Agricultural Experiment Station
Oklahoma State University

Photoperiod Effects on 'Redskin' Dahlia Pot Plants

January 1978 Bulletin 735

Contents

Photoperiod Effects on 'Redskin' Dahlia Pot Plants

Mary Ann Haliburton and R. N. Payne*

Introduction and Background

The 'Redskin' dahlia, *Dahlia pinnata* CAV., a dwarf bedding type, was a 1975 All-American award winner. Its dwarf size, decorative bronze foliage and vibrant flower colors (red, pink, rose, lavender, yellow and orange) are adaptable to possible pot plant culture. If specific cultural requirements, including photoperiod responses, could be determined, this dahlia might be brought into flower at any season, with special emphasis in the spring from Easter through Memorial Day. These spring-flowered plants could also be enjoyed as bedding plants during the summer and early fall months. Photoperiod research has been conducted on tuberous-rooted dahlias (2, 3, 4, 5, 6, 7, 9) and seedling dahlias (8), but we know of no photoperiod work specifically on 'Redskin.'

Tuberous-rooted dahlias grown in short periods (nine hours) of natural daylight flowered rapidly, but the quality of blooms and foliage was lessened. Plants grown in long days (up to 17 hours) were delayed in flowering, but flower and foliage quality was improved (6).

Research conducted from February to April indicated that a 13-hour day was optimum for flowering (2, 6). Seedling dahlias grown in a greenhouse produced flower buds more rapidly in an 8- to 10-hour natural daylight regime than with other photoperiod treatments. A similar experiment conducted at the same time of year, out-of-doors, did not give similar results, indicating that temperature as well as photoperiod was involved (8).

Specific objectives of this experiment were to determine the effects of various photoperiod regimes on flowering, height, vegetative growth and overall plant quality.

Methods and Procedures

Seed Germination

Our studies were conducted in greenhouses at Oklahoma State University, Stillwater, Oklahoma (36°9′ N latitude, 97°5′ W longitude). Seeds were

*Former graduate assistant and professor, respectively, Department of Horticulture. Research reported herein was conducted under Oklahoma Station Project No. 1411. Appreciation is expressed to Dr. Ronald McNew for assistance in statistical analysis and to Harry Macklin and Charles Steel for assistance in plant production.

germinated in wooden flats using a growing mixture of equal parts sand and peat moss. Flats and medium were steam sterilized. Seeds were sown September 10, 1975, in rows .32 cm. (1/8 in.) apart and covered slightly with the sand-peat mixture. Seeds were watered-in and glass was placed over the top of the seed flats to maintain high humidity until germination was complete. Flats were lighted 18 hours daily by two deluxe cool white and two Gro-Lux fluorescent lamps placed 12.7 cm. (5 in.) above the flats, to provide 1,000 ft-c. intensity. Germination was slow and irregular. A fertilizer solution of 20-20-20, .9 g/l (12 oz./100 gal.) water, was applied to seed flats eight days after seeds were sown. At this time, the seedlings were placed in a 15°C (60°F) greenhouse.

Transplanting and Cultural Procedures

On September 30, seedlings having four leaves were transplanted (Figure 1) into new 11-cm. (4½-in.) clay pots with one seedling per container (Figure 2) in a peat-vermiculite-perlite growing medium[1]. A surface spray of Benlate-Dexon .6g of each/1 (8 oz. each/100 gal) was applied prior to transplanting.

Figure 1. Appearance of seedlings at time of transplanting (September 30, 1975).

[1]Pro Mix BX furnished by Premier Brands Incorporated, New York, N.Y.

Figure 2. Seedlings on benches at time of transplanting (September 30, 1975).

After transplanting, a topdressing of 2.87 g. (1/2 tsp.) slow-release fertilizer (Osmocote 14-14-14) was added to each pot. Supplementary 20-20-20 (500 ppm N, P_2O_5 K_2O) applications were made 10 days after transplanting and continued every five days until termination of the experiment. All plants were hose-watered as required.

