EFFECTS OF PHOTOPERIOD ON GROWTH AND FLOWERING OF *DAHLIA PINNATA*, CAV. 'REDSKIN' POT PLANTS

By

MARY ANN HALIBURTON

Bachelor of Science in Elementary Education

The University of Texas-Austin

Austin, Texas

1962

Submitted to the Faculty of the Graduate College
of the Oklahoma State University
in partial fulfillment of the requirements
for the Degree of
MASTER OF SCIENCE
July, 1976

EFFECTS OF PHOTOPERIOD ON GROWTH AND FLOWERING

OF DAHLIA PINNATA, CAV. 'REDSKIN'

POT PLANTS

Thesis Approved:

R N Payne
Thesis Adviser

Paul J. Mitchell

Robert M. Reed

Carl E. Whitcomb

Ronald W. McNew

Norman N. Durham
Dean of the Graduate College

ACKNOWLEDGEMENTS

My sincere appreciation is extended to Dr. Richard N. Payne, my major adviser, for his continued support and guidance in the writing of this thesis and throughout my graduate program. Special appreciation is extended to my other committee members, Dr. C. E. Whitcomb, Dr. Robert Morrison, Dr. R. W. McNew, Dr. Robert Reed and Mr. Paul Mitchell for their constant interest and valuable suggestions and counsel during the course of this thesis.

Special gratitude is extended to Mr. H. C. Macklin, greenhouse foreman, and Mr. Charles Steel, assistant greenhouse foreman, and the entire greenhouse staff for their many hours of work and assistance throughout this research project.

The kindness, understanding and friendship of all the Horticultural faculty and staff as well as their time and energy in assisting me has made this research possible.

My greatest love and appreciation goes to my son, Tracey, and my parents and many friends for their patience, sacrifices and confidence.

I shall always remember the many kindnesses and the friendships with the people I have met at Oklahoma State University and the opportunity I have had to expand my knowledge.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER I

INTRODUCTION

For centuries the tuberous-rooted dahlia has occupied an honored place in the garden. No other autumn flowering plant can compare with it in variety of form and range of color.

The mysterious root, as it was known, was sent in 1789 by Vincente Cervantes of the Botanic Garden of Mexico City to his friend and colleague, Abbe Cavanilles, who was in charge of the Royal Gardens of Madrid. Years later, Cavanilles named this Mexican wildflower in honor of Dr. Andreaus Dahl, one of the leading botanists of the day. Dr. Dahl encouraged the use of the tuberous roots as a substitute for the potato. Empress Josephine was the first to appreciate the floral beauty of the dahlia.

It was not until 1872 that the dahlia appeared in New York City. In the early 1900's the dahlia lost popularity, but the advent of dwarf bedding varieties proved so useful that they inauguarated a new era of prosperity. Since that time the dahlia interest has increased until they have deposed the chrysanthemum in many parts of the country from the position of Queen of the Autumn Gardens (1).

The 'Redskin' dahlia, a dwarf bedding type, was a 1975 All-American Award winner. The 'Unwin' dwarf bedding dahlia has been available for many years, but the new 'Redskin' is even more dwarf in growth habit and has other traits that appear to lend themselves to possible pot plant culture. It has decorative bronze foliage with a spectacular color range of 4 cm (1 1/2 in) double blooms in reds, pinks, roses, lavenders, yellows and oranges. The bronze foliage creates a permanent ornamental effect in the landscape whether flowers are in bloom or not and provides a beautiful contrast for low-growing annuals like white Alyssum (Lobularia maritima).

Because of the dwarf size, foliage color and characteristics, and vibrant flower colors, it is believed that if the specific cultural requirements, especially photoperiod responses, could be determined the 'Redskin' dahlia would make an excellent pot plant. It could be sold the year around, particularly at Easter and Mother's Day and then planted out-of-doors for enjoyment during the summer and fall months. Although this is an annual bedding plant it will form tuberous-roots during short days (42) and these can be dug and saved for the next year.

Experimental work has been conducted on the photoperiod treatment of tuberous dahlias (12, 17, 20, 21, 24, 42), but to the author's knowledge only one study (36) has been published concerning photoperiod studies on seedling dahlias and none on 'Redskins'. Most of the experimental treatments were based on information concerning the tuberous-rooted dahlias.

A short day (9 hours) under natural daylight gave the fastest bloom, but lowered the quality of blooms and foliage (21). Long days up to 17 hours gave bloom; however, flowering was delayed but the flower and foliage quality improved (21). There should be an intermediate photoperiod that would give quality within an economically feasible time on the bench to make it profitable as a year around pot plant. Photoperiod work on tuberous-rooted dahlias from February to

April in natural daylight indicated that a 13 hour day was optimum for flowering (12, 21). The photoperiod increases for Stillwater, Oklahoma (36° 9' N latitude) during the above months were used to help determine the amount of time to increase photoperiod on a weekly basis (39).

Specific objectives of this study were to determine the effects of various photoperiod regimes on (a) flowering, (b) height, (c) vegetative growth and (d) overall plant quality. In addition, other aspects of photoperiod effects that might be utilized in pot plant culture and in stock plant production for possible asexual propagation of selected clones would be studied.

CHAPTER II

LITERATURE REVIEW

Photoperiod and Temperature as Related to Flowering

A literature search indicates the only research found on the dwarf bedding dahlias was in Poland. Seedlings grown in a greenhouse with 8 to 10 hours of natural daylight produced buds fastest. A similar experiment conducted during the same time of year, out-of-doors, did not give similar results. This suggested that temperature along with photoperiod may play a role in bud initiation (36). It is not known whether the dwarf bedding dahlia will respond with any similarity to the large-flowered tuberous-rooted dahlias.

Research with *Dahlia hybrida* was numerous and indicated that flowering was affected by photoperiodic lighting (12, 17, 18, 20, 21, 22, 23, 24, 32, 42). With short days of eight hours or less, flower buds aborted, and shoot growth was inhibited (13, 21). Plants grown in a greenhouse from February to April in Michigan with 16 hours of continuous light or with a four hour night break at 16° to 17° C (61° to 63° F) night and 18° to 20° C (65° to 68° F) day temperatures produced higher quality plants, but flowering was delayed (11, 13). According to Hall (17) normal vegetative growth and flower production occurred with plants grown under a two hour night break using 80 watt warm white fluorescent tubes five feet above the plants, or plants grown from February 24 to May 15 using natural daylight only. However, those with light bloomed earlier by two to four weeks and vegetative growth was increased.

According to Cathey (10) research on chrysanthemums given a four hour night break were considerably taller than those lighted at the beginning or end of the main eight hour light periods and showed typical long day responses. On chrysanthemums, artifical lights applied after the 12 hour dark period and continued until sunrise promoted internode extension without delaying flower initiation or development.

According to Konishi (21, 22) flowers were initiated in dahlias under day lengths of 8 to 16 hours, but their development was inhibited by longer photoperiods. Konishi (23) determined that long day treatments for less than 20 days did not affect the time of flowering. However short days given at the early stage of shoot growth markedly reduced shoot length and weight, total number of flowers, ray florets and double flowers, but increased the number of disc florets when applied for only five days. Lateral shoots grown under day lengths of 10 hours or less initiated flower buds five days after being pinched. Optimum day length for flower initiation was 10 hours or less, whereas later stages of flower development required day lengths of 12 to 13 hours (22). Optimum flowering occurred with 13 hours of light and a night temperature of 10° C (50° F). The night temperature did not affect the optimum photoperiod, but altered the critical day length requirement. The critical day length was greater at 10° C (50° F) than at either 5° C (41° F) or 15° C (60° F). As the critical day length for flowering increased, flowering was delayed but not reduced in amount

(24).

High night temperature accelerated shoot growth and extended the flowering period whereas low night temperature gave the best quality blooms, retarded flowering and gave a shortened flowering period (24). Zimmerman and Hitchcock (42) suggested temperature and/or light intensity as well as duration of light could be controlling or inter-realted in flower bud formation, type of root formation (fibrous or tuberous), and ease and/or speed of the rooting of cuttings.

Photoperiod, Temperature, and Exogenous Plant Growth Substances as Related to Tuberization

Zimmerman and Hitchcock (42) and Lloyd (28) reported that tuberous-rooted dahlias flowered and formed storage roots under short days and formed fibrous roots only and did not flower under long days. Moser and Hess (30) agreed with Zimmerman and Lloyd but believed that maximum tuberization occurred with night temperatures of 15° C or 21° C (60° or 70° F) and was inhibited at either 10° C or 26° C (50° or 80° F). They also found that exogenous growth inhibitors promoted tuberization. Biran (4) reported there was a positive relationship between exogenous inhibitors and tuberization.

Foliar sprays with SADH[1] at 2500 ppm or Cycocel[2] at 1500 ppm

---

[1]SADH (Succinamic acid 2,2-dimethyl hydrozide), Alar-Aminozide, B-Nine 85% wp., manufactured by Uniroyal Chemical, Division of Uniroyal, Inc., Naugatuck, Conn. 05770.

[2]Cycocel-chlormequat (2-Chloroethyl trimethylammonium chloride) manufactured by American Cyanamide Co., Ag. Division, Princeton, N. J., 08540.

increased the number and size of tuberous roots of plants grown under short day conditions (32, 34). A soil drench with Ancymidol[3] was superior to a foliar spray in reducing plant height and at 0.25 to 2.0 mg per plant did not affect the flowering date, flower size or the number of shoots produced from tuberous roots. Best results were obtained when Ancymidol was applied two to four weeks after planting (11). Mittal (29) found that dahlias sprayed twice before flowering with 200 ppm of G.A.[4] formed more lower branches, advanced flowering, increased height and node number, and had no effect on tuberization.

Tuberous-Rooted Dahlias from Seed

According to Barnes (3) plants from fast germinating seed grew taller and the slow germinators produced the most dwarf plants and those plants that produced double or semi-double flowers. Waite (40) reported that the late germinators were usually the best cultivars. Booth (8) determined that seed dahlias should be covered .64 cm (1/4 in) when sown. The seeds germinated in approximately nine days under temperature ranges of 15° to 19° C (60° to 66° F) (8). Seeds of tuberous dahlias grown in a greenhouse during March flowered that season and developed tuberous roots (2, 14, 16, 38).

Pinching and/or Cutting Back

Booth (8) pinched growing tips to cause lateral branching when the

---

[3]Ancymidol-Arest (α-cyclopiopyl-α-(4-methoxyphenyl-5-pyrimidine-methanol) manufactured by Elanco Products Company, Indianapolis, Indiana.

[4]G.A.--Gibberellic Acid, GA3, a growth regulator substance used to promote flowering, stem and root elongation.

plants reached a height of 7 to 10 cm (3 to 4 in). Maximum flowering occurred when the growing tip was removed at the sixth node. Otherwise, branching did not occur until higher on the plant when the terminal flower bud was formed and forced lateral branching (32). Krijthe (26) showed that dahlia shoots produced a terminal flower after the formation of five to seven pairs of leaves. Therefore, the height at flowering depended on the length of the internodes.

Prior to pinching or cutting back the plant, Konishi (25) found that the photoperiod conditions had no effect on the growth rate or flowering of the lateral shoots if the plant resumed growth under a 13 hour photoperiod. Plants grown under short days below the critical day length of 12 hours, were retarded in flowering, if short days had been applied prior to pinching. Mostafa and Owais (31) reported cutting back the plants to 30 cm (12 in) or leaving 4, 6, 8, 10 or all the shoots. After pinching or cutting back the plants, flower numbers correlated with shoot numbers but flower head and flower stalk diameters were inversely related to shoot numbers.

Water, Soil and Air Circulation

Waite (40) stated that dahlias should be planted in a "heavy" soil and be given good air circulation to produce a sturdier plant with tougher foliage. A "light" sandy soil produced fast growth but a weak plant. Waite (40) and Hellyer (19) also recommended keeping the dahlias moist to prevent plants from hardening, which checks growth and flowering. Repeated wilting produced an increase in the number of tuberous roots (3).

Fertilizer and pH

Barnes (3) suggested that nutritionally deficient dahlias form roots quickly and become hardened at the base of the stem. Dahlias grew well in a sandy loam at a soil pH of near 6.0. With a pH of 4.3, dwarfing occurred and the flowers lost the red pigment and turned toward blue colors. Nitrogen increased the size of flowers and encouraged dark green growth. However, too much nitrogen produced a soft spindly plant. Phosphorus was necessary to aid flowering. Potassium was necessary in all parts of the dahlia, especially for formation, growth, and firmness of tubers and for lengthening storage time of tubers. Dahlias also made a heavy demand on iron. A lack of iron produced thin, pale green and often limp foliage.

