FLOWER BUD INITIATION IN 'ECKESPOINT C-1' POINSETTIAS AS INFLUENCED BY PROPAGATION DATE AND PHOTOPERIOD

By

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

Figure Page

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CHAPTER I

INTRODUCTION AND REVIEW OF LITERATURE

Several studies have been conducted to determine the date of flower bud initiation in poinsettias grown under various cultural practices [15, 5, 9]. These studies were concerned with cultivars which descended from 'Oak Leaf', a seedling which was first grown in the United States approximately in 1923 [1]. In fact, prior to 1960 all of the commercially important cultivars originated from this seedling [14]. Since this time, cultivars which have been developed are of much more unrelated parentage and as a result the cultural methods required to grow these new cultivars differ considerably [3]. The 'C-1' poinsettia is a relatively new hybrid which is gaining increased acceptance with growers in preference to older[1] cultivars. Although workers in Ohio have estimated the date of flower bud initiation with 'C-1' grown at a 60°F night temperature to be between September 30 and October 7 in that state [7], no anatomical study of flower bud initiation in this cultivar has been reported.

It is recommended that 'C-1' plants propagated in July and August be forced at a night temperature of approximately 65°F [2] and those propagated in September at 65-68°F [3]. This would seem to indicate that either flower bud initiation or flower development

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[1]Those plants which originated as sports of the cultivar 'Oak Leaf'.

may be affected by propagation date. With the cultivar 'Barbara Ecke Supreme' it has been shown that propagation date had less effect on flower bud initiation that did variable conditions from year to year [5]. No mention was made of statistical analysis being used to evaluate the significance of these data.

Many of the "old cultivars" required supplemental long days in order to prevent premature blooming and poor quality plants for the Christmas season [8]. This is not recommended for 'C-1' indicating that prior estimations of a 12 hour critical daylength [12] may be inadequate for this cultivar [2], that floral and/or bract development may be slower, or that increased keeping quality makes the exact flowering date less important. Most "response group" work is related to a 60°F night temperature [11]. It has been shown that plants forced at higher temperatures require a shorter critical daylength for initiation to occur [9]. This would appear to be offset by reportedly more rapid development at higher night temperatures [4], although 'C-1' may not respond to higher night temperatures in the same manner as did the "old cultivars". Since only one night temperature was utilized in this experiment, it was not within the scope of this study to determine the effect due to night temperature. In addition, it has been shown that with shorter daylengths, flower bud initiation occurs more rapidly [5]. For the cultivar 'Barbara Ecke Supreme' flower bud initiation occured following a 16 day treatment with a 12 - 12¼ hour light period per day, and in 30 days with a 12 3/4 hour day and plants remained vegetative under a 13 hour day [9].

The objectives of this experiment were:

1. To determine the approximate date of flower bud initiation in 'C-1' poinsettias propagated August 16 and September 7 and grown under normal and short daylengths.

2. To determine the short day response group for the 'C-1' cultivar forced at 63-64°F night temperature in Stillwater, Oklahoma (36 07 N lat.).

3. To relate the change in the number of hours of daylight to the date of flower bud initiation and date of full bloom.

4. To determine the influence of propagation date and photoperiod on the date of flower bud initiation.

5. To make an estimate of the critical daylength for flower bud initiation for plants grown at a 63-64°F night temperature.

CHAPTER II

MATERIALS AND METHODS

Stock plants of the 'C-1'[1] cultivar were received June 18, 1970, as rooted cuttings in 2½ inch plastic pots. These plants were shifted June 20 to 6 inch pots in a soil mix consisting of 1 part peat moss, 1 part perlite, and 1 part soil. A soil drench consisting of a mixture of Terrachlor, Captan and Dexon was used June 25 in the following proportions:

Terrachlor[2]	2.5 grams/2 gallon
Captan[3]	9.0 grams/2 gallon
Dexon[4]	5.5 grams/2 gallon

A drench containing only Captan and Dexon was continued at 3 week intervals. The stock plants were then blocked off so that similar treatments would be given to plants for each propagation date. In order for the cutting material to be of equal size and physiological age, final pinches were made on stock plants six weeks prior to propagation dates. Those stock plants from which cuttings would be

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[1]Plants furnished courtesy of Paul Ecke Poinsettias, Encinitas, California.

[2]Registered trademark, 75% WP, Pentachloronitrobenzene.

[3]Registered trademark, 50% WP, N-trichloromethyl thiotetrahydro phthalimide.