Based on previous research (1) night temperatures were maintained at 15-16°C (60-63°F) and day temperatures were held as close as possible within the range from 18-20°C (65-68°F) on cloudy days to 20-24°C (68-74°F) on sunny days. Occasionally, daytime temperatures exceeded this range.

Experimental Treatments

Five treatments were established (Table 1). Twenty-five benches were arranged in a 5 × 5 square. A latin square design was used for applying treatments to benches, each bench receiving one treatment. A bench was a wooden frame, 81 × 122 cm. (32 × 48 in.), covered with welded wire mesh 2½ × 5 cm. (1 × 2 in.) and supported on concrete blocks 46 cm. (18 in.) from the floor. Number 9 galvanized wire arches were attached to the bench corners to allow support for the heat-sealed black polyethylene covering (Figure 3). A 75-watt incandescent bulb was suspended 91 cm. (36 in.) from the bench (81

Table 1. Photoperiod Lighting Regimes.

Treatment	Natural Light	Supplemental Light
Short day (9 hr.)	(9 hr.) 8 a.m. - 5 p.m.	None
Increasing Light (9-13 hr.)	(9 hr.) 8 a.m. - 5 p.m.	Add ½ hr./week 2nd through 9th week to reach 4 hr.
13 hr. Continuous Light (13 hr.)	(9 hr.) 8 a.m. - 5 p.m.	(4 hr.) 5 p.m. - 9 p.m.
Night Break (13 hr.-NB)	(9 hr.) 8 a.m. - 5 p.m.	(4 hr.) 10 p.m. - 2 a.m.
17 hr. Continuous Long Day (17 hr.)	(9 hr.) 8 a.m. - 5 p.m.	(8 hr.) 5 p.m. - 1 a.m.

cm. (32 in.) from pot rim), supplying 19 ft-c of light at plant level. All benches or chambers were covered with the black plastic coverings at 5:00 p.m. and the appropriate supplementary light followed.

Initially there were 25 plants per chamber. On the tenth day the 15 most uniform plants remaining were selected and spaced 20 × 20 cm. (8 × 8 in.) center-to-center for the remainder of the experiment.

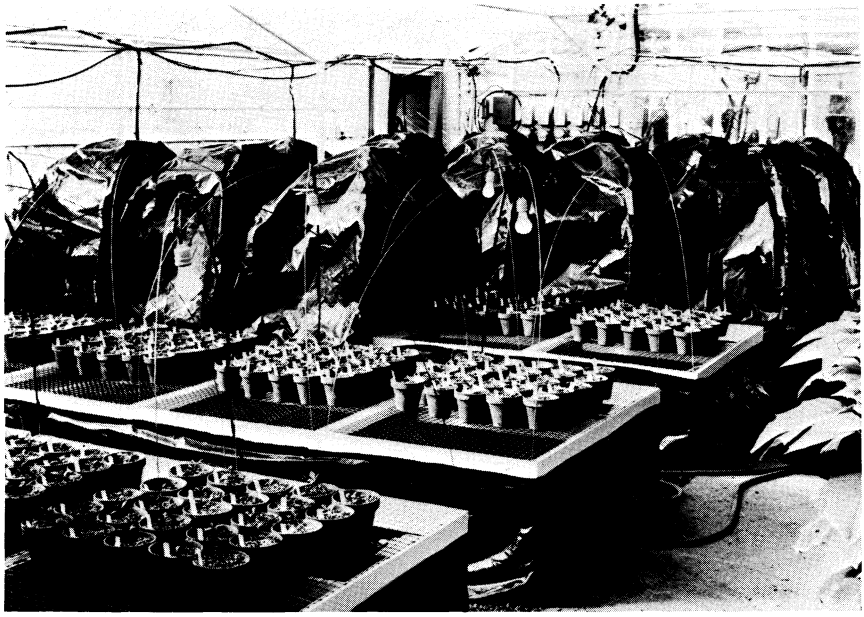

Figure 3. 5 × 5 Latin square design showing individual photoperiod treatment chambers.

