8-15. Axillary branches were pruned off of the main trunk periodically, but leaves were allowed to remain on the lower trunk until mid-October, then stripped off (14).

Growth regulators (retardants) are often used to restrict stem elongation in poinsettias. The new shorter

growing cultivars of poinsettia do not necessarily need the growth regulators. Growth regulators can be used to produce a more compact poinsettia tree which is desirable from a plant-handling and shipping standpoint, to grow 'pixie' or 'mini' pot poinsettias, and to darken leaf color by 'toning' (1,7,10).

The most commonly used growth retardants are chlormequat (Cycocel) and ancymidol (A-Rest). These can be applied either by spray or soil drench. Ancymidol can also be applied by using impregnated clay granules (6,12,20).

Many factors influence cost of production. One of these factors is finished plant spacing and percent efficiency in bench space utilized (4). The most important factor influencing production costs is the productivity of the bench use. For poinsettias, many growers have reduced production costs through space efficiency gains. However in many cases, productivity advantages such as closer spacing may be offset by reduced quality (15).

Intercropping is commonly used in nursery production but seldom utilized in the greenhouse. Shanks found that hanging poinsettia baskets and poinsettia trees could be finished at little extra space or heat cost when interspaced among and above smaller poinsettia plants or other plants such as azaleas (17).

Usually a producer of smaller 11.4 cm (4½ in) 'V-14' poinsettias would give each pot 20 x 23 cm (8 x 9 in or 0.5 sq ft) of bench space. If a grower was producing

poinsettia trees in a greenhouse with the tree spacing of 61 x 61 cm (24 x 24 in) and could grow an intercrop of eight 11.4 cm (4½ in) pot 'V-14' poinsettias under four poinsettia trees on 1.3 sq m (14 sq ft) of bench, then usable greenhouse bench space would be increased by 28.6%. If he would grow twelve 11.4 cm (4½ in) pot poinsettias as an intercrop in the same space, then usable greenhouse bench space would be increased by 42.9% (8).

When poinsettia trees are moved to a home environment, abscission of leaves and bracts results more rapidly than in the greenhouse (14). Shanks found that factors such as cultivar and stress conditions of darkness, high temperatures, and drought could affect the keeping quality of poinsettias (16,17).

Acclimatization is the process required to cause physiological changes within a plant system enabling the plant to undergo a radical change in environment without severe damage or death (19). Light acclimatization has been employed successfully with tropical trees such as Ficus benjamina and Brassaia actinophylla and with African violets (2,3,19).

The objectives of this study were as follows:

1. To develop local schedules for large, medium, and small poinsettia trees;
2. To calculate total space usage in sq m wks (sq ft wks) for each size of poinsettia tree;

3. To determine the feasibility of growing 11.4 cm ($4\frac{1}{2}$ in) pot poinsettias beneath poinsettia trees;
4. To compare the effects of 40% shade (0, 3, 4, or 5 weeks) on keeping quality.
5. To determine if the keeping quality of poinsettia trees is related to the tree size.

CHAPTER II

MATERIALS AND METHODS

Facilities

Research was conducted at the Oklahoma State University Horticulture Research Greenhouses in Stillwater, Oklahoma (36°9' N latitude, 97°5' N longitude). The experiment was conducted in a fiberglass covered greenhouse. Heat was provided by two gas-fired Modine heaters with two Acme jet tubes to circulate the heat. Summer cooling was provided by Acme 'Kool-Cell' evaporative cooling pads and two exhaust fans. Raised welded wire benches 46 cm (18 in) from the floor supported by concrete blocks were used. The headhouse conference room (20°C (68°F), 918 lux (85 ft c), 11.96 $mE/m^2/sec$ fluorescent light) was used to simulate a low light consumer environment for the keeping quality portion of the study.

'V-14 Glory' Stock Plants

The poinsettia cultivar used was 'Gutbier's V-14 Glory'. All cuttings used in propagation were taken from the same stock plants. The rooted cuttings used for the stock plants

were received from Paul Ecke[1] on March 18, 1982. On that day, the stock plant cuttings were panned in 15 cm (6 in) azalea pots.

The growing medium was Pro Mix BX.[2] The contents of 0.77 m^3 (a cubic yard) of Pro Mix BX are as follows:

Sphagnum Peat	.465 m^3 (13.2 bushels)
Vermiculite	.155 m^3 (4.4 bushels)
Perlite	.155 m^3 (4.4 bushels)
Dolomite	4.54 kg (10 lbs)
0-8.8-0 (0-20-0)	1.134 kg (2.5 lbs)
13.8-0-36.9 (13.8-0-44.5)	680 g (1.5 lbs)
Fritted Trace Elements	85 g (3 oz)
Wetting Surfactant	142 g (5 oz)

After panning each plant was watered and a fungicide drench was applied to each plant. The fungicide drench was made with fenanainosulf (Lesan) 35% wp and benomyl (Benlate) 50% wp at the rate of 237 g (8 oz) of each chemical per 378.5 l (100 gal) of water. Each plant received 177 ml (6 oz) of the fungicide drench. The fungicide drench was applied at regular four week intervals throughout the experiment. All plants were fertilized using Peters Peat Lite Special[3] 15-7-14 (15-16-17) at 250 ppm N, 116 ppm P, and

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[1]Rooted cuttings for stock plants courtesy of Paul Ecke Poinsettias, Encinitas, California.