[4]Registered trademark, 35% WP, P-(Dimethylamino) benzenediazo sodium sulfonate.

taken August 16 were soft pinched July 3 while the stock plants for the September 7 propagation were soft pinched June 29 and July 27.

Stem cuttings were made August 16 and September 7. The basal ends of the cuttings were dipped in Hormodin #2[5], placed in BR-8 blocks and rooted under intermittent mist in a lightly shaded fiberglass greenhouse. In order to allow for better air flow the blocks were placed on a bench surface of stretched chicken wire. In addition, a 70°F minimum night temperature was maintained during propagation.

Plants from the August 16 propagation were panned 3 per 6 inch pot September 10. Plants from the September 7 propagation were planted in a like manner September 28. Plants were fertilized once or twice weekly with 20-20-20 at 1 ounce per 3 gallons of water, as the need was indicated by soil tests, and the fungicidal drench program previously described for the stock plants was utilized.

Plants from each propagation date were given the following treatments:

Treatment A: Plants were grown under normal daylength throughout the experiment.

Treatment B: Plants were placed in a 9 hour daylength by the use of 'blackcloth' nightly from 5:00 p.m. - 8:00 a.m., beginning September 19 and continuing until maturity.

Plants in both treatments were placed on benches designated 1 and 2, in a random fashion in a glass greenhouse having pad and fan cooling with air flow perpendicular to the length of the house. As soon as natural fall temperatures allowed (approximately September 23), a 63-64°F night temperature was maintained as closely as possible

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[5]3000 parts per million (ppm) indolebutyric acid (IBA) in talc.

throughout the experiment. Figure 1 shows a layout and description of the experimental design. The procedure for sampling described in Figure 1 was accomplished by shuffling IBM cards which were coded for each pot.

Beginning September 19 and continuing every 3 days until October 22 (date 12) two stem apices were removed from plants from each treatment in each location. On September 19 the daylength was approximately 12.3 hours (36° N lat.) [10]. The daylength October 22 was 11.0 hours [10]. The September cuttings were not rooted when sampling started. These cuttings on the propagation bench were sampled, labeled and placed in proper locations when rooted. Plants in some locations did not show obvious external symptoms of flower bud initiation by October 22 so in all cases sampling was continued until bract color was visible in a sampled plant. It should be noted that samples taken after October 22 could not be considered unbiased, therefore, no attempt was made to analyze the significance of these data. After removal, the apices were fixed in individual coded bottles containing 50% FPA [13] dehydrated with t-butyl alcohol and embedded in Paraplast.[6] Longitudinal sections were cut 10 microns in thickness on a rotary microtome, fixed to slides and stained with a modified Johansen Quadruple stain [6]. The histological materials were then viewed microscopically in order to determine the stage of development as described by Goddard [5]. These stages are: V = vegetative, F = floral initiation, F_1 = cyathia notching, F_2 = stamen primordia visible, F_3 = pistil primordia visible.

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[6]Trademark for paraffin embedding material with a melting point of 56-57°C.