El-Gamassy and Moustafa (14) found that good growth, flowering and tuber yield were obtained when each 10 cm (4 in) container was fertilized at planting time with 46 grams of calcium nitrate, 60 grams of superphosphate and 10 grams of potassium sulphate. Four weeks later plants were fertilized again with 40:40:20 grams/container.

Pot plants produced the best growth, flowering and tuber yield when calcium nitrate at the rate of 40 grams per 10 cm (4 in) container was applied in three monthly doses beginning at planting time. Phosphorus and potassium gave better results at the rate of 60 grams of calcium superphosphate and 20 grams of potassium sulphate per 10 cm (4 in) container when applied in three monthly doses beginning one month after planting (15).

De Hertogh (11) reported one dahlia per 15 cm (6 in) container fertilized every three weeks with 300 ppm of nitrogen, phosphorus and potassium gave satisfactory growth and flowering. He indicated more research was in progress to determine the exact fertilizer rate to obtain optimum growth and flowering.

Propagation from Tuberous-Rooted Stem Pieces and Vegetative Stem Cuttings

It is possible to grow dahlias from seed, tuberous-roots with stem pieces attached, or vegetative stem cuttings. Rooke (35) found that 50 watt mercury phosphorus lamps suspended 129 cm (51 in) above the bench and 198 cm (78 in) apart for 16 hours produced two to three times more cuttings than the unlighted tubers. Canham (9) believed that a two-hour night break using warm white fluorescent tubes over the tubers produced a higher percentage of rooting than continuous light.

From one healthy large-flowered tuberous-rooted stock plant, six to eight cuttings can be produced (37). Biran (7) found when the base of the cutting had been shaded while still attached to the mother plant the rooting percentage and the average number of roots/cutting were markedly increased compared with unshaded controls. Post (32) suggested that all stock plants be grown at 15° C (60° F).

According to Biran and Halevy (6) dahlia cuttings with actively growing buds were hard to root compared with those having non-growing or inhibited buds. Biran and Halevy (5) found that rooting inhibitors were apparently formed in the roots and translocated to the shoots and that abscisic acid (ABA) was not the main inhibitor.

Lebar (27) and Waite (40) agreed that short-jointed cuttings 5 to 10 cm (2 1/4 to 4 in) in length with one pair of fully expanded leaves, a pair of partially expanded leaves, and a well defined growing point were the best size cuttings. Yashchenko's (43) data indicated that dahlias formed with three whorled phyllotaxy were best for producing clones for vegetative propagation.

Hellyer (19) found that rooting was enhanced when cuttings dipped in hormone were placed 1 cm (1/2 in) into the rooting medium. According to Walker (41) the best temperature to root cuttings was between 13° and 15° C (55° and 60° F). Higher temperatures caused faster rooting but weaker plants.

Biran and Halevy (5) demonstrated that dipping cuttings in 125 ppm indolebutyric acid and either 20 ppm N-6-benzyladenine or 0.75 to 3.00 ppm absicisic acid for 16 hours enhanced rooting. Read and Hoysler (33) indicated that cuttings dipped in 2,500 ppm of SADH produced significantly greater numbers of adventitious roots than did untreated cuttings. Similar treatments with Cycocel caused a depression of root production which suggested that Cycocel reacted as an "anti-auxin."

Zimmerman and Hitchcock (42) indicated that photoperiod was a factor in the rooting of cuttings. Cuttings made at different times of the year reacted differently. For example, June cuttings produced normal fibrous roots, whereas October cuttings often formed no roots but the basal ends of the stems served as storage organs. This suggested that temperature, light intensity, and light duration played a very important role in the rooting and growing of the dahlia.

CHAPTER III

METHODS AND MATERIALS

Seed Germination

Research was conducted at Oklahoma State University Greenhouses in Stillwater, Oklahoma (36° 9' N latitude, 97° 5' N longitude). Seeds were germinated in wooden flats using a growing mixture of equal parts sand and peat moss. Flats and medium were sterilized and sprayed with a mixture of Dexon and Benlate at a rate of four ounces of each per 100 gallons of water. Seeds were planted on September 10, 1975 in rows .32 cm (1/8 in) apart and covered with .32 cm (1/8 in) of the germinating medium. Glass was placed over the top of the seed flats to maintain high humidity and was removed when germination was completed. The germinating medium was watered thoroughly before sowing seed and hand watered as needed to prevent drying.

Seed flats were placed under a fluorescent light system using two Deluxe cool white and two Grow-Lux bulbs placed 12.70 cm (5 in) above the seed flats. This gave 1000-ft.-c of light 18 hours a day. Germination was slow and irregular. A fertilizer solution of 20-20-20 at the rate of 12 ounces per 100 gallons of water was applied to the seed flat when the seedlings were eight days old. On the eighth day after germination, seed flats were moved to a 15° C (60° F) greenhouse for three days prior to transplanting.

Transplanting and Cultural Procedures

Seedlings were transplanted on September 30, 1975 with each seedling having four leaves (Figure 1). All seedlings were transplanted into new 11 cm (4 1/2 in) clay pots with one seedling per container (Figure 2). The growing medium was Pro Mix$_{B_x}$.[1] Contents are shown below.

Sphagnum peat---------------13.2 bu.

Vermiculite----------------- 4.4 bu.

Perlite--------------------- 4.4 bu.

Dolomite--------------------10 lbs.

0-20-0---------------------- 2 1/2 lbs.

KNO_3----------------------- 1 1/2 lbs.

Fritted Trace Elements------ 3 oz.

Wetting Surfactant---------- 5 oz.

All containers were filled with the mix and wetted before transplanting. Each compressed bale of Pro Mix (13 cu ft) filled 440, 11 cm (4 1/2 in) containers. A surface spray of Benlate and Dexon[2] was applied prior to transplanting to prevent Damping-off.

After each seedling was transplanted a top dressing of 2.87 grams (one-half teaspoon) slow release fertilizer (Osmocote 14-14-14) was applied per 11 cm (4 1/2 in) pot containing 33 cu in of growing medium. One cu ft of growing medium filled 52 11 cm (4 1/2 in) containers. In

---

[1] Pro Mix$_{B_x}$ furnished by Premier Brands Peat Moss Corporation, New York, New York.

[2] Benlate and Dexon used at a rate of eight ounces of each per 100 gallons of water.

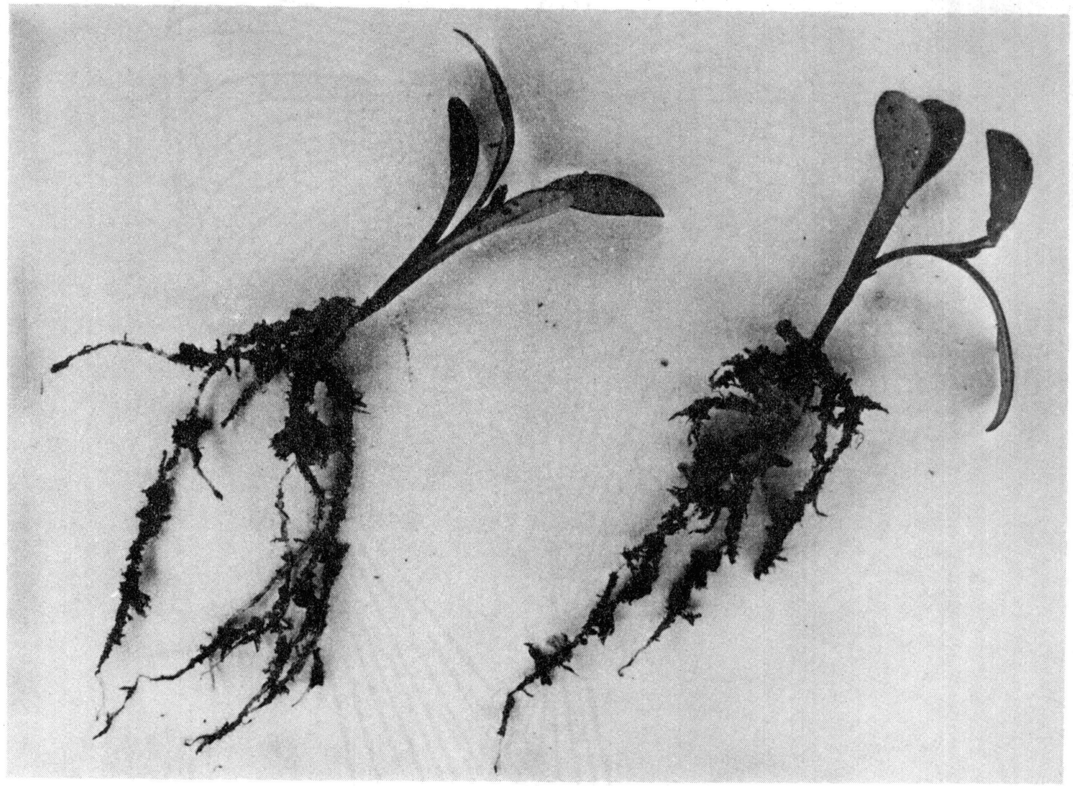

Figure 1. Appearance of Seedlings at Time of
Transplanting--September 30,
1975

Figure 2. Seedlings on Benches at Time of Transplanting--
September 30, 1975

addition, supplementary liquid fertilizer applications of 20-20-20 (500 ppm) were applied every five days. Spurway soil tests of nitrates, phosphorus and potassium along with pH and soluble salts were made weekly. The first liquid application began 10 days after transplanting and continued every five days until termination of the experiment. Watering was done by hose as needed.

Based on previous research (11) night temperatures were maintained at 15° to 16° C (60° to 63° F). Day temperatures were maintained as close as possible within a range of 18° to 20° C (65° to 68° F) on cloudy days to 20° to 24° C (68° to 74° F) on sunny days. Occasionally, daytime temperatures exceeded this range.

Experimental Treatments

Five treatments were established:

Treatment 1: 9 hours light (S. D.)
(8 a.m. to 5 p.m.) Natural daylight
(No supplementary light)

Treatment 2: 9 to 13 hours increasing light (I. L.)
Light increasing 30 minutes weekly
2nd through 9th week
(8 a.m. to 5 p.m.) Natural daylight
1st week--No additional light
2nd week, 5:00 p.m. to 5:30 p.m.--Incandescent light
3rd week, 5:00 p.m. to 6:00 p.m.--Incandescent light
4th week, 5:00 p.m. to 6:30 p.m.--Incandescent light
Etc., up to 10 weeks.

Treatment 3: 13 hours continuous light (C. L.)

(8 a.m. to 5 p.m.) Natural daylight

(5 p.m. to 9 p.m.) Incandescent light

Treatment 4: 13 hours light (4 hr night break) (N. B.)

(8 a.m. to 5 p.m.) Natural daylight

(10 p.m. to 2 a.m.) Incandescent light

Treatment 5: 17 hours light (17 hr L. D.)

(8 a.m. to 5 p.m.) Natural daylight

(5 p.m. to 1 a.m.) Incandescent light

Experimental Design

Initially there were 25 containers per chamber. This was reduced to 15 containers of the most uniform plants by the tenth day. The 15 remaining containers were then spaced 20 cm x 20 cm (8 in x 8 in) center-to-center for the remainder of the experiment resulting in 75 plants per treatment, 5 replications of 15 plants each in the 5 x 5 Latin Square design.

Physical Arrangement

In establishing the 5 x 5 Latin Square design each chamber or bench was 81 x 122 cm (32 x 48 in). The wooden frame covered with welded wire mesh 2 cm x 5 cm (1 in x 2 in) was supported on concrete blocks 46 cm (18 in) from the floor. Number nine galvanized wire arches were attached to the bench corners to allow support for the heat sealed coverings (Figure 3). Appropriate lighting for each bench was electrically controlled. A 75 watt incandescent bulb was suspended 91 cm (36 in) from the height of the bench [81 cm (32 in) from pot rim], allowing 19 ft.-c.