[2]Pro Mix BX is a product of Premier Peat Brands Corp., New York, New York.

[3]Peat-Lite Special is a product of Robert B. Peters Company, Inc., Allentown, Pannsylvania.

233 ppm K. The fertilizer solution was applied at every watering throughout the entire propagation time of this experiment utilizing a Smith injector at the ratio of 1:100.

On April 8, 1982, three weeks after panning, the stock plants were pinched to promote lateral branching. On April 24, the stock plants were transplanted into 30.5 cm (12 in) azalea pots. The lateral breaks grew well and six weeks later, on May 21, 1982, the first cuttings were taken.

Cultural Practices

Fertilizer applications for all tree lots and 11.4 cm (4½ in) pot intercrops were identical. A Gewa 1:100 proportioner was used. The fertility program for all plants began during the propagation and early growth period. Peters Peat-Lite Special 15-7-14 (15-16-17) was applied weekly at 500 ppm N, 232 ppm P, and 466 ppm K for two applications as soon as any roots appeared during propagation. Then all plants were fertilized at every watering at 250 ppm N, 116 ppm P, and 233 ppm K.

On August 20, the rate was increased to 300 ppm N, 139 ppm P, and 280 ppm K from 15-7-14 (15-16-17). Finally on October 15, the type of fertilizer was changed to Peters Poinsettia Finisher 15-8.8-20.8 (15-20-25) at 300 ppm N, 176 ppm P, and 416 ppm K until December 10.

A fungicide drench of fenanainosulf (Lesan) 35% wp and benomyl (Benlate) 50% wp, as described for stock plants, was applied every four weeks to all plants. Aldicarb (Temik)

was top-dressed at monthly intervals for insect control. The growing medium used was Pro Mix BX. Pad and fan cooling was employed to hold temperatures as cool as possible in the summer. As soon as the natural fall temperatures allowed, a night temperature range of 17-17.7°C (63-64°F) was maintained as closely as possible with daytime temperatures ranging from about 20°C (68°F) on cloudy days to 26°C (79°F) on sunny days.

Experimental Treatments

The experiment was comprised of three parts:

1. Poinsettia trees were grown to establish local schedules, to obtain a variety of sizes, and to derive bench-space-use requirements for each size tree produced;
2. Small 11.4 cm (4½ in) pot poinsettias were intercropped under the poinsettia tree canopy to attempt to increase space utilization;
3. A representative group of each of the poinsettia tree sizes was subjected to sun or shade "acclimatization" for various periods of time to determine which tree size and shade grouping would have the best keeping quality.

Poinsettia Tree Production

Five different groups of poinsettia trees designated as Lot #1, Lot #2, Lot #3, Lot #4, and Lot #5 were grown. All

cuttings were rooted in 11.4 cm (4½ in) pots under intermittent mist. Five lots of cuttings were propagated at two week intervals starting May 21 and ending July 16 (see Table I for detailed schedule for each tree size). Later the rooted cuttings were panned into the appropriate sized pot ranging from a 25.4 cm (10 in) pot for Lot #1 down to a 16.5 cm (6½ in) pot for Lot #5. Each lot of cuttings was transplanted 5.5 weeks after propagation. Lot #1 was transplanted into a 25.4 cm (10 in) pot on June 29, Lot #2 into a 21.6 cm (8½ in) pot on July 13, Lot #3 into a 19 cm (7½ in) pot on July 27, Lot #4 into a 17.8 cm (7 in) pot on August 10, and Lot #5 into a 16.5 cm (6½ in) pot on August 24.

The lowest six branches on all trees were removed in the seventh week after propagation (Table I). Then nine weeks after propagation, the next six lower branches were removed (Table I).

Lots #1, #2, and #3 were pinched twice at eleven weeks and at fifteen weeks from propagation, whereas Lots #4 and #5 were pinched only once at eleven weeks after propagation (Table I). Lot #1 was pinched on August 6 and September 3; Lot #2 was pinched on August 20 and September 17; Lot #3 was pinched on September 3 and October 1; Lot #4 was pinched on September 17; and finally, Lot #5 was pinched on October 1.

All but the top ten axillary shoots were removed from all the trees in each lot three weeks after the first pinch.

TABLE I

POINSETTIA TREE PRODUCTION SCHEDULE

	Lot #1	Lot #2	Lot #3	Lot #4	Lot #5
Propagation Date 11.4 cm (4½ in) pot 15 x 15 cm (6 x 6 in) spacing	05/21	06/04	06/18	07/02	07/16
1st Spacing Move 20.3 x 20.3 cm (8 x 8 in) spacing (2 weeks)	06/04	06/18	07/02	07/16	07/30
Transplant Date 30.5 x 30.5 cm (12 x 12 in) spacing	06/29	07/13	07/24	08/10	08/24
Pot Size (cm)	25.4 (10")	21.6 (8½")	19 (7½")	17.8 (7")	16.5 (6½")
(5.5 weeks)					
Lowest 6 Branches Removed (7 weeks)	07/09	07/23	08/06	08/20	09/03
Lower 6 Branches Removed (9 weeks)	07/23	08/06	08/20	09/03	09/17
45.7 x 45.7 cm (18 x 18 in) spacing	08/06	08/20	09/03	09/17	09/17
Wks from Propagation	11	11	11	11	9
1st Pinch (11 weeks)	08/06	08/20	09/03	09/17	10/01
Remove all but the top 10 remaining axillary shoots (14 weeks)	08/27	09/10	09/24	10/08	10/22
2nd Pinch (15 weeks)	09/03	09/17	10/01	NONE	NONE
Final Spacing 61 x 61 cm (24 x 24 in) spacing	09/17	09/17	09/17	N/A	N/A
Wks from Propagation	17	15	13		
Remove all leaves and undesirable axillary shoots below the branches (18 weeks)	09/24	10/08	10/22	11/05	11/19
Cycocel/Alar Growth Retardant (18 weeks)	09/24	10/08	10/22	N/A	N/A
Full Bloom: 12/10 Wks from Propagation	29	27	25	23	21

Four weeks later all leaves and undesirable axillary shoots below the top ten branches were removed from all the trees in each lot.