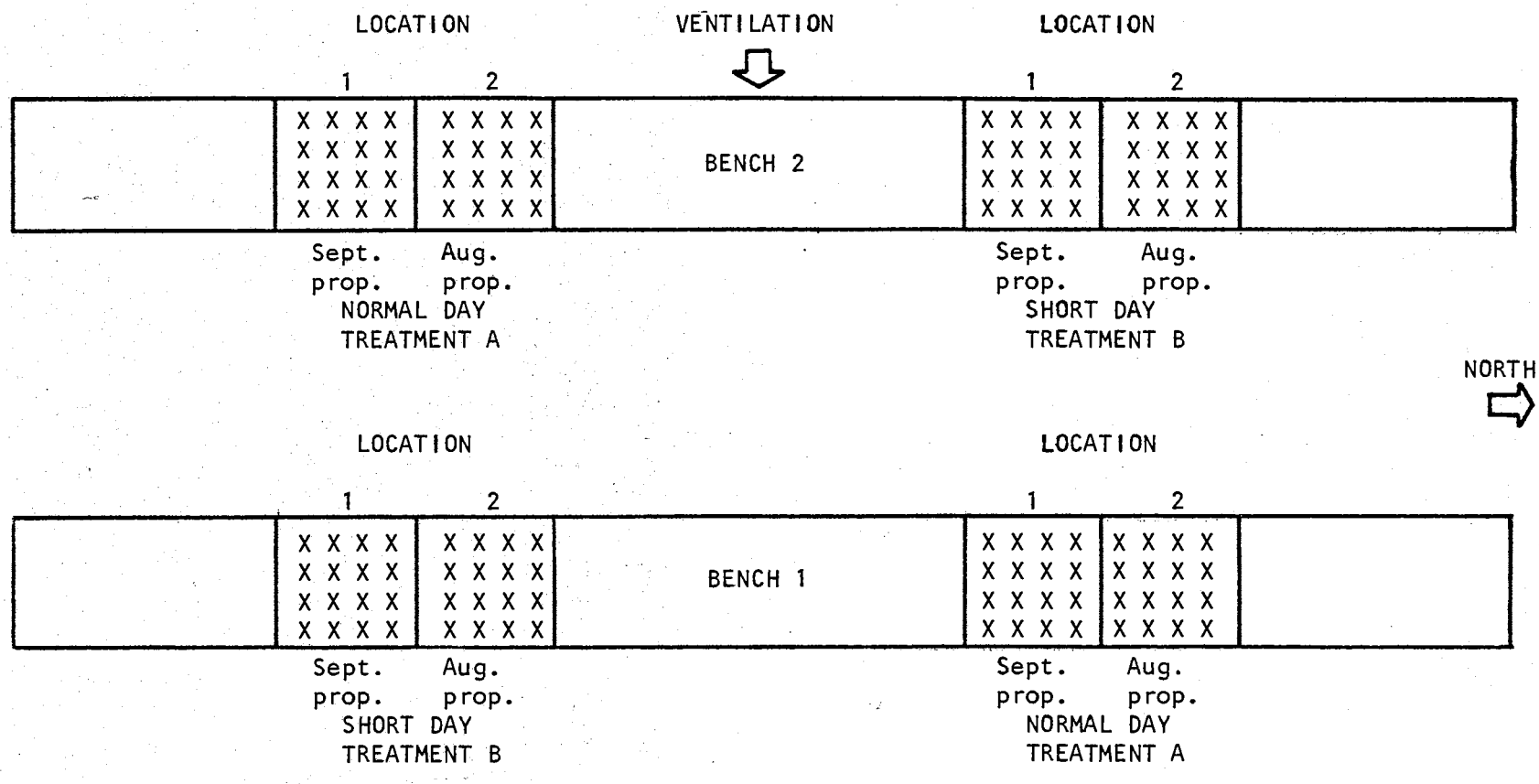

Figure 1. Split plot design with the main plot being treatment and the sub-plot being propagation date. In each sub-plot, of the 16 pots, 4 were left unsampled and from the remaining 12 pots 2 were randomly selected for each sampling date, and one of the 3 plants per pot was sampled from each pot. This was done through the first 6 sampling dates (9/19-10/4) until one plant had been removed from each of the 12 pots. For the last 6 sampling dates (10/7-10/22) these same pots were again randomly chosen and sampled in a like manner. This process was followed for replicates on each bench giving four samples for each propagation date and treatment on each sampling date.

CHAPTER III

RESULTS AND DISCUSSION

Stages of plant development were observed and recorded for plants from the two photoperiod treatments and propagation dates and are shown in Table I. The dates of flowering are also included.

Plants in all treatments remained vegetative through October 1. Probability of flower bud initiation from October 4 through October 16 is summarized in Table II.[1] All plants had reached a discernable stage of flower bud initiation by October 19.

As noted in Table II, on October 4 the probability of initiation was significantly greater for plants from the August propagation, treatment B (short days) than for plants in the other treatments. This was also the case on October 7. By October 10 the probability of initiation for plants from the August propagation, treatment B (short days) was significantly greater than for plants in the September propagation, treatment B, the August propagation, treatment A (normal days) or the September propagation, treatment A. At the same time the probability of floral initiation for plants in the August propagation, treatment A (normal days) became significantly greater than for the September propagation treatments. This appears to indicate that date of initiation is influenced by date of propagation.

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[1] It is assumed that these probabilities have approximately a normal distribution.