Experimental Results and Discussion

The means from the five replications of each treatment derived from plants which responded were used to obtain an analysis of variance for each character. The means reported are the means of the five replication means.

Days to First Bud, First, Third and Fifth Flower

As photoperiod increased, the number of days to first visible flower bud increased (Table 2). The 9-hour and 9- to 13-hour plants required an average of 30 days to reach first bud. The 13-hour-NB and 17-hour plants were last to produce buds and required an average of 43 days. Plant development at 36 days from transplanting is shown in Figure 4.

The number of days from transplant to first flower was shortest (56 days) in the 9-hour plants; however, only 62% flowered. The 9-hour short day was sufficient to initiate as 100% were initiated, but 9 hours were not enough light for continued growth and development. The 9-hour plants continued to reach first flower only through the ninth week (Figure 5). Low percentages of 9-hour plants reached third and fifth flower. By the tenth week the 9-hour plants appeared stunted and chlorotic and many buds had aborted.

Although the 13-hour-NB plants were the last to flower (74 days) (Table 2), nearly all of the plants reached first flower. Longer photoperiods improved the foliar appearance of the plants as they had more and larger leaves. There was no significant difference in days to first flower between plants in the 13-hour-NB and 17-hour treatments (74.9 and 72.0 days, respectively). The 9- to 13-hour and 13-hour plants reached first flower significantly sooner, 62.1 and 63.0 days, respectively.

The same trends were apparent at third and fifth flowering (Table 2).

Figure 4. 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, 9 hr., 9-13 hr., 13 hr.-NB, 13 hr., 17 hr.

Table 2. Effect of Photoperiod Treatments on Mean Days to Flowering.

Treatments	Mean Days to 1st Bud: Mean Days to 1st Bud[1]	Mean Days to 1st Bud: No. Budded[2]	Mean Days to 1st Bud: % Budded[3]	Mean Days to 1st Flower: Mean Days to 1st Flower	Mean Days to 1st Flower: No. Flowered	Mean Days to 1st Flower: % Flowered	Mean Days to 3rd Flower: Mean Days to 3rd Flower	Mean Days to 3rd Flower: No. Flowered	Mean Days to 3rd Flower: % Flowered	Mean Days to 5th Flower: Mean Days to 5th Flower	Mean Days to 5th Flower: No. Flowered	Mean Days to 5th Flower: % Flowered
9 hr.	30.49 a	75	100	56.22 a	47	62.6	58.93 a	33	44.0	65.05 a	22	29.3
9-13 hr.	30.88 a	75	100	62.17 b	74	98.6	65.71 b	71	94.6	73.53 b	71	94.6
13 hr.	35.26 b	75	100	63.08 b	74	98.6	65.87 b	74	98.6	71.90 b	74	98.6
13 hr.-NB	43.24 c	75	100	74.92 c	74	98.6	77.95 c	72	96.0	84.68 c	71	94.6
17 hr.	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.