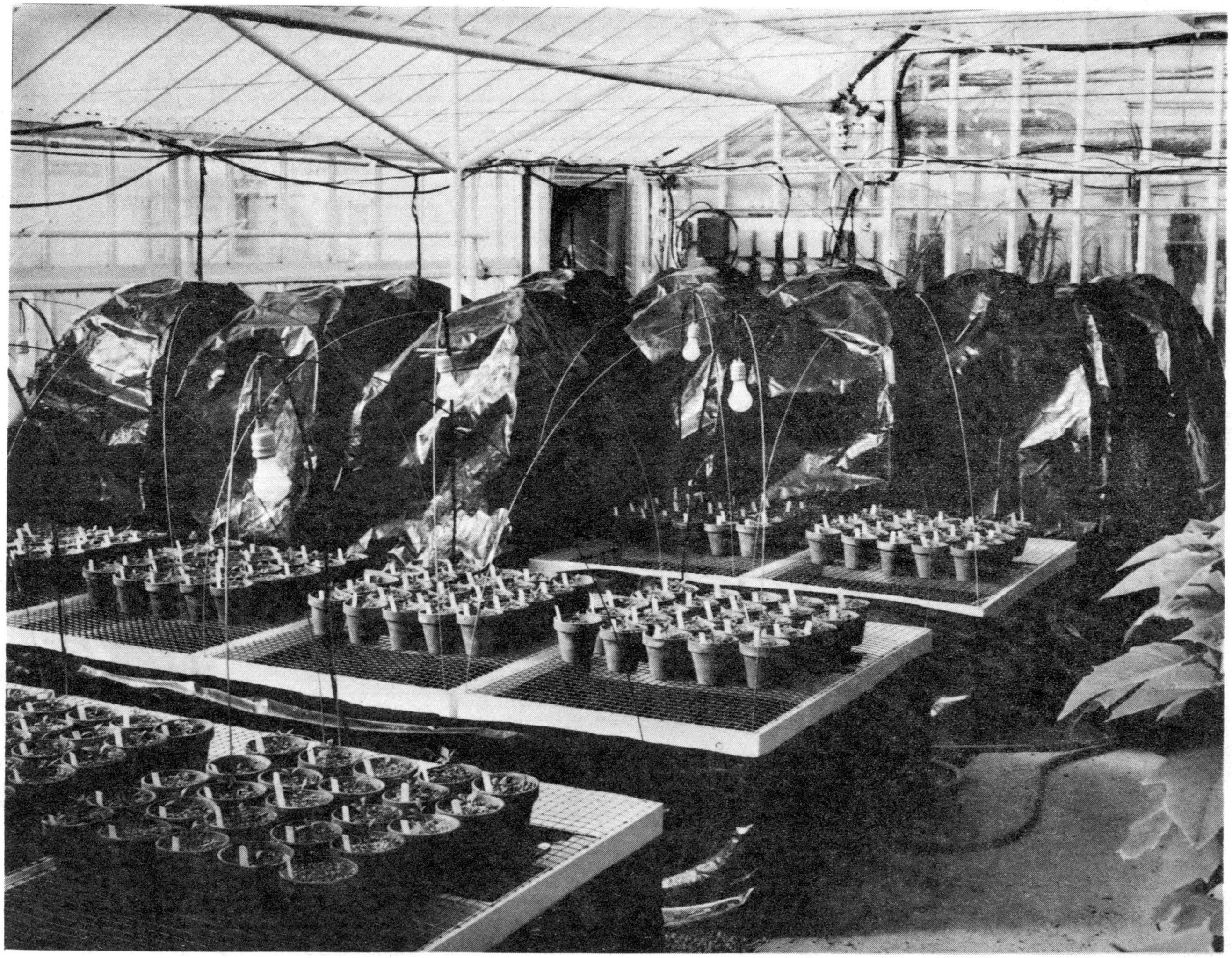

Figure 3. 5 x 5 Latin Square Design Showing Individual Photoperiod Treatment Chambers

of light to be provided at plant level. All benches were wired so light in the repetitions of each treatment would automatically cut on and off at the same time. All benches or chambers were covered with the black plastic coverings at 5:00 p.m. and the appropriate supplementary light followed.

Data Recorded

The following measurements were made and data stored in the computer.

Transplant Data

Height of plant from pot rim three days after transplant.

Number of pairs of leaves day before pinch.

Height of plant from pot rim day before pinch.

First Visible Flower Bud Data

Number of days to first bud.

Number of branches.

Total buds on the plant.

Height.

First Open Flower Data

Number of days to first open flower.

Number of major branches.

Number of nodes.

Internode length.

Number of flowers on the plant.

Total buds on the plant.

Height.

Flower diameter.

Flower color of first flower.[3]

Flower Opening Sequence and Experiment Termination Data

Number of days to first flower.

Number of days to third flower.

Number of days to fifth flower.

Total flowers on the plant at fifth flower (termination).

Total branches on the plant at fifth flower (termination).

Total buds on the plant at fifth flower (termination).

Height of plant at fifth flower (termination).

Weekly Height Data

Height from pot rim taken weekly from time of pinch until termination (termination date for each plant was when it reached fifth flower, or if it did not reach fifth flower, when the total experiment was terminated on February 9, 1976 [134 days from transplanting]).

---

[3]Nickerson Color Fan used to code flower color. Flower color information cannot be programmed on the computer at this time.

CHAPTER IV

RESULTS AND DISCUSSION

In studying the effects of the photoperiod treatments there are three times in the life of the plant that are particularly important--first bud, first flower and fifth flower to termination. Means for each of the five replications of a treatment were derived from plants which responded. An unweighted means analysis of variance was obtained for each character. A reported mean was the mean of the five replication means.

Days to First Bud, First, Third and Fifth Flower

As photoperiod increased, the days to first visible flower bud increased (Table I-A, Figure 4-A). The S. D. and I. L. plants required an average of 30 days to reach first bud. The N. B. and L. D. plants were last to show bud, and required 43.2 and 42.5 days, respectively. Plant development at 36 days from transplanting is shown in Figure 5.

The number of days from transplant to first flower was the shortest (56 days) in the S. D. plants; however, only 62.2% (47 of the 75 plants) flowered (Table I-B, Figure 4-B). The S. D. was enough light to initiate buds as 100% initiated buds (Table I-A), but was not enough light for continued growth and development. The S. D. plants continued to reach first flower only through the ninth week (Table II, Figure 6).

TABLE I

EFFECT OF PHOTOPERIOD TREATMENTS ON MEAN DAYS TO FLOWERING

Treatments	A Mean Days to 1st Bud			B Mean Days to 1st Flower			C Mean Days to 3rd Flower			D Mean Days to 5th Flower		
	Mean Days to 1st Bud[1]	No. Budded[2]	% Budded[3]	Mean Days to 1st Flower	No. Flowered	% Flowered	Mean Days to 3rd Flower	No. Flowered	% Flowered	Mean Days to 5th Flower	No. Flowered	% Flowered
S. D.	30.49 a	75	100	56.22 a	47	62.6	58.93 a	33	44.0	65.05 a	22	29.3
I. L.	30.88 a	75	100	62.17 b	74	98.6	65.71 b	71	94.6	73.53 b	71	94.6
C. L.	35.26 b	75	100	63.08 b	74	98.6	65.87 b	74	98.6	71.90 b	74	98.6
N. B.	43.24 c	75	100	74.92 c	74	98.6	77.95 c	72	96.0	84.68 c	71	94.6
L. D.	42.53 c	74	98.6	72.07 c	69	92.0	76.98 c	69	92.0	83.78 c	67	89.3
L.S.D. (.05)	1.85			3.54			1.79			3.38		

[1]Means within a column followed by the same letter do not differ significantly at the .05 level (L.S.D. Test).

[2]Number of plants out of 75 that reached first bud, first, third, or fifth flower on which the mean was based.

[3]Percent of the total plants (75) in each treatment that reached first visible bud, first, third, or fifth flower.

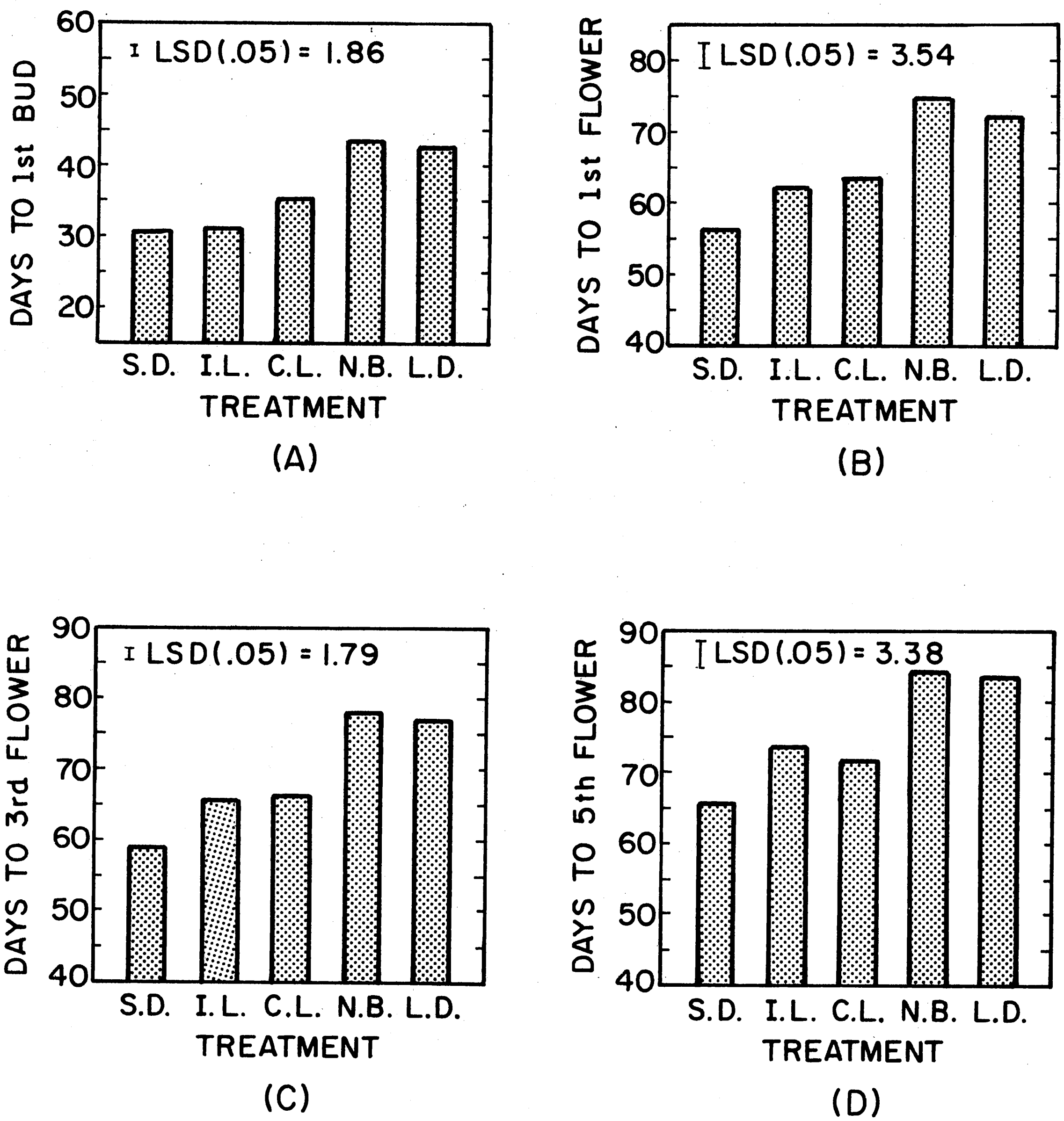

Figure 4. Influence of Photoperiod Treatments on Flowering--(A) Days to First Bud, (B) Days to First Flower, (C) Days to Third Flower, (D) Days to Fifth Flower (See Table I-A, B, C, D for number of plants on which each mean was based.)

Figure 5. Photoperiod Effects Showing the Development of *Dahlia pinnata*, 'Redskin' on the Mean Date to First Visible Bud for all Treatments (36 Days from Transplanting)--Left to Right: S. D., I. L., N. B., C. L., L. D.