TABLE I

STAGE OF APICAL DEVELOPMENT OF 'ECKESPOINT C–1'[1] POINSETTIAS PROPAGATED AUGUST 16 AND SEPTEMBER 7, AND GROWN UNDER NORMAL (TREATMENT A) AND SHORT (TREATMENT B) DAYLENGTHS: V–VEGETATIVE, F–FLOWER BUD INITIATION, F_1–CYATHIA NOTCHING, F_2–STAMEN PRIMORDIA VISIBLE, F_3–PISTIL PRIMORDIA VISIBLE

FLOWERING DATES[1] / SAMPLING DATES		11/24/70		11/24/70		11/28/70		12/8/70		12/4/70		12/8/70		12/8/70		12/14/70	
(15)	10/31	—	—	—	—	F_3	—	F_3	—	—	—	F_3	—	F_3	—	F_2	—
(14)	10/28	—	—	—	—	F_3	—	F_3	—	F_3	—	—	—	F_3	—	—	—
(13)	10/25	—	—	—	—	F_3	—	F_2	—	F_3	—	F_2	—	F_2	—	F_1	—
(12)	10/22	F_3	F_3	F_3	F_3	F_3	F_2	F	F	F_3	F_2	F_3	F_2	F_1	F_1	F	F_1
(11)	10/19	F_3	F_3	F_3	F_3	F	F	F	F	F	F	F_1	F_1	F	F	F	F
(10)	10/16	F_3	F_3	F_3	F_3	F	F	F	F	F	F	F_1	F_2	V	F	V	V
(9)	10/13	F_2	F_2	F_2	F_2	F	F	V	V	V	F	F	F	V	V	V	V
(8)	10/10	F	F_1	F	F_2	V	V	V	V	V	V	F	F	V	V	V	V
(7)	10/7	F	F	F	F	V	V	V	V	V	V	F	V	V	V	V	V
(6)	10/4	V	V	F	F	V	V	V	V	V	V	V	V	V	V	V	V
(5)	10/1	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V
(4)	9/28	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V
(3)	9/25	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V
(2)	9/22	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V
(1)	9/19	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V
		SAMPLE		SAMPLE		SAMPLE		SAMPLE		SAMPLE		SAMPLE		SAMPLE		SAMPLE	
		1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
		BENCH 1		BENCH 2		BENCH 1		BENCH 2		BENCH 1		BENCH 2		BENCH 1		BENCH 2	
		AUGUST PROPAGATION TREATMENT B				SEPTEMBER PROPAGATION TREATMENT B				AUGUST PROPAGATION TREATMENT A				SEPTEMBER PROPAGATION TREATMENT A			

[1]Flowering dates: determined when all four unsampled pots showed pollen shed

TABLE II

PROBABILITY OF FLOWER BUD INITIATION IN 'C-1' POINSETTIAS PROPAGATED AUGUST 16 AND SEPTEMBER 7 AND GROWN UNDER NORMAL AND SHORT DAYLENGTHS

Date	Treatment	Propagation Date	n = 4 Probability of Initiation[1]
(6)	B	August	0.5a
10/4/70	B	September	0.0a
	A	August	0.0c
	A	September	0.0c
(7)	B	August	1.0a
10/7/70	B	September	0.0c
	A	August	0.25c
	A	September	0.0c
(8)	B	August	1.0a
10/10/70	B	September	0.0c
	A	August	0.5b
	A	September	0.0c
(9)	B	August	1.0a
10/13/70	B	September	0.5b
	A	August	0.75ab
	A	September	0.0c
(IC)	B	August	1.0a
10/16/70	B	September	1.0a
	A	August	1.0a
	A	September	0.25c

[1]Significant differences noted by the letters a, b, and c were determined for a binomial distribution with a tabulated t value of 1.96.

On October 13, plants from both August propagation treatments and from the September propagation, treatment B (short days), show a significantly greater probability of initiation than for plants in the September propagation, treatment A (normal days). The August propagated plants grown under short days (treatment B) still showed a significantly greater probability of initiation when compared to plants from the September propagation grown under short days (treatment B). This suggests a possible link between physiological maturity or rooting with ability to respond to a short day stimulus.

Since it has been suggested [3] that 'C-1' plants not be grown at night temperatures higher than 62-64°F through the first week in October, it should be noted that in this experiment plants propagated in September were given 70°F night temperatures during the propagation period for approximately a week (September 23 - September 28) after normal fall weather would have allowed maintenance of 63-64°F night temperatures. This may have delayed flower bud initiation. Plants in the September propagation, treatment B (short days) were blackclothed starting September 19, before they had developed sufficient root system and had started active growth, and this may have accounted for some delay in flower bud initiation in these plants. The blackclothed plants were slightly earlier in initiating flower buds than plants under normal days, and by October 16, only the September propagated plants grown under normal days (treatment A), had not shown flower bud initiation in all plants.