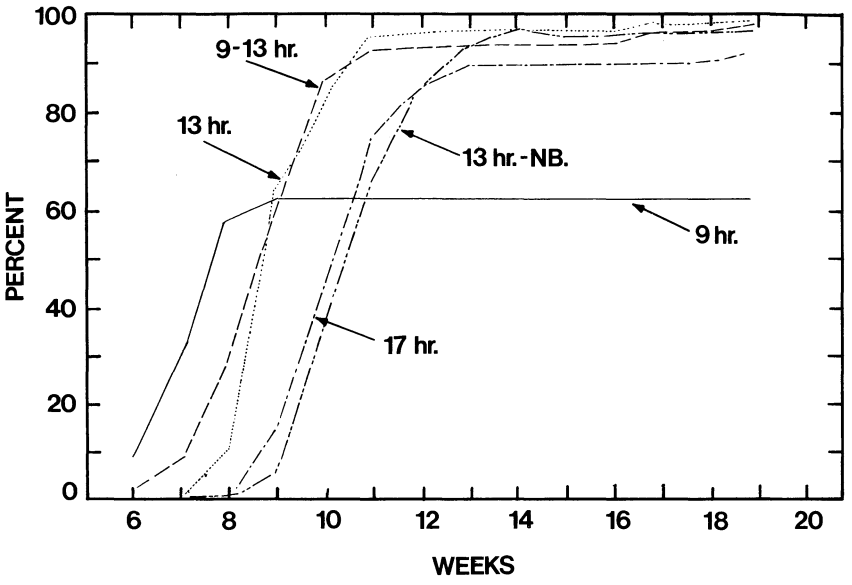

Figure 5. Percent of plants reaching first flower by weeks.

Since flowering was delayed in the 13-hour-NB and 17-hour treatments, further research is warranted to determine if a longer night break (6 or 8 hours), or possibly two interruptions in the long night, or even 24-hour lighting might decrease flowering even more and encourage vegetative growth for stock plant production of clones.

If a higher percentage of the 9-hour plants had reached first flower while maintaining quality these plants would have many characteristics desirable for pot plant production. The 9- to 13-hour plants set buds at the same time as the 9-hour plants, but flowered at the same time as the 13-hour plants. Further research might determine if it is possible to cause the 9- to 13-hour plants with early bud initiation to flower earlier than the 13-hour plants. If this were possible the 9- to 13-hour plants would then be a composite of the best characteristics from both treatment regimes.

The range of first flower dates was wide (Table 3), indicating that precise crop timing of a seedling mixture such as 'Redskin' might be difficult. Development of vegetatively propagated selections (clones) would be beneficial.

Plant development at 65 days from transplanting is shown in Figure 6. The 9- to 13-hour and 13-hour plants were comparable in number of buds and flowers. The appearance of one 'Redskin' selection showing possible value as a pot plant can be seen in Figure 7. With clone selection it should be possible to consistently produce desirable pot dahlias. Plants with the best traits, such as: 1) having several flowers open at one time, 2) good texture, substance and flower form and 3) good foliage, could be selected.

Table 3. 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	Earliest First Flower	Latest First Flower
9 hr.	56	19 of 47 (40.4%)	45	69
9-13 hr.	62	46 of 74 (62.2%)	40	128
13 hr.	63	45 of 74 (60.8%)	52	118
13 hr.-NB	74	41 of 74 (55.4%)	57	125
17 hr.	72	37 of 69 (53.6%)	57	133

Number of Buds and Flowers

The number of buds and flowers peaked at the 9- to 13-hour increasing light and 13-hour continuous light treatments (Table 4). One problem with these dahlias as pot plants may be the relatively low number of flowers open at a given time. Clone selection and research on various photoperiod treatment combinations may overcome this.

Flower Diameter

The flower diameter of the first flower on each plant was measured (Table 5). The 13-hour-NB plants had the largest flower diameter and the 9-hour and 9- to 13-hour plants had the smallest. Although the 13-hour-NB (light 10 p.m. - 2 a.m.) treatment delayed flowering, its 7.4 cm. average flower diameter would be most desirable.

Figure 6. 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, 9 hr., 9-13 hr., 13 hr-NB, 13 hr., 17 hr.