TABLE II

EFFECT OF PHOTOPERIOD TREATMENTS ON PERCENT OF PLANTS REACHING FIRST FLOWER BY WEEKS

Treatments	Percent of Plants at First Flower at a Given Number of Weeks from Potting													
	6 Weeks	7 Weeks	8 Weeks	9 Weeks	10 Weeks	11 Weeks	12 Weeks	13 Weeks	14 Weeks	15 Weeks	16 Weeks	17 Weeks	18 Weeks	19 Weeks
S. D.	8.0	28.0	58.0	62.6	62.6	62.6	62.6	62.6	62.6	62.6	62.6	62.6	62.6	62.6
I. L.	1.3	8.0	29.3	61.3	86.6	93.3	93.3	94.6	94.6	94.6	94.6	97.3	97.3	98.6
C. L.	0	0	10.6	64.0	82.6	96.0	97.3	97.3	97.3	97.3	97.3	98.6	98.6	98.6
N. B.	0	0	0	05.3	36.0	65.3	85.3	93.3	97.3	97.3	97.3	97.3	98.6	98.6
L. D.	0	0	0	14.6	38.6	73.3	85.3	89.3	90.6	90.6	90.6	90.6	90.6	92.0

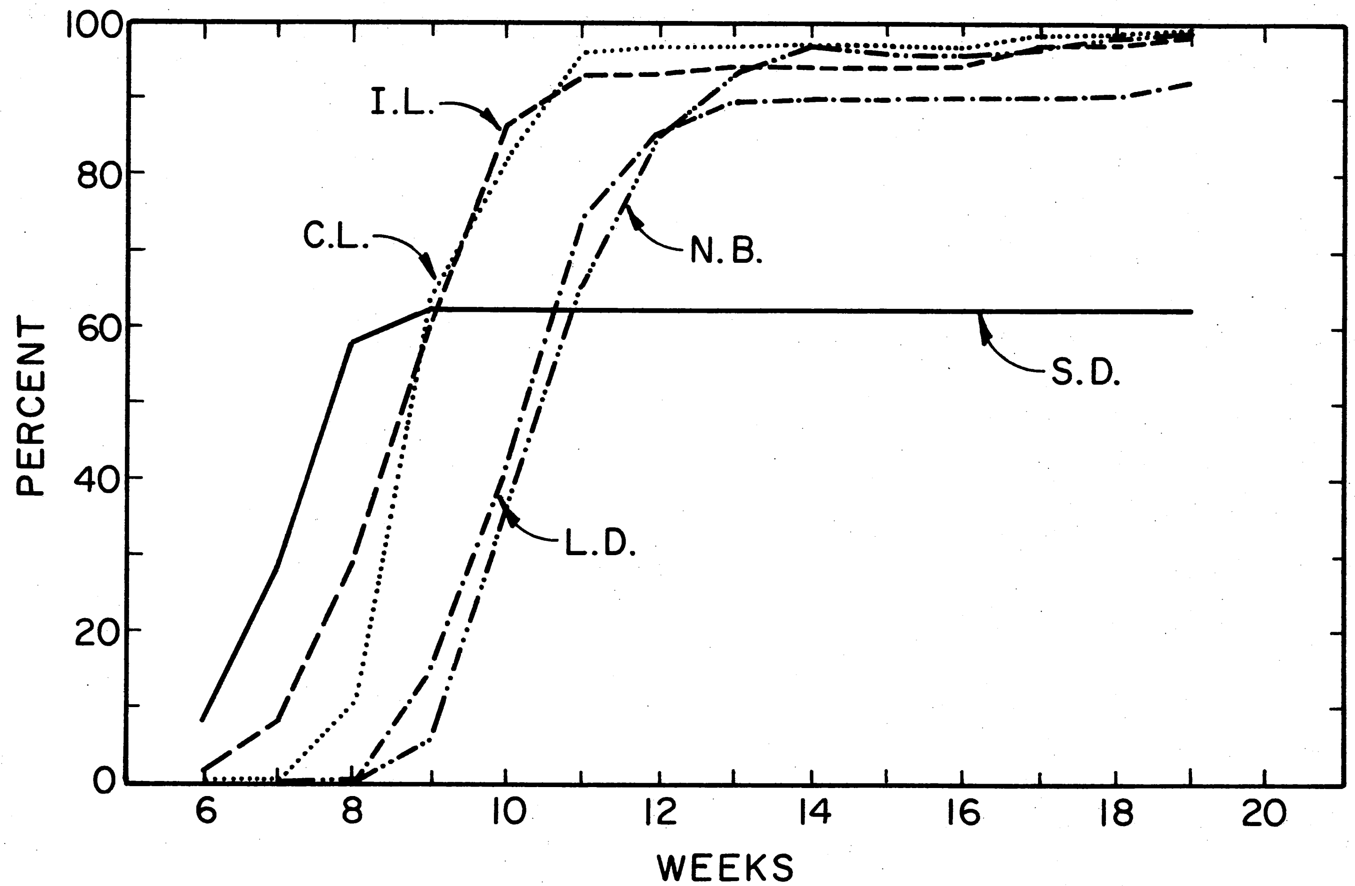

Figure 6. Percent of Plants Reaching First Flower by Weeks

By the tenth week the plants appeared stunted and chlorotic. Many buds had aborted and no new buds were forming with the S. D. plants by the mean day to third flower for the S. D. plants (Table I-C).

While the S. D. plants were the first to flower (56 days) the N. B. plants were the last to flower (74 days) (Table I-B) but 74 out of the 75 plants (98.6%) reached first flower (Table I-B). The additional lighting improved the appearance of the plants and they were fuller with more and larger leaves. There was no significant difference in days to first flower between plants in the N. B. and L. D. treatments (74.9 and 72.0 days, respectively). The I. L. and C. L. plants reached first flower significantly sooner than this, 62.1 and 63.0 days, respectively. The same trends were apparent at third and fifth flowering (Table I-C and D, Figure 4-C and D). Since flowering was delayed in the N. B. and L. D. treatments (Tables I, II, III and IV, Figures 6, 7 and 8), further research is warranted to determine if a longer night break (six or eight hours), or possibly two interruptions in the long night, or even 24 hr lighting might decrease flowering even more and encourage more vegetative growth for stock plant production of clones.

If a higher percentage of the S. D. plants had reached first flower while maintaining quality the S. D. plants would have had many characteristics desirable for pot plant production. The I. L. plants set buds at the same time as the S. D. plants, but flowered at the same time as the C. L. plants. Further research is warranted to determine if it is possible to cause the I. L. plants with their early bud initiation to flower earlier than the C. L. plants. If this were possible the I. L. plants would then be a composite of the best characteristics in the S. D. and the C. L. plants.

TABLE III

EFFECT OF PHOTOPERIOD TREATMENTS ON PERCENT OF PLANTS REACHING THIRD FLOWER BY WEEKS

Treatments	Percent of Plants at Third Flower at a Given Number of Weeks from Potting												
	7 Weeks	8 Weeks	9 Weeks	10 Weeks	11 Weeks	12 Weeks	13 Weeks	14 Weeks	15 Weeks	16 Weeks	17 Weeks	18 Weeks	19 Weeks
S. D.	1.3	10.6	37.3	44.0	44.0	44.0	44.0	44.0	44.0	44.0	44.0	44.0	44.0
I. L.	2.6	10.6	41.3	70.6	81.3	84.0	90.6	92.0	93.3	93.3	94.6	94.6	94.6
C. L.	0	4.0	49.3	80.0	90.6	94.6	96.0	96.0	96.0	97.3	98.6	98.6	98.6
N. B.	0	0	2.6	22.6	42.6	80.0	85.3	92.0	94.6	94.6	94.6	96.0	96.0
L. D.	0	0	8.0	28.0	57.3	82.6	88.0	90.6	90.6	90.6	90.6	90.6	92.0

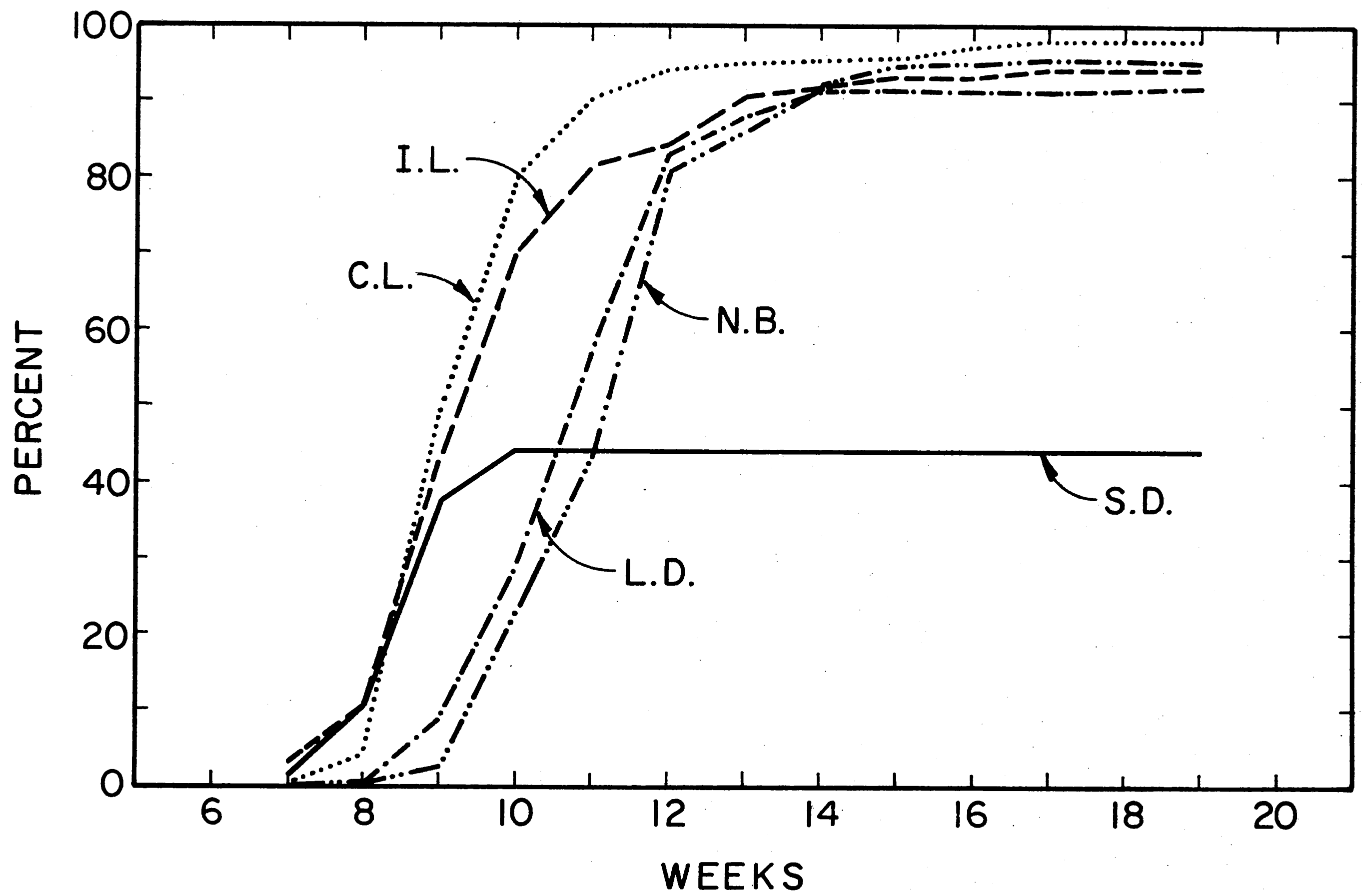

Figure 7. Percent of Plants Reaching Third Flower by Weeks

TABLE IV

EFFECT OF PHOTOPERIOD TREATMENTS ON PERCENT OF PLANTS REACHING FIFTH FLOWER BY WEEKS

Treatments	Percent of Plants at Fifth Flower at a Given Number of Weeks from Potting												
	7 Weeks	8 Weeks	9 Weeks	10 Weeks	11 Weeks	12 Weeks	13 Weeks	14 Weeks	15 Weeks	16 Weeks	17 Weeks	18 Weeks	19 Weeks
S. D.	0	0	17.3	25.3	26.6	28.0	29.3	29.3	29.3	29.3	29.3	29.3	29.3
I. L.	0	5.3	21.3	57.3	76.0	81.3	84.0	85.3	86.6	90.6	90.6	93.3	94.6
C. L.	0	0	10.6	53.3	82.6	93.3	93.3	96.0	96.0	96.0	98.6	98.6	98.6
N. B.	0	0	1.3	6.6	28.0	58.6	74.6	78.6	86.6	89.3	92.0	92.0	94.6
L. D.	0	0	1.3	12.0	36.0	66.6	78.6	81.3	81.3	86.6	89.3	89.3	89.3