If one attempts to follow floral development as indicated by the progression from cyathia notching to initiation of stamen primordia and finally pistil primordia, the importance of physiological age,

and possibly early rooting was especially evident in the short day (B) treatments. In this instance the August propagated plants showed very rapid development as compared to the plants propagated in September. Figure 2 shows a median or near median longitudinal section of a stem apex at the beginning of the experiment (September 19) and also compares apices from the various treatments at the October 10 stage of development. The advanced stage of initiation in plants from the August treatments was evident. This was particularly obvious in plants from short day treatments (Figure 2b). Figure 3 shows similar longitudinal sections sampled October 16. Again the August propagated plant grown under short days (treatment B) was in a much more advanced stage of development (Figure 3a). The September propagated plant grown under normal days had not yet reached a definite floral stage, but apparently was almost in a transitional stage (Figure 3d). The plant propagated in August and grown under normal days had made little change in floral development (Figure 3c) and may have been less advanced than was the plant from the September propagation grown under short days (treatment B, Figure 3b). The data in Table I showed that this was not the case for all samples, as August propagated plants grown under normal days and sampled from bench 2 showed more advanced stages of development. This points out the fact that variation between plants in the same treatment did exist. If one could observe a plant over a period of time without having to sacrifice the apex for processing then perhaps more uniform data might be obtained.

There were also a difference in size of plants between those propagated in August and in September as shown in Figures 4, 5, and 6. Difference in size was particularly obvious November 2 (Figure 4)

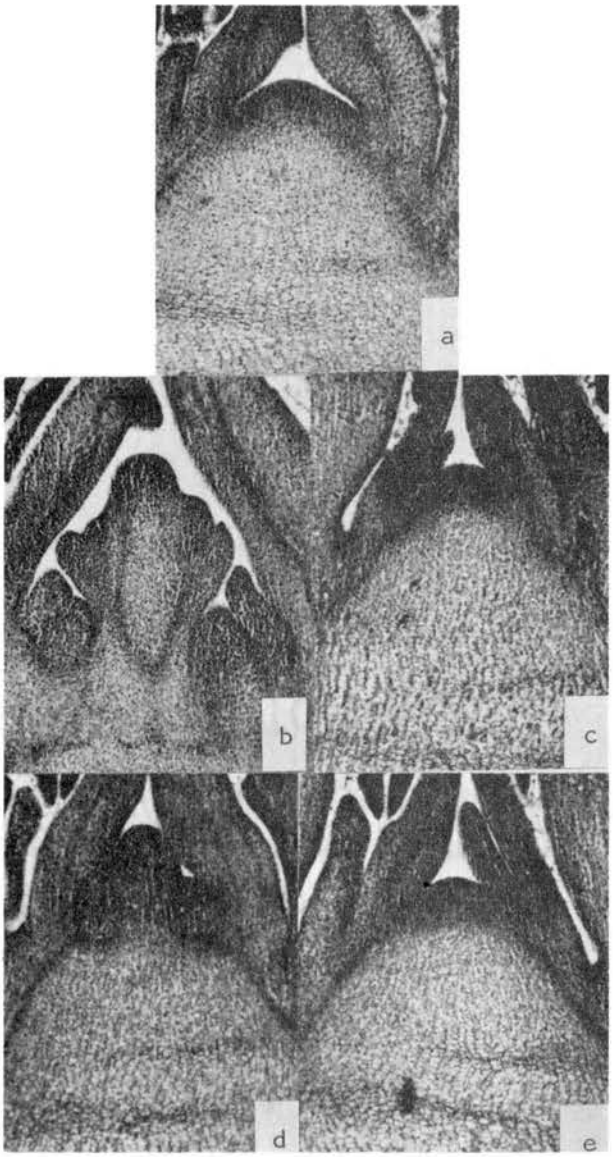

Figure 2. Median longitudinal stem apices of 'Eckespoint C-1' poinsettias. a. Vegetative apex sampled September 19. Samples b-e were taken October 10. b. floral apex from the August propagation grown under 9 hr. short days; c. vegetative apex from the September propagation grown under short days; d. floral apex from the August propagation grown under normal days; e. vegetative apex from the September propagation grown under normal days.