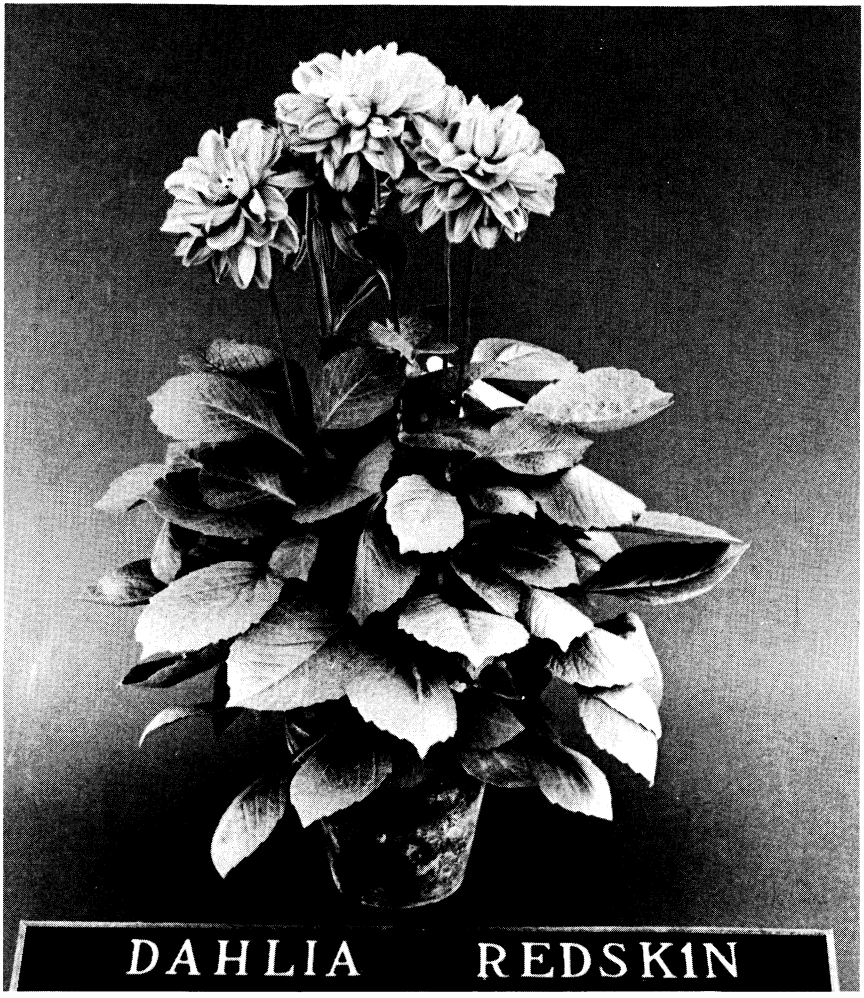

Figure 7. Appearance of one selection of the *Dahlia pinnata*, 'Redskin' showing possible value as pot plant on the 68th day from transplanting.

Number of Nodes and Internode Length at First Flower

As photoperiod increased so did the number of nodes (Table 6). Short-day plants (9-hour) had significantly shorter internodes than each of the other treatments.

Table 4. Effect of Photoperiod Treatments on Mean Number of Buds and Flowers at First Bud, First Flower and Fifth Flower (Termination).

Treatments	First Bud		First Flower				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
9 hr.	3.38 ab[1]	75[2]	1.88 a	10.22 b	12.10	47	2.29 d	2.90 d	4.38	22
9-13 hr.	3.49 a	75	2.26 a	18.37 a	20.63	74	5.76 ab	16.24 a	21.94	71
13 hr.	3.50 a	75	2.24 a	16.87 a	19.11	74	6.00 a	15.29 a	21.29	74
13 hr.-NB	2.90 b	75	2.00 a	11.33 b	13.33	74	5.21 bc	11.97 b	17.70	71
17 hr.	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.

Table 5. Effect of Photoperiod Treatments on Mean Flower Diameter of First Flower.

Treatments	Flower Diameter of First Flower	No. Flowered
9 hr.	6.04 b[1] cm.	47[2]
9-13 hr.	6.07 b cm.	74
13 hr.	6.33 ab cm.	74
13 hr.-NB	7.41 a cm.	74
17 hr.	6.49 ab cm.	69
L.S.D. (0.5)	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.

Table 6. Effect of Photoperiod Treatments on Mean Number of Nodes and Mean Internode Length at Time of First Flowering.