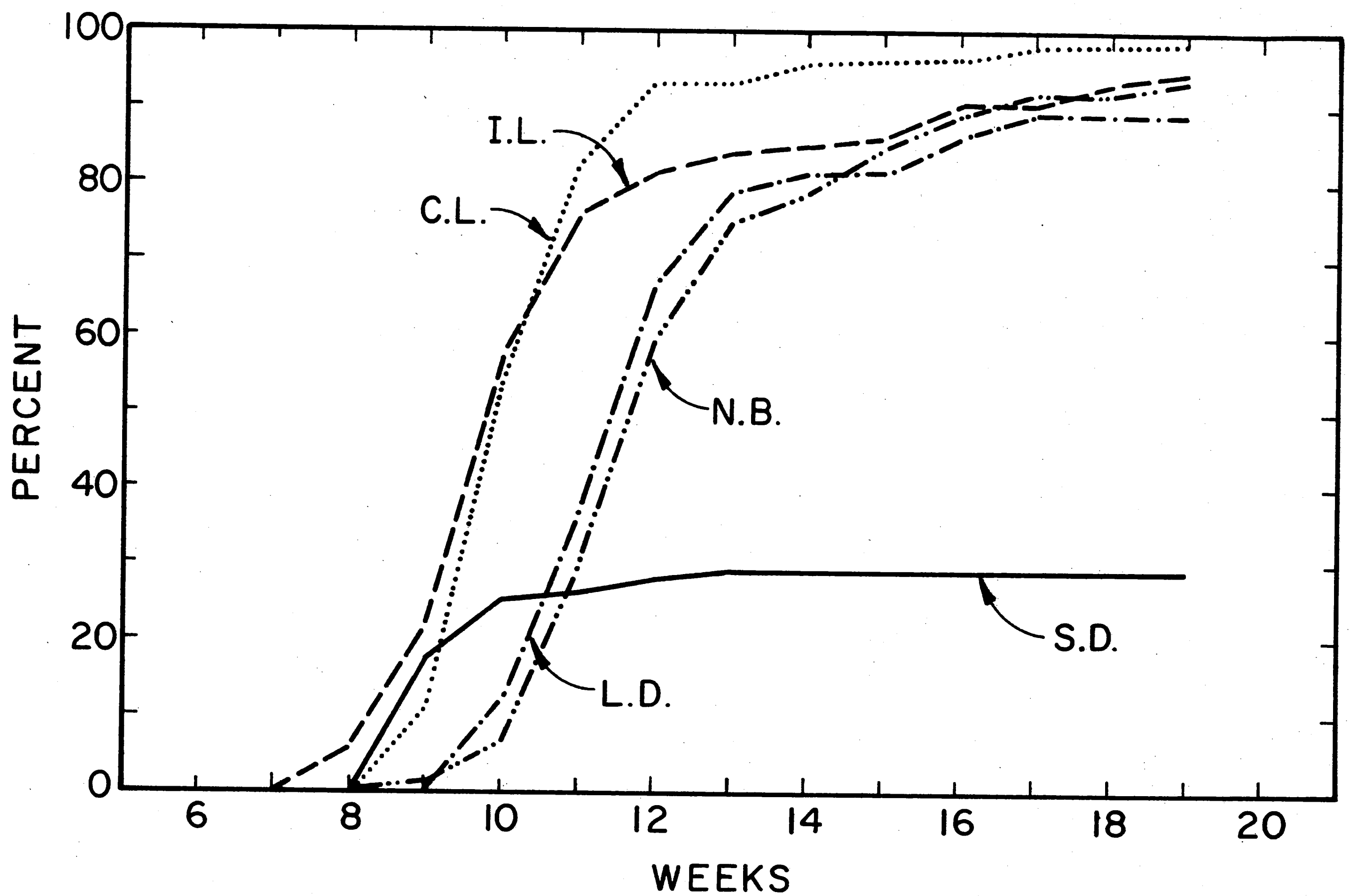

Figure 8. Percent of Plants Reaching Fifth Flower by Weeks

Sixty percent of the C. L. and I. L. plants reached first flowering by their mean flowering dates. Fifty percent plus of the N. B. and L. D. plants, but only 40% of the S. D. plants obtained their first flower by their mean flowering dates (Table V). It is interesting to note the significant differences in number of days to first flower among the C. L., I. L. and N. B. treatments (all three treatments having different combinations of 13 hours) (Table I-B).

Plant development at 65 days from transplanting is shown in Figure 9. The I. L. and C. L. plants were comparable in number of buds and number of flowers. The appearance of the 'Redskin' showing possible value as a pot plant can be seen in Figure 10. With clone selection it should be possible to consistently produce desirable pot dahlias.

Number of Days from First to Third Flower, First to Fifth Flower, and Third to Fifth Flower

The number of days from first to fifth flowers (Table VI-B, Figure 8-B) was the shortest in the S. D. and C. L. plants with an average of 8.48 days for both treatments. However, note the significant differences in percentage of plants reaching fifth flower with the S. D. and C. L. treatments (29% and 98.6%, respectively) (Table I-D). The I. L., L. D. and N. B. plants increased 13.05, 12.73 and 10.82 days, respectively, between first and fifth flower (Table VI-B, Figure 11-B). The delay in the I. L. plants may have occurred when the light stopped increasing and stabilized at 13 hours. The same trends were apparent between first and third flower (Table VI-A, Figure 11-A). No significant differences were noted between third and fifth flower (Table VI-C).

TABLE V

EFFECTS OF PHOTOPERIOD TREATMENTS ON MEAN FIRST FLOWERING DATE AND RANGES

Treatments	Mean Days to 1st Flower	No. and % Flowering by Mean 1st Flowering Date for Each Treatment	1st Date of 1st Flowering	Last Date of 1st Flowering
S. D.	56	19 of 47 (40.4%)	45	69
I. L.	62	46 of 74 (62.2%)	40	128
C. L.	63	45 of 74 (60.8%)	52	118
N. B.	74	41 of 74 (55.4%)	57	125
L. D.	72	37 of 69 (53.6%)	57	133

Figure 9. Photoperiod Effects Showing the Development of _Dahlia pinnata_, 'Redskin' on the Mean Date to First Flower for all Treatments (65 Days from Transplanting)--Left to Right: S. D., I. L., N. B., C. L., L. D.

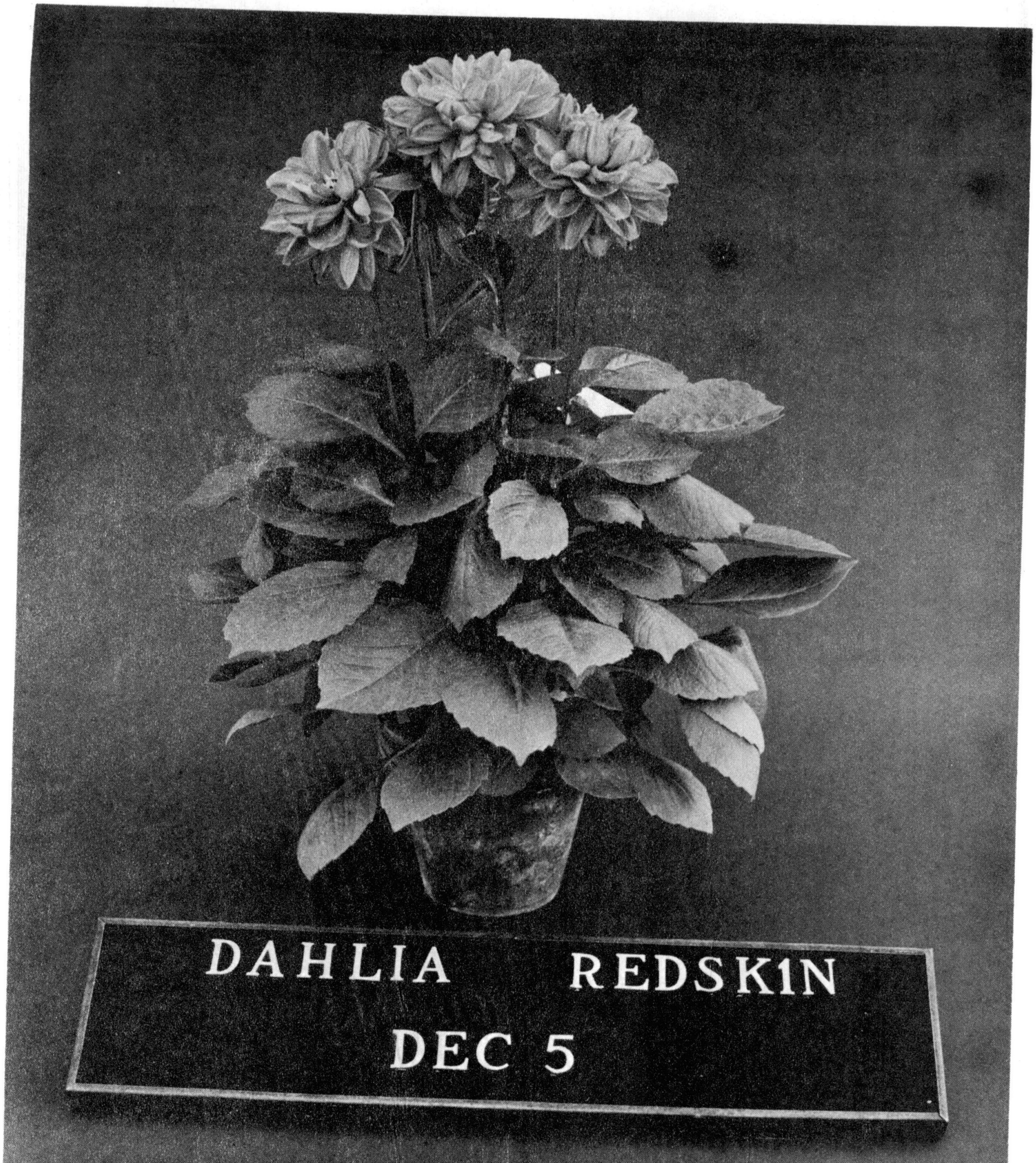

Figure 10. Appearance of the Dahlia pinnata, 'Redskin' Showing Possible Value as Pot Plant on the Sixty-eighth Day from Transplanting

TABLE VI

EFFECTS OF PHOTOPERIOD TREATMENTS ON DAYS FROM FIRST TO THIRD FLOWER, FIRST TO FIFTH FLOWER, AND THIRD TO FIFTH FLOWER

Treatments	A		B		C	
	Days From 1st to 3rd Flower	No. Flowered	Days From 1st to 5th Flower	No. Flowered	Days From 3rd to 5th Flower	No. Flowered
S. D.	2.80 a[1]	33[2]	8.11 c	22	5.34 a	22
I. L.	5.23 b	71	13.05 a	71	7.81 a	71
C. L.	2.80 a	74	8.84 bc	74	6.03 a	74
N. B.	3.83 ab	72	10.82 abc	71	7.29 a	71
L. D.	5.76 b	69	12.73 ab	67	7.56 a	67
L.S.D. (.05)	2.05		3.92		2.73	

[1]Means within a column followed by the same letter do not differ significantly at the .05 level (L.S.D. Test).

[2]Number of plants out of 75 that reached first or fifth flower on which the mean was based.

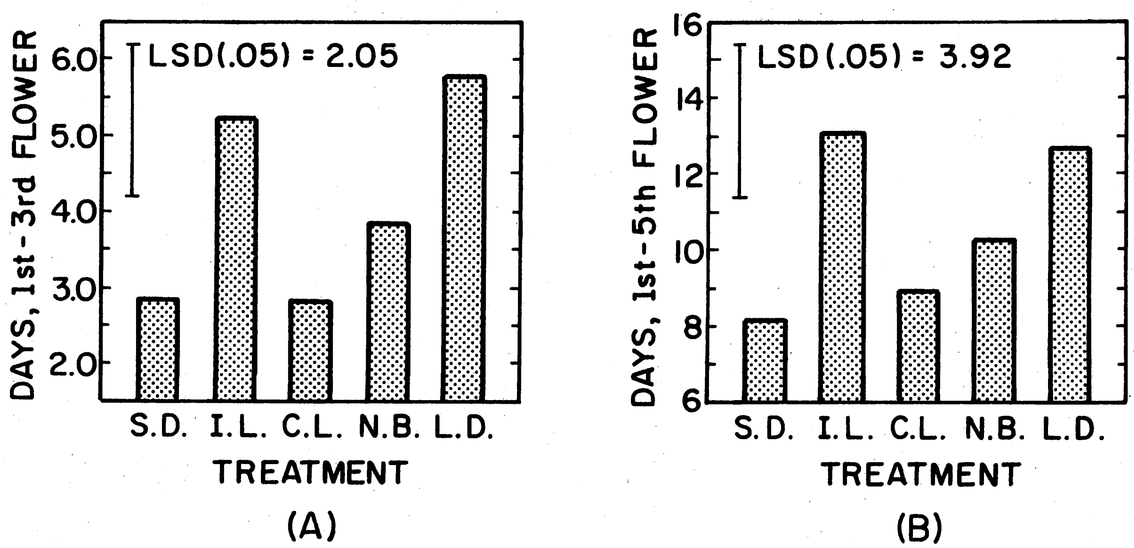

Figure 11. Influence of Photoperiod Treatments on Number of Days from First to Third Flower and First to Fifth Flower--(A) Days from First to Third Flower, (B) Days from First to Fifth Flower (See Table VI-A, B for number of plants on which each mean was based.)