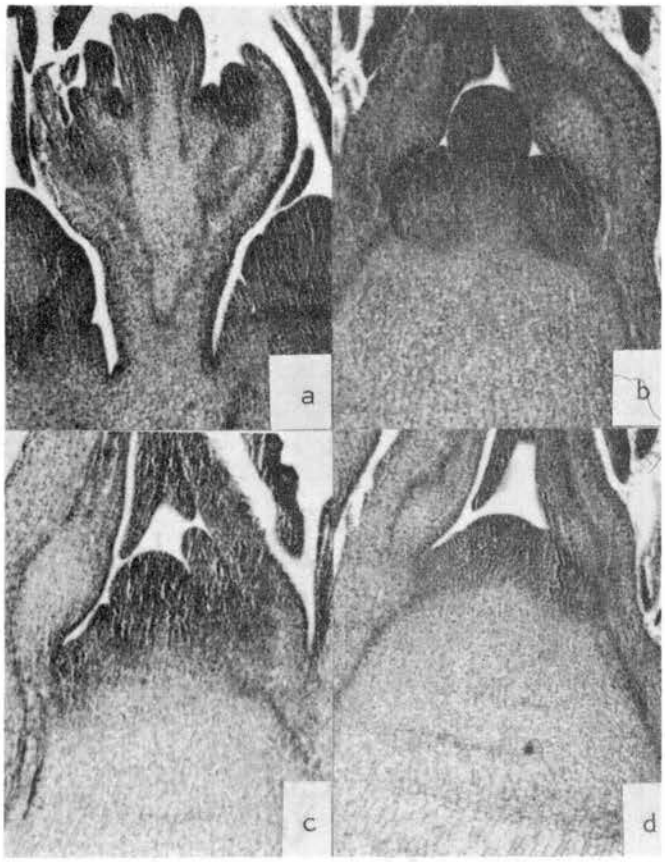

Figure 3. Median longitudinal stem apices of 'Eckespoint C-1' poinsettias sampled October 16. a. floral apex from the August propagation grown under 9 hr. short days; b. floral apex from the September propagation grown under 9 hr. short days; c. floral apex from the August propagation grown under normal days; d. vegetative apex from the September propagation grown under normal days.

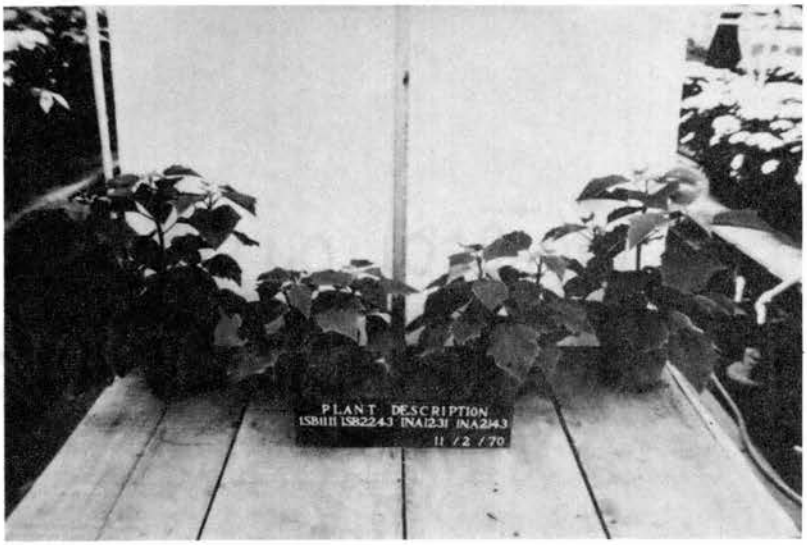

Figure 4. Unsampled plants grown at 63-64° F night temperature. Plants from left to right: August propagation grown under 9 hr. short days, September propagation grown under 9 hr. short days, September propagation grown under normal days, August propagation grown under normal days. Plants photographed November 2, 1970.