Eighteen weeks after propagation, chlormequat/succinamic acid (Cycocel[4]/Alar[5]) retardant foliar spray at 2000 ppm of each material was applied to plants in Lots #1, #2, and #3 only, on September 24, October 8, and October 22, respectively. The growth retardant spray material was made by dissolving 9 g of succinamic acid (Alar) and 64 ml of chlormequat (Cycocel) in 3.785 l (1 gal) of water.

Lots #1, #2, and #3 were moved four times as the trees grew larger to accomodate growth. Lots #4 and #5 were moved only three times (Table I). Spacings were 15 x 15 cm (6 x 6 in); 20.3 x 20.3 cm (8 x 8 in); 30.5 x 30.5 cm (12 x 12 in); 45.7 x 45.7 cm (18 x 18 in); and 61 x 61 cm (24 x 24 in).

The experiment was terminated on December 10 when all plants were judged to be in full bloom. This was 29 weeks from propagation for Lot #1, 27 weeks for Lot #2, 25 weeks for Lot #3, 23 weeks for Lot #4, and 21 weeks for Lot #5.

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[4]Alar-Succinamic acid (2,2-dimethyl hydrozide), Alar-Aminozide, B-Nine 85% wp, manufactured by Uniroyal Chemical, Division of Uniroyal, Inc., Naugatuck, Connecticut.

[5]Cycocel-chlormequat (2-Chloroethyl trimethylammonium chloride), an 11.8% liquid formulation manufactured by American Cyanamide Co., Ag. Division, Princeton, New Jersey.

Poinsettia Intercropping

On August 20, 450 cuttings from 'V-14 Glory' stock plants were propagated. All cuttings were direct-rooted in 11.4 cm (4½ in) pots under intermittent mist.

Four weeks later on September 17, the intercropping plants were placed under the five tree lots at three densities. Lots #1, #2, and #3 had 0, 8, and 12 11.4 cm (4½ in) intercropping plants under a canopy of four trees occupying 1.3 sq m (14 sq ft). Lots #4 and #5 had 0, 8, and 12 intercrop plants under a canopy of six trees occupying 1.3 sq m (14 sq ft).

On September 24, one week later, all cuttings of the 'V-14 Glory' intercrop were pinched to six nodes. The growth retardant spray of chlormequat (Cycocel) and succinamic acid (Alar) at the rate of 2000 ppm of each material was applied twice to all of the intercrop plants on October 22 and October 29.

Poinsettia Tree Keeping Quality

The five poinsettia tree lots were divided into the four treatments shown below. For the "shade acclimatization" treatments 1, 2, and 3, 40% Solar-Shade fabric obtained from Jednak Floral Co., Columbus, Ohio, was used to provide the shading. The treatments were:

1. Five weeks of shade beginning on November 12;
2. Four weeks of shade beginning on November 19;

3. Three weeks of shade beginning on November 26;

4. Zero weeks of shade--full sun for entire crop life.

On December 17, all plants were placed in the headhouse conference room for five weeks. The experiment was terminated January 21, 1983.

Experimental Design

Trees and Intercropping

On September 17, the five poinsettia tree lots and the small pot intercrop plants were placed into five latin squares. The latin squares were made up of three rows and three columns and three treatments. The three treatments were intercropping densities of 0, 8, and 12 11.4 cm (4½ in) pot poinsettias for a total of 60 11.4 cm (4½ in) pots per latin square. In Lots #1, #2, and #3, each replication consisted of four trees for a total of 36 trees. Trees were spaced at 61 x 61 cm (24 x 24 in). In Lots #4 and #5, there were six trees per replication for a total of 54 trees. These trees were spaced at 45.7 x 45.7 cm (18 x 18 in).

Keeping Quality

In the keeping quality experiment, 53 poinsettia trees were arranged into a completely randomized design. Eight poinsettia trees from Lot #1 and twelve from each of Lots #2, #3, and #4 were equally allocated to the four shading treatments. From Lot #5, three trees were assigned to five weeks shade and two each to the other shade levels.

Physical Arrangement

The poinsettia tree and intercropping studies were conducted at the Oklahoma State University Horticulture Research Greenhouses. Each of the five latin squares was placed on three 1.06 x 3.65 m (3½ x 12 ft) welded wire benches. Lot #1 was located on the east half of the greenhouse closest to the cooling pads. Lot #2 was located on the east half of the greenhouse between Lots #1 and #3. Lot #3 was the greatest distance from the cooling pads on the east half of the greenhouse. Lots #4 and #5 were located on the west half of the greenhouse with Lot #4 closest to the cooling pads.