Number of Buds and Flowers

On the day the first visible bud was recorded the number of other visible buds on the plant were also recorded. There was a significant increase in number of buds (Table VII, Figure 12) with the S. D., C. L. and I. L. plants over the N. B. or L. D. plants. However, the S. D. treatment initiated the same number of buds 6.5 days faster (Table I-A) than the C. L. or I. L. treatments.

The number of buds on the plant at first flower (Table VII, Figure 12) increased significantly with the I. L. and C. L. treatments with 18.3 and 16.8 buds, respectively, over all other treatments (average of other treatments was 11 buds). This indicated that at first bud (36 days) (Table I-A) the N. B. and L. D. treatments were limiting factors on bud initiation (Table VII) but by first flower (65 days) (Table I-B), the S. D. was also a limiting factor on bud initiation.

The number of buds left on the plant at termination date or fifth flower followed the same trend as number of buds at first flower (Table VII, Figure 12). The S. D. had become even more limiting on bud initiation. By fifth flower (75 days) (Table I-D) there was even a significant decrease in buds between S. D. plants and the N. B. or L. D. plants.

Although the number of days to first bud was the shortest in the S. D. plants (Table I-A), without increasing light a large percent of these buds did not develop and very few new buds were initiated (Table VII). The I. L. plants had 10 1/2 hours of light at bud initiation and initiated the same number of buds (3) in the same number of days (30) as the S. D. plants (Table I-A). However, by first flower (65

TABLE VII

EFFECT OF PHOTOPERIOD TREATMENTS ON MEAN NUMBER OF BUDS AND FLOWERS AT FIRST BUD, FIRST FLOWER AND FIFTH FLOWER (TERMINATION)

Treatments	A First Bud		B First Flower				C Fifth Flower (Termination)			
	Average No. Buds	No. Budded	Average No. Open Flowers	Average No. Buds	Total Flowers and Buds	No. Flowered	Average No. Open Flowers	Average No. Buds	Total Flowers and Buds	No. Flowered
S. D.	3.38 ab[1]	75[2]	1.88 a	10.22 b	12.10	47	2.29 d	2.90 d	4.38	22
I. L.	3.49 a	75	2.26 a	18.37 a	20.63	74	5.76 ab	16.24 a	21.94	71
C. L.	3.50 a	75	2.24 a	16.87 a	19.11	74	6.00 a	15.29 a	21.29	74
N. B.	2.90 b	75	2.00 a	11.33 b	13.33	74	5.21 bc	11.97 b	17.70	71
L. D.	2.83 b	74	1.98 a	11.23 b	13.21	69	4.84 c	9.70 c	14.50	67
L.S.D. (.05)	0.59		0.49	1.84			0.57	1.90		

[1]Means within a column followed by the same letter do not differ significantly at the .05 level (L.S.D. Test).

[2]Number of plants out of 75 that reached first bud, first or fifth flower on which the mean was based.

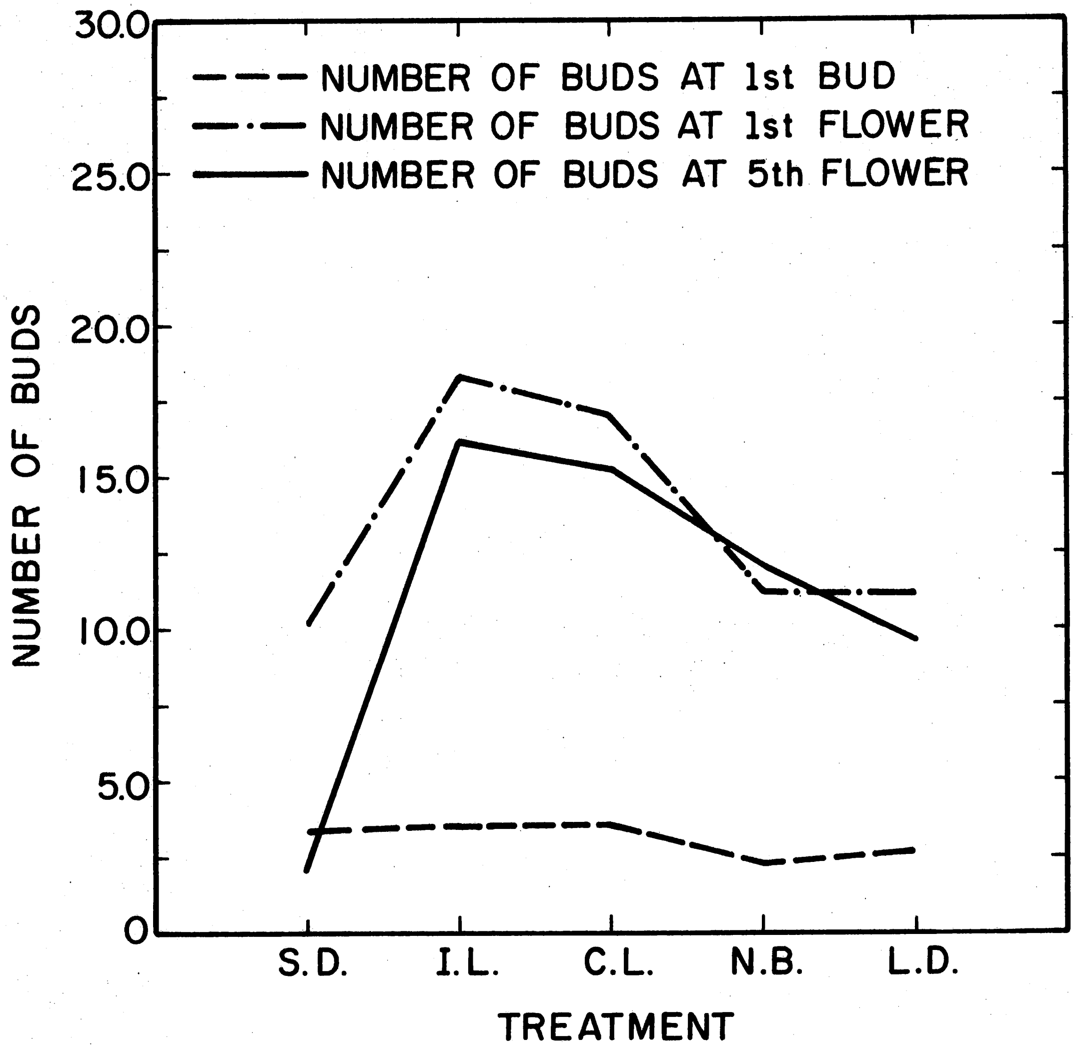

Figure 12. Influence of Photoperiod Treatments on Mean Number of Buds at First Bud, First Flower and Fifth Flower

days) (Table I-B), I. L. plants were receiving 13 hours of light. The increase in buds was significantly higher in the I. L. plants than the S. D., N. B. or L. D. treatments (avg. buds 1st flower--18.37) an increase of 17.14 buds since first bud. While the S. D. plants (avg. buds 1st flower--10.22) had increased only 8.72 buds since first bud. By termination date (fifth flower), the I. L. plants (avg. buds 5th flower--16.24) while remaining at 13 hours of light had developed 2.54 new buds. The S. D. plants (avg. buds at 5th flower--2.09) had gained no new buds and had 7.73 buds abort. The number of hours of light a plant is given affects the bud count but the variation in combining a particular number of hours of light can also affect the bud count (Figure 12).

There were significant differences between treatments in the total number of flowers on the plant at fifth flower (termination) (Table VII). The least flowers occurred in the S. D. treatment with a mean of 2.29 flowers per plant. The C. L. and I. L. treatments showed 6.0 and 5.7 flowers, respectively. This was a significant increase over the S. D. plants or the L. D. plants with 4.8 flowers per plant at termination. The S. D. and L. D. photoperiods were limiting factors in total number of flowers on the plant.

Flower Diameter

The flower diameter of the first flower on each plant was measured. A significant difference in flower diameter (Table VIII) was between the S. D. or I. L. plants (avg. dia.--6.04 and 6.07 cm, respectively) and the N. B. plants (avg. dia.--7.41 cm). There was no statistical difference in flower diameter between the N. B., C. L. or L. D. plants. The increase in flower diameter in the N. B. plants was enough larger visually to warrant incorporating a night break of some combination in future work. This 7.41 cm flower diameter size would be most desirable for pot plant production.

TABLE VIII

EFFECT OF PHOTOPERIOD TREATMENTS ON MEAN FLOWER DIAMETER OF FIRST FLOWER

Treatments	Flower Diameter of First Flower	No. Flowered
S. D.	6.04 b[1] cm	47[2]
I. L.	6.07 b cm	74
C. L.	6.33 ab cm	74
N. B.	7.41 a cm	74
L. D.	6.49 ab cm	69
L.S.D. (.05)	1.35	

[1]Means within a column followed by the same letter do not differ significantly at the .05 level (L.S.D. Test).

[2]Number of plants out of 75 that reached first flower on which the mean was based.

Flower Color

The color of the first flower in each treatment was recorded. The colors were fairly well distributed among the treatments (Table IX).

TABLE IX

FLOWER COLOR DISTRIBUTION AMONG PHOTOPERIOD TREATMENTS

	Flower Colors				
Treatments	Purple	Red-Purple	Red	Yellow	Yellow-Red
S. D.	9%	37%	32%	19%	2%
I. L.	15%	39%	35%	8%	2%
C. L.	9%	37%	32%	19%	2%
N. B.	3%	43%	32%	20%	1%
L. D.	6%	43%	35%	14%	1%

Number of Nodes and Internode Length at First Flower

As light increased so did the number of nodes (Table X-A, Figure 13). The smallest number of nodes was in the S. D. plants with an average of only 4.4 nodes per plant. There was no significant difference between the S. D. plants and the I. L. plants. This indicated that at first bud time (30 days) the one and one-half to two hours of additional light that the I. L. plants were receiving was not enough to cause a significant difference in number of nodes over S. D. plants. No significant difference in number of nodes was found between the N. B. and L. D. plants (avg. nodes--6.8 and 7.1, respectively).

TABLE X

EFFECT OF PHOTOPERIOD TREATMENTS ON MEAN NUMBER OF NODES AND MEAN INTERNODE LENGTH AT FIRST FLOWER

Treatments	A: No. of Nodes at 1st Flower	A: No. Flowered	B: Internode Length at 1st Flower	B: No. Flowered
S. D.	4.43 b[1]	47[2]	5.01 b cm	47
I. L.	4.77 b	74	5.83 a cm	74
C. L.	5.39 c	74	6.41 a cm	74
N. B.	6.84 a	74	6.35 a cm	74
L. D.	7.14 a	69	5.89 a cm	69
L.S.D. (.05)	0.43		0.68	

[1]Means within a column followed by the same letter do not differ significantly at the .05 level (L.S.D. Test).

[2]Number of plants out of 75 that reached first flower on which the mean was based.