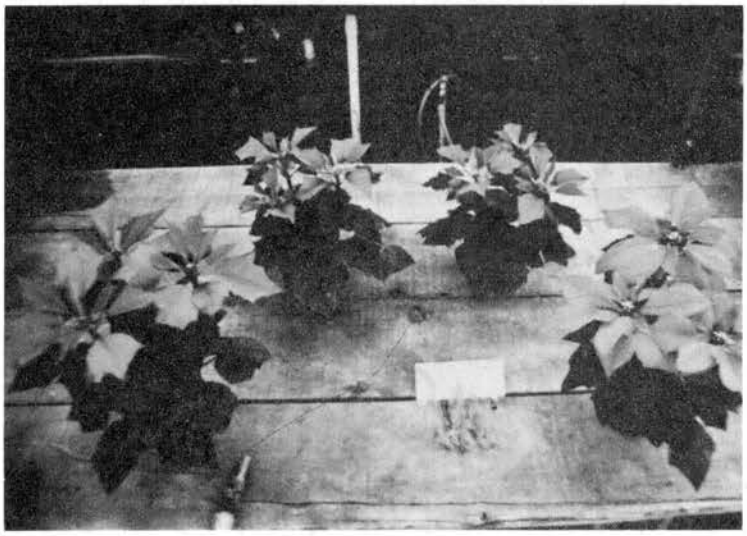

Figure 5. Unsampled plants grown at 63-64° F night temperature. Plants from left to right: August propagation grown under normal days, September propagation grown under normal days, September propagation grown under short days, August propagation grown under short days. Plants photographed December 1, 1970.

Figure 6. Side and overhead views of unsampled plants grown at 63-64° F night temperature. Plants from left to right: September propagation grown under short days, August propagation grown under short days, August propagation grown under normal days, September propagation grown under normal days. Plants photographed December 14, 1970.

and December 1 (Figure 5). By December 14 (Figure 6), the difference was less distinct.

Determination of average date of flower bud initiation (Table III) was accomplished by averaging the dates at which plants in a given treatment on benches 1 and 2 showed flower bud initiation in both samples. These data emphasize the importance of date of propagation in the initiation of flowers of 'C-1' poinsettias. Comparison of treatment B (short days) plants propagated in August and September shows a difference of 9 days in date of initiation, while a similar comparison with treatment A (normal day) shows a difference of 6 days. Some differences were also evident when comparing date of floral initiation of plants propagated at the same time, but grown under 9 hour and normal photoperiods. For the August propagation, plants grown under short days initiated flower buds 7 days earlier than plants grown under normal days. This difference was 4 days in the September propagated plants. Earlier initiation by plants under short days may have been due to more rapid formation of the primary cyathia under 9 hour days, and in addition, the critical daylength may have been shorter than the 12.3 hours which existed September 19, the date when short days were started for treatment B. One may estimate an approximate critical daylength for the conditions of this experiment by subtracting the number of days required to initiate flower buds under short days (treatment B) from the average date of flower bud initiation for each normal day treatment. The number of hours of daylight on this calculated date would be the approximate critical daylength. For the plants propagated in August this would be October 13 minus 16 days which would give the date of September 27. On this date there are 12.0 hours

TABLE III

AVERAGE DATE OF FLOWER BUD INITIATION IN 'C-1' POINSETTIA PROPAGATED AUGUST 16 AND SEPTEMBER 7 AND GROWN UNDER NORMAL AND SHORT DAYLENGTHS

	Bench 1	Bench 2	Average Date	Natural[3] Daylength on Average date of Initiation	No. of Short Days Applied
August, B[1]	10/7/70	10/4/70	10/6/70	--	16
September, B	10/13/70	10/16/70	10/15/70	--	25
August, A[2]	10/16/70	10/10/70	10/13/70	11.4 hr.	--
September, A	10/19/70	10/19/70	10/19/70	11.2 hr.	--

[1]Treatment B (9 hour daylength from September 19 to maturity).

[2]Treatment A (normal daylength throughout the experiment).

[3]Accurate to within 2-3 minutes [10].

(maximum variation 2-3 minutes) of light per day (36° N. lat.) [10]. For the plants propagated in September this would be October 19 minus 25 days which would give the date of September 24. On this date there are 12.1 (maximum variation 2-3 minutes) hours of light per day [10]. It would appear that based on these calculations the critical daylength for 'C-1' is similar to that required for the "old cultivars". The difficult question is whether the plants respond much more rapidly under a 9 hour photoperiod than under this approximately 12 hour (but decreasing to an average of 11.3 hours by the date of flower bud initiation) photoperiod. As previously mentioned 'Barbara Ecke Supreme' initiated flower buds within 16 days at 65°F night temperature in a continuous 12-12½ hour photoperiod while at 12 3/4 hours it required 30 days [9].