The keeping quality study was conducted in Greenhouse 3 and the headhouse conference room of the Oklahoma State University Horticulture Research Greenhouses. All plants were grown in full sun in House 1 until November 12, when they were moved to House 3. Plants were placed at the proper time into their respective shade treatments (1 through 4) on raised benches (full sun or covered by the 40% shade cloth). At the end of five weeks, the poinsettia trees were placed in the conference room (December 17) in a completely randomized design to determine keeping quality. Each plant occupied 0.84 sq m (9 sq ft) of space. This study was conducted for a five week period ending January 21, 1983.

Data Recorded

Poinsettia Tree Production

All data except pollen date were collected December 2 through December 10, 1982. Pollen dates were recorded November 23 through December 10.

Vegetative Plant Height (cm). Vegetative plant height was measured from the pot rim to the tallest point of the tree.

Canopy Diameter (cm). Circumference of the circle shape was measured and the diameter was calculated from the formula: circumference divided by pi (3.14) equals diameter.

Average Bract Diameter (cm). An average bract in a uniform, central location from each plant was selected and measured from the tip of one bract leaf to the tip of the opposite bract leaf.

Caliper (cm). The stem or trunk of the tree was measured approximately 15 cm (6 in) above the pot rim.

Anthesis Date. The date was recorded when the poinsettia tree had approximately one-half of the bracts showing pollen in three or more cyathia.

Poinsettia Intercropping

All data except light intensity were collected on

December 15, 1982. Light intensity was recorded on November 15.

Vegetative Plant Height (cm). Vegetative plant height was measured from above the pot rim to the tallest point of the plant.

Average Bract Diameter (cm). An average bract in a uniform, central location from each plant was selected and measured from the tip of one bract leaf to the tip of the opposite bract leaf.

Number of Bracts. The total number of bracts developed by each plant was recorded.

Total Fresh Weight (g). The plants were watered in advance of this measurement to insure turgidity. The entire plant was cut off from the root ball at the soil line. Total fresh weight was measured with a gram scale.

Quality Rating. A scale of 1-7 was used. One was the poorest quality and seven was the best quality. Features taken into consideration were degree of bract development, bract quality and color, and amount and quality of vegetative growth (Figure 1).

Light Intensity.[6] The light intensity was measured

[6]Light intensity was measured in microEinsteins per square meter per second using the LI-190SB quantum sensor of the LI-COR LI-188B integrating/radiometer/photometer.

Figure 1. Quality Rating of 11.4 cm (4½ in) Pot Poinsettias (1-7)

below each of the five lots of trees at the height of the intercrop. Nine readings were made per latin square, one reading for each experimental treatment.

Poinsettia Tree Keeping Quality

The data were collected for five weeks beginning December 17, 1982, and ending January 21, 1983.

Light Intensity. The light intensity in $mE/m^2/sec$ was measured on the full sun bench and the 40% shade bench while plants were being forced. Also, $mE/m^2/sec$ and lux (foot candles) were measured (top of each plant) in the headhouse conference room during the keeping quality study.

Number of Leaves/Bracts Dropped. The trees were removed from the greenhouse, placed in the low-light-level room, and monitored daily for the total number of leaves and/or bracts that fell to the floor. No distinction was made between vegetative leaves and bract leaves.

Number of Live Leaves/Bracts. At the termination of the keeping quality study, the total number of leaves and bracts left on each tree was counted. The parameters, total leaves/bracts and percent leaf/bract senescence, were calculated by the computer.

Date Tree No Longer Usable. The date the tree was judged to be no longer usable was determined (when the

leaves/bracts of the poinsettia tree had deteriorated to the point that the plant was no longer "showy" or attractive).

CHAPTER III

EXPERIMENTAL RESULTS

Poinsettia Tree Production

Vegetative Plant Height

Each tree lot was significantly different in average vegetative plant height (Table II). Lot #1 trees were tallest and Lot #5 trees were the shortest plants produced. The average height of Lot #1 trees was 86.9 cm; Lot #2, 81.3 cm; Lot #3, 72.7 cm; Lot #4, 68.8 cm; and Lot #5, 52.2 cm.

Canopy Diameter

Lot #1 trees had the largest average canopy diameter with a diameter of 83.4 cm (Table II). Lot #2 trees had an average canopy diameter of 71.2 cm and were significantly larger than trees in Lots #3, #4, and #5. Lot #4 trees had a significantly larger average canopy diameter than trees in Lots #3 and #5, and averaged 58.0 cm. No significant difference was found between trees in Lots #3 and #5, the two smallest average canopy diameters (53.2 cm and 52.1 cm, respectively).

TABLE II

COMPARISON OF POINSETTIA TREE PARAMETERS

	Height cm	Diameter cm	Bract Diameter cm	Caliper cm	Pollen Date
Lot #1 Prop. 5/21	86.9 A[z]	83.4 A	37.3 B	1.8 A	Dec. 7 A
Lot #2 Prop. 6/4	81.3 B	71.2 B	35.8 C	1.6 B	Dec. 4 B
Lot #3 Prop. 6/18	72.7 C	53.2 D	34.0 D	1.5 C	Dec. 2 C
Lot #4 Prop. 7/2	68.8 D	58.0 C	41.2 A	1.4 D	Nov. 26 D
Lot #5 Prop. 7/16	52.2 E	52.1 D	36.0 C	1.2 E	Nov. 24 E
PR > F	0.0001	0.0001	0.0001	0.0001	0.0001

[z]Duncan's Multiple Range Test at the alpha level of .05 was utilized to separate the means. Means within a column followed by the same letter are not significantly different. Means for tree Lots #1, #2, and #3 are averages of 24 trees, and Lots #4 and #5 are averages of 36 trees.