The difference in internode length was significant between the S. D. treatment and each of the other treatments (Table X-B). It is interesting to compare the mean number of nodes and internode length for

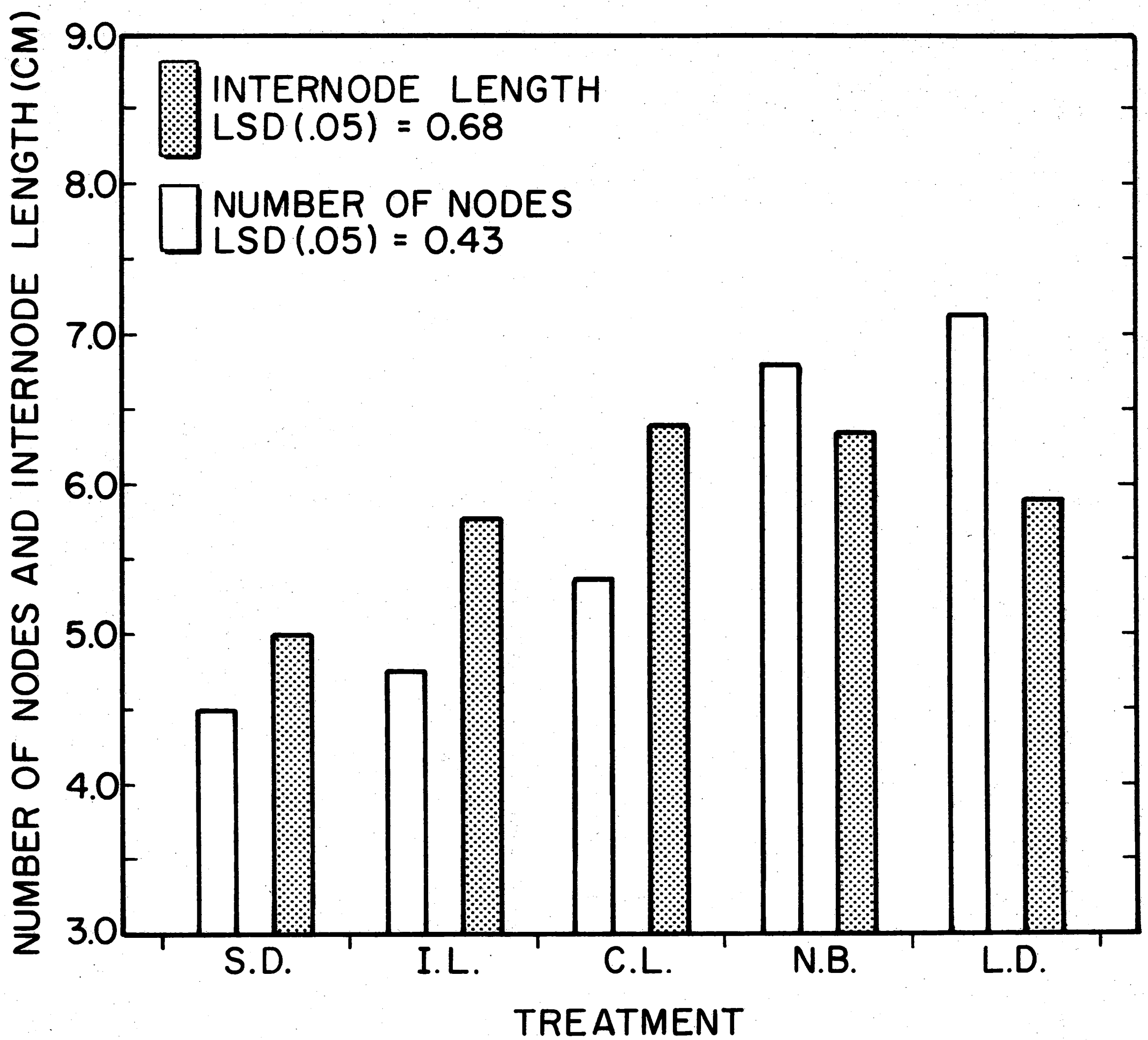

Figure 13. A Comparison of Node Number and Internode Length Showing the Influence of Various Photoperiod Treatments

each treatment at first flower as seen in Figure 13. As nodes increased internode length increased in the S. D., I. L. and C. L. plants but as nodes continued to increase in the N. B. and L. D. plants the internode length began to decrease.

Plant Heights

Height measurements were taken on a weekly basis from transplanting until termination. Average mean heights for each treatment from week 3 (one week after pinch) through week 9 are shown in Table XI and Figure 14. Once a significant difference between two treatments occurred, that difference was significant throughout the rest of the experiment. In week 3 the only significant difference was between the S. D. and the L. D. with the L. D. plants being the tallest. By week 9 there were significant differences among all treatments except the C. L. and N. B., and the I. L. and N. B. plants.

The weekly heights were on a fixed time and should not be compared with the heights at first bud, first flower or fifth flower (termination) as those heights were based on the average number of days it took for all plants in all treatments to reach first bud, first flower, or fifth flower (termination). At first bud and first flower there were significant differences in height between all treatment combinations (Table XII-A, B). As light increased, height increased but flowering was delayed (Table I-C, D).

At fifth flower (Table XII-C) there was the same trend in height increases as there was at first bud or first flower except in the case of the S. D. plants. The S. D. plants decreased in height from an average of 21.83 cm at first flower to 19.02 cm at fifth flower. This

TABLE XI

EFFECTS OF PHOTOPERIOD TREATMENTS ON MEAN WEEKLY HEIGHTS AND DIFFERENCES AMONG TREATMENTS IN THE SAME WEEK[1]

Treatments	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8	Week 9
S. D.	3.7 b[2]	8.0 a	10.4 d	12.5 d	15.4 d	17.5 d	17.4 d
I. L.	4.4 ab	8.9 ac	12.0 cd	16.8 cd	23.0 cd	25.8 c	29.3 b
C. L.	5.8 ab	11.9 bc	15.7 ab	20.4 ab	27.1 ab	30.4 ab	31.1 a
N. B.	5.0 ab	10.6 abc	13.8 bc	18.1 bc	24.3 bc	27.7 bc	31.0 ab
L. D.	6.9 a	13.2 b	17.0 a	22.7 a	29.3 a	33.2 a	37.7 c

[1]Average of 75 plants.

[2]Means within vertical columns followed by the same letter do not differ significantly at the .05 level (L.S.D. = 3.15).

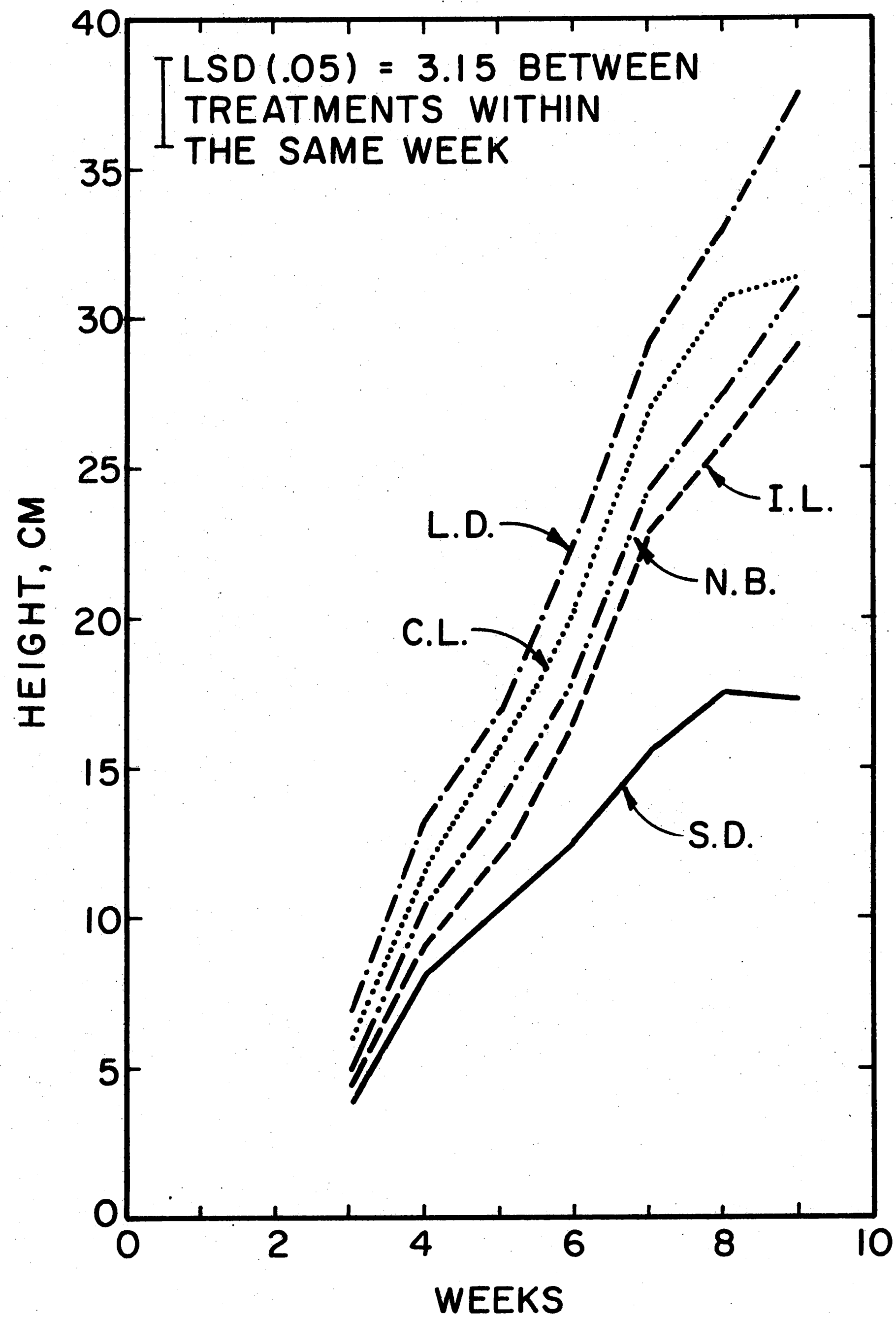

Figure 14. Influence of Photoperiod Treatments on Mean Height at Weekly Intervals

TABLE XII

EFFECT OF PHOTOPERIOD TREATMENTS ON MEAN HEIGHT AT FIRST BUD, FIRST FLOWER AND FIFTH FLOWER (TERMINATION)

	A Height at First Bud			B Height at First Flower			C Height at Fifth Flower (Termination)		
Treatments	Mean Ht.	No. Budded	% Flowered	Mean Ht.	No. Flowered	% Flowered	Mean Ht.	No. Flowered	% Flowered
S. D.	8.94 a[1]	75[2]	100[3]	21.83 a	47	62.6	19.02 b	22	29.3
I. L.	10.39 b	75	100	28.91 b	74	98.6	33.64 c	71	94.6
C. L.	15.55 c	75	100	33.79 c	74	98.6	37.22 a	74	98.6
N. B.	18.47 d	75	100	37.79 d	74	98.6	40.38 a	71	94.6
L. D.	22.52 e	74	98.6	41.44 e	69	92.0	45.19 d	67	89.3
L.S.D. (.05)	1.15			2.87			3.47		

[1]Means within a column followed by the same letter do not differ significantly at the .05 level (L.S.D. Test).

[2]Number of plants out of 75 that reached first bud, first, or fifth flower on which each mean was based.

[3]Percent of the total plants (75) in each treatment that reached first bud, first or fifth flower, on which the mean was based.

indicated that many buds had aborted by fifth flower time causing a decrease in height. The S. D. was definitely a limiting factor on height. Also at fifth flower (termination) there was no significant difference in height between the C. L. plants (37.22 cm) and the N. B. plants (40.38 cm). It would be interesting to know if there is a point where additional hours of light would also cause a decrease in height or what effect other variations in combining a certain number of hours of light would have on the height of the 'Redskin' dahlia.

It is interesting to note the percentage of the final height that was obtained by pinch, first bud, first and fifth flower (termination) (Table XIII). The L. D. plants had obtained 49.8% of their final height by first bud, whereas the I. L. plants had obtained only 30.8% of their final height by first bud time.

As seen in Table XII the largest percentage of final height for all treatments came between first visible bud and first flowering. An average of 50% of the final height of the plants occurred at this time. Only 38% of the final height was obtained between pinch and first bud and only 5% of the final height was reached between first flowering and termination for all treatments. The height increases among the three 13 hour light treatments were very significant. Different heights were obtained depending on what combination of 13 hours of light the plants were given.

Number of Branches

There were no significant differences among treatments in the number of branches at first bud, first flower or fifth flower (termination). The author would recommend pinching the plants at the third or fourth

TABLE XIII

EFFECTS OF PHOTOPERIOD TREATMENTS ON THE PERCENT OF FINAL HEIGHT THAT WAS REACHED AT VARIOUS STAGES OF GROWTH

Treatments	% Final Ht. Reached by Pinch	% Final Ht. Obtained Between Pinch and First Bud	% Final Ht. Reached by First Bud	% Final Ht. Obtained Between First Bud and First Flower	% Final Ht. Reached by First Flower	% Final Ht. Obtained Between First Flower and Termination	% Final Ht. Reached by Termination
S. D.	2.7	38.0	40.9	59.0	100	-13.0	Decreased in Ht.
I. L.	2.7	28.1	30.8	55.1	85.9	14.1	100
C. L.	5.1	36.6	41.7	49.1	90.8	9.2	100
N. B.	3.3	42.4	45.7	47.8	93.6	6.4	100
L. D.	6.0	43.8	49.8	41.9	91.7	8.3	100

CHAPTER V

SUMMARY AND CONCLUSIONS

If the photoperiod responses relative to vegetative growth and flowering of *Dahlia pinnata*, 'Redskin' with its vibrant flower colors and bronze foliage could be determined, this would be beneficial in determining the optimum environment for production of dahlia pot plants for year around sales. A market should exist, particularly at Easter and Mother's Day, as well as for the dual use as a bedding plant for summer and fall bloom.