In another study [11] 'Barbara Ecke Supreme' showed little difference in the number of days to initiate flower buds when grown under 9 to 11 hour daylengths at 60-65°F night temperatures, but there was a considerable difference in time to initiate between 9 and 12 hour daylengths. If 'C-1' is similar, then the one week's difference in time to initiate between August propagated plants under 9 hour and normal daylengths could be due, at least in part, to the fact that normal daylengths of 12.0 hours or over existed from September 19 (12.3 hours) through September 27 (12.0 hours), a period of 8 days. After this time the 9 hour and normal daylengths (less than 12 hours) probably had nearly equal effects relative to primary cyathia formation.

For the September propagated plants under short days (treatment B), an average period of 25 days elapsed from start of short days to flower bud initiation (Table III). The September propagated plants

under normal days were exposed to less than 12.0 hour daylengths starting September 28 (11.9 hours). From this date to October 19 (the average initiation date) covers a period of 21 days. It is possible that induction began about September 24 (daylength 12.1 hours), 25 days from the average initiation date of October 19, and that rate of formation of the primary cyathia became more rapid once daylengths of less than 12.0 hours occurred.

It is not entirely clear why there was only a 4 day average difference in date of floral initiation between plants in the short day and normal day treatments, but as mentioned previously, these plants were not well established by September 19, and the first few days of the blackclothing treatment may have been less effective on these plants than it would have been if the plants had been somewhat more "mature".

If one looks at the daylength on the average dates of initiation for the normal daylength treatments these are 11.4 hours (October 13) for the plants propagated in August and 11.2 hours (October 19) for the plants propagated in September. Subtracting from the approximate critical daylength calculated for these two propagation dates (12.0-12.1 hr.) we see that there was a change of .6-.9 hours in the length of day from induction of floral stimulus to initiation of flower buds. A similar calculation with average flowering date and critical daylength shows that a change in daylength from 2.2-2.3 hours after the induction of floral stimulus was sufficient to cause flowering at a night temperature of 63-64°F.

In order to arrive at an approximate short day response group for the 'C-1' cultivar, the remaining plants which were not sampled were

observed to determine when plants reached anthesis. In Table IV average date of flowering of plants was computed from data in Table I, averaging the flowering date of plants from replicate 1 on bench 1 with those of the replicate from bench 2. From these data in Table IV there is some indication of a consistent difference in replicates. Plants on bench 2 appeared to be slightly slower in the development of flowers. It should be remembered that plants on bench 2 were adjacent to the cooling pads and exposed to a higher humidity, a slightly lower light intensity, and during developmental stages a slightly lower night temperature than plants on bench 1.

TABLE IV

AVERAGE DATES OF FLOWERING OF 'C-1' POINSETTIAS PROPAGATED AUGUST 16 AND SEPTEMBER 7 AND GROWN UNDER NORMAL AND SHORT DAYLENGTHS

	Bench 1	Bench 2	Average Date
August, B[1]	11/24/70	11/24/70	11/24/70
September, B	11/28/70	12/8/70	12/3/70
August, A[2]	12/4/70	12/8/70	12/6/70
September, A	12/8/70	12/14/70	12/11/70

[1]Treatment B (9 hr. daylength from September 19 to maturity).

[2]Treatment A (normal daylength throughout the experiment).

If for treatment B one considers the day when a 9 hour photoperiod was started (September 19) as the beginning of induction then the following short day responses for plants forced at a night temperature of 63-64°F may be calculated using the average date of flowering as an end point:

August, B (short days)	66 days = 9 weeks, 3 days
September, B	75 days = 10 weeks, 5 days

Thus, an additional 9 days are required for plants propagated in September to reach anthesis. It should be mentioned that the blackcloth treatment begun September 19 is not a recommended practice and was started at this time only to allow handling and processing of both treatments simultaneously.

Calculation of a precise critical daylength for plants in the normal daylength treatment was not possible, under the conditions of this experiment. However, using the approximate critical daylength or date of induction of a floral stimulus for the normal daylength treatment (A) the following short day response for plants grown under normal daylengths may be calculated:

August, A (normal days)	70 days = 10 weeks
September, A	78 days = 11 weeks, 1 day

In this case those plants propagated in September required an additional 8 days to reach anthesis.

Thus, under a 9 hour daylength at 63-64°F night temperatures, 'C-1' responded as a 9½-10½ week cultivar, depending upon propagation date, while under the gradually decreasing conditions of normal daylength, August propagated plants responded as a 10 week cultivar, while September propagated plants responded as an 11 week cultivar.

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