Average Bract Diameter

Average bract diameter for trees in Lot #4 was 41.2 cm and was significantly larger than the average for any of the other tree lots (Table II). Lot #1 bracts averaged 37.3 cm and were significantly larger than bracts in Lots #2, #3, and #5. Both Lot #2 and Lot #5 bracts were significantly larger than those in Lot #3 which were the smallest (34.0 cm). Lot #2 bracts averaged 35.8 cm and those in Lot #5 averaged 36.0 cm. No significant difference in bract size was found between these two lots.

Caliper

Each lot of trees was significantly different in average caliper (Table II). Lot #1 trees had largest caliper and Lot #5 trees had the smallest caliper. The average caliper of Lot #1 trees was 1.8 cm; Lot #2, 1.6 cm; Lot #3, 1.5 cm; Lot #4, 1.4 cm; and Lot #5, 1.2 cm.

Anthesis Date

The largest trees matured the slowest. Lot #1 trees had an average pollen date of December 7 which was significantly later than the pollen dates for all other tree lots (Table II). Lots #2, #3, #4, and #5 plants had average pollen dates of December 4, December 2, November 26, and November 24, respectively. The average pollen date for each tree lot was significantly different.

Poinsettia Intercrop

There were no significant interactions between tree sizes (lots) and intercrop pot densities.

Vegetative Plant Height

No significant difference was found in the average vegetative heights of the 11.4 cm (4½ in) pot 'V-14 Glory' intercrops grown under tree Lots #3 and #5 (Table III). Average plant heights for these plants were 20.8 cm and 20.6 cm, respectively, significantly the tallest intercrop plants. Similarly, no significant difference was found between the intercrops grown under tree Lots #2 and #4. Heights for these plants were 18.1 cm and 18.8 cm, respectively. The significantly smallest average height was 16.7 cm for plants grown under tree Lot #1.

In averaging the height of the intercrop plants grown under all tree lot treatments, no significant difference was found between intercrop densities of 8 and 12 pots. Average heights for the 8 pot density was 19.0 cm and for the 12 pot density, 18.9 cm (Table IV).

Average Bract Diameter

The average bract diameter of 26.1 cm for the intercrop grown under tree Lot #3 was significantly largest (Table III). The intercrop plants grown under Lot #5 averaged 24.1 cm, significantly larger than for the plants grown beneath tree Lots #1, #2, and #4. No significant difference was found

TABLE III

COMPARISON OF POINSETTIA INTERCROP PARAMETERS OVER THE TWO PLANT DENSITIES

Intercrops Grown Beneath Poinsettia Trees	Height cm	Bract Diameter cm	Number of Bracts	Fresh Weight g	Rating 1-7
Lot #1	16.7 C[z]	17.2 D	6 A	68.5 D	4.0 C
Lot #2	18.1 B	21.1 C	6 A	89.2 C	5.1 B
Lot #3	20.8 A	26.1 A	6 A	130.6 A	6.4 A
Lot #4	18.8 B	20.2 C	6 A	82.9 C	4.2 C
Lot #5	20.6 A	24.1 B	6 A	106.3 B	5.4 B
PR > F	0.0035	0.0008	N.S.	0.0001	0.0002

[z]Duncan's Multiple Range Test at the alpha level of .05 was utilized to separate the means. Means within a column followed by the same letter are not significantly different. Each mean presented is the mean of 60 plants.

TABLE IV

COMPARISON OF POINSETTIA INTERCROP PARAMETERS OVER ALL TREE LOT TREATMENTS

Treatment	Height cm	Bract Diameter cm	Number of Bracts	Fresh Weight g	Rating 1-7
8 Pots 28.6%[y]	19.0 A[z]	22.5 A	6 A	101.6 A	5.3 A
12 Pots 42.9%	18.9 A	21.0 B	6 A	89.4 B	4.7 B
PR > F	N.S.	0.0223	N.S.	0.0016	0.0014

[z]Duncan's Multiple Range Test at the alpha level of .05 was utilized to separate the means. Means within a column followed by the same letter are not significantly different. Each mean presented for the 8 pot density is the mean of 120 plants and for the 12 pot density, 180 plants.

[y]Percent increase in usable bench space.

between the plants grown under tree Lots #2 and #4. The average bract diameter for the Lot #2 intercrop plants was 21.1 cm and for the Lot #4 intercrop plants, it was 20.2 cm, both significantly larger than for plants grown under tree Lot #1 which averaged 17.2 cm.

A significant difference was found when averaging the bract diameters for intercrop plants grown at different densities (Table IV). The average bract diameter of 22.5 cm for the 8 pot density plants was significantly larger than the 21.0 cm of the 12 pot density plants.

Number of Bracts

No significant difference was found in average number of bracts between the intercrop plants grown under the five tree lots. Also, pot density caused no significant differences. All intercrop plants had an average of six bracts per plant (Tables III and IV).