After conducting the experiment and analyzing the data, the following information would be what the author considers "ideal" for this dahlia as a pot plant. For comparative purposes the treatment(s) that came the nearest to meeting these "ideal" conditions are as follows:

"Ideal" Pot Plant

		Nearest Treatment to "Ideal" Condition with Treatment Mean	
Condition	"Ideal" No.	Treatment	Mean
Days to First Bud	30 days	I. L.	30 days
		S. D.	30 days
Days to First Flower	60 days	I. L.	62 days
		C. L.	63 days
Nodes	5.0	I. L.	5.39 nodes
Internodes	6.1 cm	I. L.	5.83 cm
		C. L.	6.41 cm

Condition	"Ideal" No.	Nearest Treatment to "Ideal" Condition with Treatment Mean: Treatment	Mean
Flower Diameter	6.8 to 7.0 cm	N. B.	7.41 cm
Total Buds at First Flower	16	I. L. C. L.	18.37 buds 16.87 buds
Height at First Flower	30 to 31 cm	I. L. C. L.	28.91 cm 33.79 cm
Height at Termination	34 to 35 cm	I. L.	33.64 cm
Total Flowers (Open at One Time)	8 to 10	I. L. C. L.	5.76 flowers 6.00 flowers
Branches	8 to 10	None	No significant difference among treatments

The desirable and undesirable features about each treatment, when comparing it to the "ideal" plant, are as follows:

Treatments	Desirable	Undesirable
S. D.	Days to first bud	Days to first flower Number of nodes Internode length Buds at first flower Flower diameter Height at first flower Height at termination Branches Branches with buds or flowers Number of flowers open at one time Poor foliage development
I. L.	Days to first bud Days to first flower Nodes Internode length Buds at first flower Height at first flower Height at termination Branches with buds at first bud	Branches Flower diameter Fair foliage development

Treatments	Desirable	Undesirable
I. L. (continued)	Flowers open at one time High percent of flower development	
C. L.	Days to first flower Internode length Buds at first flower Flower diameter Height at first flower Flowers open at one time High percent of flower development Good foliage development	Days to first bud Nodes Branches Height at termination Branches with buds or flowers
N. B.	Flower diameter Excellent foliage development	Days to first bud Days to first flower Nodes Internode length Buds at first flower Height at first flower Height at termination Branches Branches with buds or flowers Flowers open at one time
L. D.	Flower diameter Good foliage development	Days to first bud Days to first flower Nodes Internode length Buds at first flower Height at first flower Height at termination Branches Branches with buds or flowers Flowers open at one time

As photoperiod lighting increased (9 hr, 13 hr, 17 hr) the following also increased significantly:

Days to first bud, first, third and fifth flower

Number of nodes

Height from transplant to termination

As photoperiod lighting increased (9 hr, 13 hr, 17 hr) the following increased significantly between 9 hr and 13 hr and decreased significantly at 17 hr:

Total buds at first and fifth flower

Total flowers on plant at termination

The possibility of establishing stock plants for asexual propagation of selected clones using two to four cuttings per 15 cm (6 in) container, also increases the desirability of the 'Redskin' dahlias for pot plant culture.

If the early bud initiation were maintained, days to flower reduced slightly, and height and foliage quality increased slightly, the I. L. treatment could produce the "ideal" pot dahlia. Until future work is completed the nine to thirteen hour increasing light (I. L.) treatment and the thirteen hour continuous light (C. L.) treatment appear to be the best treatments of the five treatments in this experiment for producing dahlias as a pot plant.

Although no statistical data were collected on the dahlia roots, it was observed that tuberous-roots did form under all photoperiod treatments. Visually, it was obvious that the S. D. plants had the largest and most tubers while the N. B. and L. D. plants had the fewest and smallest tuberous-roots.

The results of this experiment were significant enough to warrant future studies on photoperiod, clone selection, growth regulators, light intensity, and temperature as related to growth and flowering of the _Dahlia pinnata_, 'Redskin' for pot plant culture.

LITERATURE CITED

1. Anderson, A. W. 1966. The Coming of the Flowers. New York: Dover Publications, Inc., 109-112.

2. Bahr, Fritz. 1922. Commercial Floriculture. New York: At de La Mare Comp., Inc., 337-380.

3. Barnes, A. T. 1966. The Dahlia Grower's Treasury. London: W. H. and L. Collingridge, Limited, 126-140.

4. Biran, I., I. Gur and A. H. Halevy. 1972. The relationship between exogenous inhibitors and endogenous levels of ethylene, and tuberization of dahlias. Physiol. Plant., 27:226-230.

5. Biran, I. and A. H. Halevy. 1973a. Endogenous effects of growth regulators and their relationship to the growing of dahlia cuttings. Physiol. Plant., 28:436-442.

6. Biran, I. and A. H. Halevy. 1973b. The relationship between rooting of dahlia cuttings and the presence and type of bud. Physiol. Plant., 28:244-247.

7. Biran, I. and A. H. Halevy. 1973c. Stock plant growing and rooting of dahlia cuttings. Scientia Horticulturae, 2:125-131.

8. Booth, Charles O. 1957. An Encyclopedia of Annual and Biennial Garden Plants. London: Faber and Faber Limited, 245-246.

9. Canham, A. E. 1969. The effect of night-break lighting on the production of cuttings from dahlia tubers. Shinfield Progr., 14:38-39.

10. Cathey, H. M. 1974. Participation of phytochrome in regulating internode elongation of chrysanthemum morifolium. J. Am. Sci. Hort. Sci., 99(1):17-23.

11. DeHertogh, A., N. Blakely and W. Szlachetka. 1973. The influence of Ancymidor, Chlormequat and Daminozide on the growth and development of forced Dahlia variabilis Willd. Michigan Agricultural Exp. St. J., Article No. 7226.

12. DeHertogh, A. and N. Blakely. 1974. Greenhouse forcing of tuberous-rooted dahlias as potted plants. Hort. Sci., 9(3) Sec. 2. Program and Abstract, 71st Annual Meeting.

13. DeHertogh, A. 1975. Personal communication. Dept. of Horticulture, Michigan State University, East Lansing, Mich.

14. El-Gamassy, A. M. and M. B. Moustafa. 1964a. Nutritional requirements of dahlia plants. 3. Effect of fertilizer rates on the growth, flower quality, and yield of tuberous roots of dahlia plants grown in pot and field. A. Ann. Agric. Sci. Cairo, 9(1):395-421.

15. El-Gamassy, A. M. and M. B. Moustafa. 1964b. Nutritional requirements of dahlia plants. 4. Effect of application time of phosphatic and potassic fertilizers on the growth, flower quality and yield of tuberous roots of dahlia plants. Ann. Agric. Sci., Cairo, 9(1):423-431.

16. Foley, Daniel J. 1945. Garden Flowers in Color. New York: Macmillan Co., 90-92.

17. Hall, O. G. 1968. The response of plants to night-break light. Shinfield Progr., 12:23-26.

18. Hall, O. G. 1969. Dahlias for early cut flower production. Shinfield Progr., 14:36-37.

19. Hellyer, A. G. L. 1956. Dahlias. London: W. H. and L. Collingridge Limited, 148-155.

20. James, H. 1936. Dahlias for Garden and Exhibition. London: John Gifford Ltd., 1922, 202-209.

21. Konishi, K. and K. Inaba. 1964. Studies on flowering control of dahlias. I. On optimum day length. J. Jap. Soc. Hort. Sci., 33:171-180.

22. Konishi K. and K. Inaba. 1966a. Studies on flowering control in dahlias. III. The effects of day length on the initiation and development of flower buds. J. Jap. Soc. Hort. Sci., 35:73-79.

23. Konishi, K. and K. Inaba. 1966b. Studies on flowering control in dahlias. IV. The effect of day length at the early stage of shoot growth upon the flowering date and the quality of cut flowers. J. Jap. Soc. Hort. Sci., 35:195-202.

24. Konishi, K. and K. Inaba. 1966c. Studies on flowering control in dahlias. V. The effects of night temperature and light intensity and duration on flowering. J. Jap. Soc. Hort. Sci., 35:317-324.

25. Konishi, K. and K. Inaba. 1966d. Studies on flowering control in dahlias. VI. On various factors affecting flowering. J. Jap. Soc. Hort. Sci., 35:422-428.

26. Krijthe, N. 1938. De Ontwikkeling Der Knoppen Van Enkele Voorjaarsgewaasen I. (The development of the meri stem of several spring crops I.) (Mignon-Dahlias and Lilium regale), Meded. Landbouwhoogesch, Wageningen, 42(3):1-51.

27. Lebar, T. R. H. 1955. Dahlias for Everyone. London: Blandford Press, 62-75.

28. Lloyd, F. G. 1968. Dahlias--production of healthy tubers under glass. 9th Progr. Rep. Exp. Husb. Fms. Exp. Hort. Stats., 66-67.

29. Mittal, S. P. 1967. Studies on the effect of gibberellin on growth and flowering of dahlia. Madras Agric. J., 54:163-167.

30. Moser, B. C. and C. E. Hess. 1968. The physiology of tuberous root development in dahlia. Proc. Am. Soc. Hort. Sci., 93: 595-603.

31. Mostafa, M. B. and M. H. A. Owais. 1970. Dahlia flower production as affected by the number of shoots left on the plants. Cairo, U.A.R. Research Bulletin, Faculty of Agri., Ain Shams University, No. 316:1-10.

32. Post, Kenneth. 1949. Florist Crop Production and Marketing. New York: Orange Judd Publishing Company, Inc., 439-444.

33. Read, P. E. and V. C. Hoysler. 1969. Stimulation and retardation of adventitious root formation by application of B-Nine and Cycocel. Amer. Soc. Hort. Sci., 94:314-316.

34. Read, P. E., C. W. Dunham and D. J. Fieldhouse. 1972. Increasing tuberous root production in Dahlia pinnata Cav. with SADH and Chlormequat. Hort. Sci., 7(1):62-63.

35. Rooke, J. E. 1967. Light treatment for dahlia cuttings. Gdnrs'. Chron., 162(5):10.

36. Roslin Ozbodny Instytut. 1973. The effects of photoperiod on dwarf dahlia cultivars raised from seeds. Bulletin of the Roslin Ozbodny Instytyt Sadownictawa, Poland, Annual Report, 1972.

37. Shewell-Cooper, W. E. 1961. The ABC's of Dahlias. London: The English University Press Ltd., 13-20.

38. Taylor, Norman. 1961. Encyclopedia of Gardening. Boston, Mass.: Houghton Mifflin Company, 273-276.

39. United States Naval Observatory, Nautical Almanac Office. 1974. The American Ephemeris and Nautical Almanac for the Year 1976. Washington, D. C.: U. S. Government Printing Office, 436-439.

40. Waite, W. H. 1925. _A Little Book of Modern Dahlia Culture_. New York: At De La Mare Co., Inc., 46-53.

41. Walker, Marian C. 1954. _Dahlias for Every Garden_. New York: M. Barrows and Co., Inc., Pub., 92-99.

42. Zimmerman, P. W. and H. E. Hitchcock. 1929. Root formation and flowering of dahlia cuttings when subjected to different day lengths. _The Botanical Gazette_, 87:1-13.

43. Yashchenko, N. P. 1972. Some characteristics of leaf arrangement and branching in dahlias. _Byulleten'Glavnogo Botanicheskogo Suda_, No. 83:104-106.

VITA

Mary Ann Haliburton

Candidate for the Degree of

Master of Science

Thesis: EFFECTS OF PHOTOPERIOD ON GROWTH AND FLOWERING OF *DAHLIA PINNATA*, CAV. 'REDSKIN' POT PLANTS

Major Field: Horticulture

Biographical:

Personal Data: Born in Dallas, Texas, August 29, 1940, the daughter of Mr. and Mrs. Doyle Smith.

Education: Graduated from Woodrow Wilson High School, Dallas, Texas in 1958; graduated from the University of Texas, Austin, Texas in 1962 with a Bachelor of Science in Elementary Education; completed the requirements for a Master of Science degree in Horticulture at Oklahoma State University in July, 1976.

Professional Experience: Teacher, Austin Independent School District, 1962-1964; Owner and Operator, The Clay Pot, 1972-present; Graduate Research Assistant, Department of Horticulture, Okahoma State University, 1976-present.