Total Fresh Weight

The intercrop plants grown beneath tree Lot #3 had an average total fresh weight of 130.6 g, significantly greater than the fresh weights of plants grown under all other tree lots (Table III). The average fresh weight of 106.3 g for plants grown under tree Lot #3 was significantly greater than the weight of plants grown under tree Lots #1, #2, and #4. No significant difference was found between plants grown under tree Lots #1 and #4 which measured 89.2 g and

82.9 g, respectively. Lot #1 intercrop plants' fresh weight was 68.5 g and was significantly smaller than for all other intercrop plants.

The average total fresh weight for plants in the 8 pot density spacing, averaged for all tree lot treatments, was 101.6 g and was significantly greater than for the 12 pot density plants which had an average fresh weight of 89.4 g (Table IV).

Quality Rating

The average quality rating of 6.4 for the intercrop plants grown beneath tree Lot #3 was significantly better than for all other intercrop plants (Table III). The plants grown under tree Lots #2 and #5 had quality ratings of 5.1 and 5.4, respectively. These ratings were not significantly different, but they were significantly better than the quality ratings for plants grown beneath tree Lots #1 and #4. No significant difference was found between plants grown under Lots #1 and #4. The quality ratings of 4.0 (plants under Lot #1) and 4.2 (plants under Lot #4) were significantly lower quality ratings over all the treatments.

When averaging over all tree lot treatments, the quality rating of 5.3 for the 8 pot density plants was significantly better than the 12 pot density rating of 4.7 (Table IV).

Light Intensity

The amount of light received by the canopy for all lots averaged 724 mE/m^2/sec (Table V). The intercropping plants beneath tree Lot #3 received 200.3 mE/m^2/sec, greater than any of the other treatments. Plants under Lot #5 received 136.7 mE/m^2/sec; Lot #4, 89.5 mE/m^2/sec; Lot #2, 83.7 mE/m^2/sec; and Lot #1, 29.0 mE/m^2/sec.

Keeping Quality

Light Intensity

The light intensity readings during the shading period in the greenhouse at plant height were 853.7 mE/m^2/sec for the full sun bench and 251.0 mE/m^2/sec for the "40%" shade bench. In the headhouse conference room, average light intensity readings were 11.96 mE/m^2/sec and 918 lux (85 ft c) at the top of the plants.

Percent Leaf/Bract Senescence

The number of leaves/bracts dropped or dead (December 17 to January 21) was added to the number of live leaves/bracts to obtain the total number of leaves/bracts per plant. Percent leaf/bract senescence was calculated by dividing the number of leaves/bracts dropped or dead by the total number of leaves/bracts per plant.

Plants in tree Lot #5, the smallest tree, had by far the best keeping quality (Table VI), with only 15.1%

TABLE V

LIGHT INTENSITIES ($mE/m^2/sec$)[z]

Poinsettia Tree Lot #	Canopy	Understory
1	710	29.0
2	677	83.7
3	643	200.3
4	810	89.5
5	779	136.7
	$\bar{m}$ 724	

[z]Readings (9 per mean shown) were taken inside a fiberglass greenhouse on November 15, 1982. Outside light intensity was 1,150 $mE/m^2/sec$.

TABLE VI

PERCENT LEAF/BRACT SENESCENCE[z]

Poinsettia Tree Lot #	% Leaf/Bract Senescence
1	47.8 A[y]
2	42.5 A
3	48.6 A
4	29.4 B
5	15.1 C

[z]Percent leaf/bract senescence was figured for the five week period in a 20°C (68°F), 918 lux (85 ft c), 11.96 mE/m^2/sec fluorescent light room.

[y]Duncan's Multiple Range Test at the alpha level of .05 was utilized to separate the means. Means followed by the same letter are not significantly different.

leaf/bract senescence. Next was Lot #4 with 29.4%. No significant difference in percent leaf/bract senescence was observed between tree Lots #1, #2, and #3. Percent leaf/bract senescence for Lot #1 was 47.8%, Lot #2 was 42.5%, and Lot #3 was 48.6%.

No significant difference in percent leaf/bract senescence was observed for the four shade treatments, nor was there any significant interaction between tree size (lot) and shade treatment (Table VII).

Percent of Plants Still Usable

Five weeks after the keeping quality experiment was started, the study was terminated and the unattractive plants (considered no longer usable) in each poinsettia tree lot were counted and divided by the total number of trees in each lot. The number calculated is called the "percent showy".

At termination, all plants in Lot #5 were still showy (Table VIII). The "percent showy" for Lot #5 was significantly better than for Lots #1 and #3. None of the plants in Lot #3 were still showy at the end of the five week test.

TABLE VII

SIGNIFICANCE OF THE PERCENT LEAF/BRACT SENESCENCE

Source of Variation	PR > F	
Tree Lots (1-5)	0.0001	**
40% Shade (0, 3, 4, or 5 weeks)	0.9190	N.S.[z]
Lot x Shade	0.7458	N.S.

[z]N.S. means non significant above 0.05.

TABLE VIII

PERCENT OF TREES STILL USABLE
AFTER FIVE WEEKS OF DISPLAY
IN KEEPING QUALITY STUDY

Poinsettia Tree Lot #	"% Showy"
1	50.0 B[z]
2	66.7 AB
3	0.0 C
4	66.7 AB
5	100.0 A

[z]Duncan's Multiple Range Test at the alpha level of .05 was utilized to separate the means. Means within a column followed by the same letter are not significantly different.

CHAPTER IV

DISCUSSION AND CONCLUSIONS

Poinsettia tree Lot #1 had the largest plant height, canopy diameter, and caliper (Figure 2). The anthesis date (December 7) for Lot #1 was found to be the latest of the five treatments. Production time for Lot #1 was the longest (29 weeks). Lot #2 was second to Lot #1 in all parameters studied (Figure 3). Lot #3 was the least attractive of all the treatments ranking last in canopy diameter and average bract diameter (Figure 4). There was not enough time for adequate growth between the first and second pinches on Lot #3 trees, and it would have been better not to apply growth retardant to these trees. The largest average bract diameter was measured on Lot #4 trees (Figure 5). Tree Lot #5 matured earliest (November 24). This may seem strange, but the axillary branches had a considerable length of time to develop since this lot was pinched only once on October 1. It is likely that these shoots were more physiologically advanced in development than shoots on the larger double-pinched trees, and thus flowered earlier. This lot was the smallest in plant height, canopy diameter, and caliper (Figure 6). Production time for Lot #5 was the shortest (21 weeks).

Figure 2. Lot #1 propagated May 21
Height - 86.9 cm
Diameter - 83.4 cm
Sq M Wks - 6.41
Sq Ft Wks - 69

Figure 3. Lot #2 propagated June 4
Height - 81.3 cm
Diameter - 71.2 cm
Sq M Wks - 5.99
Sq Ft Wks - 65

Figure 4. Lot #3 propagated June 18
Height - 72.7 cm
Diameter - 53.2 cm
Sq M Wks - 5.58
Sq Ft Wks - 60

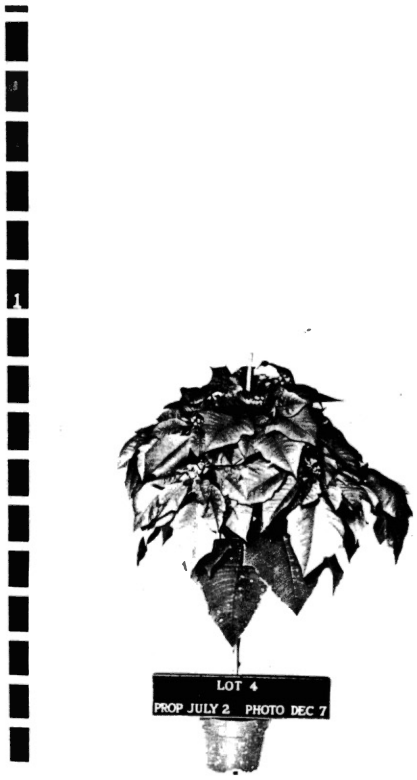

Figure 5. Lot #4 propagated July 2
Height - 68.8 cm
Diameter - 58.0 cm
Sq M Wks - 3.21
Sq Ft Wks - 35

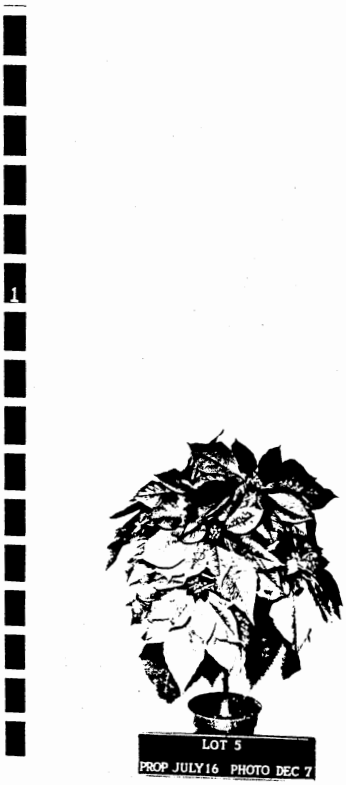

Figure 6. Lot #5 propagated July 16
Height - 52.2 cm
Diameter - 52.1 cm
Sq M Wks - 3.02
Sq Ft Wks - 33

The various tree sizes are shown in Figures 2 through 6 along with the finished size and total number of "square meter weeks" and "square feet weeks" required to produce each plant. For example, the smallest tree, Lot #5, occupied 0.023 sq m (0.25 sq ft) for 2 weeks, 0.043 sq m (0.44 sq ft) for 3.5 weeks, 0.093 sq m (1.0 sq ft) for 3.5 weeks, and 0.209 sq m (2.25 sq ft) for 12 weeks (Table IX). Square meter weeks at each spacing were 0.05, 0.14, 0.32, and 2.51, respectively, for a total of 3.02 square meter weeks. Square feet weeks at each spacing were 0.5, 1.5, 3.5, and 27.0, respectively, for a total of 32.5 sq feet weeks.

Wholesale prices for each tree lot were calculated using the total square feet weeks times $0.27 (cost of one ft^2/wk) plus the cost of the cutting (Table X). An estimate of minimum wholesale selling price for each tree would be Lot #1, $25.00; Lot #2, $22.00; Lot #3, $20.00; Lot #4, $12.50; and Lot #5, $11.00 (Table XI). Production cost methods are those derived by Irwin (11), and may not be the same for other growers. Each grower would be required to derive his own costs.

The 11.4 cm (4½ in) 'V-14' poinsettia intercrop grown beneath tree Lot #3 was rated best in all parameters measured. This was where the highest light readings were measured (200.3 mE/m^2/sec), probably due to the sparseness and small canopy size of tree Lot #3. The intercrop grown under Lot #1 was rated worst in all parameters measured because of the low light intensity (29.0 mE/m^2/sec). A

TABLE IX

POINSETTIA TREE BENCH SPACE
USE REQUIREMENTS PER TREE

Spacing	Lot #1		Lot #2		Lot #3		Lot #4		Lot #5	
	# wks	in^2 wks	# wks	in^2 wks	# wks	in^2 wks	# wks	in^2 wks	# wks	in^2 wks
15 x 15 cm (6 x 6 in)	2	72	2	72	2	72	2	72	2	72
20.3 x 20.3 cm (8 x 8 in)	3.5	224	3.5	224	3.5	224	3.5	224	3.5	224
30.5 x 30.5 cm (12 x 12 in)	5.5	792	5.5	792	5.5	792	5.5	792	3.5	504
45.7 x 45.7 cm (18 x 18 in)	6	1,944	4	1,296	2	648	12	3,888	12	3,888
61 x 61 cm (24 x 24 in)	12	6,912	12	6,912	12	6,912	N/A	--	N/A	--
Total in^2 weeks		9,944		9,296		8,648		4,976		4,688
Total ft^2 weeks		69.06		64.56		60.06		34.56		32.56
Total m^2 weeks		6.41		5.99		5.58		3.21		3.02

TABLE X

POINSETTIA TREE COST CALCULATIONS

Poinsettia Tree Lot #	Total Sq Ft[a]	.27 Cost[b]	Plant Cost[c]	Basic Cost[d]	10% Loss	Total Cost[e]	Cost x 1.25[f]
1	69.06	18.65	0.20	18.85	0.19	$19.04	$23.80
2	64.56	17.43	0.20	17.63	0.18	$17.81	$22.26
3	60.06	16.22	0.20	16.43	0.16	$16.59	$20.74
4	34.56	9.33	0.20	9.53	0.10	$ 9.63	$12.04
5	32.56	8.79	0.20	8.99	0.09	$ 9.08	$11.35

[a]Total square feet weeks to produce crop.

[b]All cost but plant material divided by square feet bench area, divided by 52 equals cost per week ($0.27 in 1981). Irwin (11).

[c]Laid-in plant cost of unrooted cutting.

[d]Space and plant cost total to establish figure for loss.

[e]Total cost to produce plant.

[f]Cost x 1.25 equals necessary price to return a legitimate profit. (20% return of selling price)

TABLE XI

POINSETTIA TREE SPACE REQUIREMENTS
AND SUGGESTED WHOLESALE PRICES

Poinsettia Tree Lot #	Sq M Wks Required	Sq Ft Wks Required	Suggested Wholesale Price
1	6.41	69	$25.00
2	5.99	65	$22.00
3	5.58	60	$20.00
4	3.21	35	$12.50
5	3.02	33	$11.00

density of eight 11.4 cm (4½ in) pots grown beneath poinsettia trees on 1.3 sq m (14 sq ft) of bench was rated better than the twelve pot density.

Poinsettia tree Lot #5 proved to be the best keeper. All plants were still showy at the termination of the experiment. These plants were the youngest (propagated 7/16), as well as being the smallest in size. Apparently, these factors contributed to better water and nutrient transport to all plant parts during the keeping quality study. It is also possible that the root system was in better condition than in the older trees. Further work on why the keeping quality was closely related to plant size would be of interest. Lot #3 trees were found to be the worst keeper. At the end of the five week test period, none of the twelve plants tested were still "showy". The two pinches and growth retardant treatment probably affected leaf area and total photosynthesis and carbohydrate storage. Applying the 40% shade at the end of the production cycle did not improve keeping quality for any of the trees tested.

Staby and Kofranek found that the keeping quality of traditional-grown 'Annette Hegg Dark Red' poinsettias improved when night temperature was reduced 2°C from normal forcing temperatures and light intensity was reduced by 50% for the entire production cycle (18). The difference in their findings and the results of this study could be due to the different cultivar tested or to the difference between poinsettia trees and traditional-grown poinsettias, but more

likely, it is because Staby and Kofranek grew their poinsettias at the lower light intensity and lower temperatures for the entire production cycle.

In conclusion, all trees were satisfactory in appearance except for Lot #3 which appeared sparse (Figure 4). Also the canopy and small bracts of Lot #3 poinsettia trees looked out of proportion with their height. This may be due to insufficient time for adequate growth. Probably the second pinch (October 1) or perhaps the growth retardant spray (October 22) should have been omitted (Table I).

A wholesale grower test-marketed a few of the plants, and Lots #1 and #2 actually sold better than the smaller plants. This was surprising, but with proper promotion, the smaller trees should be good sellers. They were attractive and had good keeping quality.

In general, the intercropping of 11.4 cm (4½ in) 'V-14' poinsettias with poinsettia trees at an eight pot density would be feasible if the grower could ensure that the intercrop received a light intensity of 200 mE/m^2/sec or greater beneath the tree canopy. This could be done by spacing Lots #4 and #5 wider. Growing poinsettias under Lots #1 and #2 is not recommended; however, intercropping with a low light requiring crop such as azaleas would be possible.

Subjecting the poinsettia trees to 40% shade during the last weeks of production had no effect on keeping quality, whereas tree size was found to be a significant factor. The smaller trees kept better over the five week test period

than the larger trees. The extremely reduced light intensity created a greater stress on the larger trees.

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