Treatments	No. of Nodes at 1st Flower	No. Flowered	Internode Length at Time of 1st Flowering	No. Flowered
9 hr.	4.43 b[1]	47[2]	5.01 b cm.	47
9-13 hr.	4.77 b	74	5.83 a cm.	74
13 hr.	5.39 c	74	6.41 a cm.	74
13 hr.-NB	6.84 a	74	6.35 a cm.	74
17 hr.	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.

Plant Heights

As photoperiod increased, plant height increased (Table 7). The 17-hour long-day treatment resulted in significantly taller plants than the night break treatment (13-hour-NB) in which plants were lighted from 10 p.m. - 2 a.m., a conventional long-day treatment.

Table 7. Effect of Photoperiod Treatments on Mean Height at First Bud, First Flower and Fifth Flower (Termination).

Treatments	Height at First Bud Stage			Height at First Flower Stage			Height at Fifth Flower Stage (Termination)		
	Mean Ht.	No. Budded	% Flowered	Mean Ht.	No. Flowered	% Flowered	Mean Ht.	No. Flowered	% Flowered
9 hr.	8.94 a[1]	75[2]	100[3]	21.83 a	47	62.6	19.02 b	22	29.3
9-13 hr.	10.39 b	75	100	28.91 b	74	98.6	33.64 c	71	94.6
13 hr.	15.55 c	75	100	33.79 c	74	98.6	37.22 a	74	98.6
13 hr.-NB	18.47 d	75	100	37.79 d	74	98.6	40.38 a	71	94.6
17 hr.	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.

Summary and Conclusions

If the photoperiod responses relative to vegetative growth and flowering of *Dahlia pinnata* 'Redskin' could be determined, it would be possible to produce dahlia pot plants for year-round sales.

The data from this study show the conditions considered as best for pot plants (Table 8).

Table 8. "Ideal" Pot Plants.

		Nearest Treatment to "Ideal" Condition With Treatment Mean	
Condition	**"Ideal" No.**	**Treatment**	**Mean**
Days to First Bud	30 days	9-13 hr.	30 days
		9 hr.	30 days
Days to First Flower	60 days	9-13 hr.	62 days
		13 hr.	63 days
Nodes	5.0	9-13 hr.	5.3 nodes
Internode Length	6.1 cm.	9-13 hr.	5.8 cm.
		13 hr.	6.4 cm.
Flower Diameter	6.8 to 7.0 cm.	13 hr.-NB	7.4 cm.
Total Buds at First Flower	16	9-13 hr.	18.3 buds
		13 hr.	16.8 buds
Height at First Flower	30 to 31 cm.	9-13 hr.	28.9 cm.
		13 hr.	33.7 cm.
Height at Termination	34 to 35 cm.	9-13 hr.	33.6 cm.
Total Flowers (Open at One Time)	8 to 10	9-13 hr.	5.7 flowers
		13 hr.	6.0 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 listed in Table 9.

Table 9.

Treatments	Desirable	Undesirable
9 hr.	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

Table 9. (continued).

Treatments	Desirable	Undesirable
9-13 hr.	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 Flowers open at one time High percent of flower development	Branches Flower diameter Fair foliage development
13 hr.	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
13 hr.-NB	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
17 hr.	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 increased the following also increased:

- Days to first bud, first, third and fifth flower
- Number of nodes
- Plant height

The following increased significantly between 9-hour and 13-hour and decreased significantly at 17-hour.

- Total buds at first and fifth flower
- Total flowers on plant at termination of the experiment

If the early bud initiation were maintained, days to flower reduced slightly and height and foliage quality increased slightly, the 9- to 13-hour treatment could produce the "ideal" pot dahlia. Until future work on various photoperiod combinations is completed the 9- to 13-hour increasing light treatment and the 13-hour continuous light treatment appear to be the best of the five treatments used in this study to produce dahlias as pot plants.

The possibility of establishing stock plants for asexual propagation of selected clones should enhance the possibility of using the 'Redskin' dahlias for pot plant culture.

Although no 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 9-hour plants had the largest and most tuberous root formation while the 13-hour-NB and 17-hour plants had the fewest and smallest tuberous roots.

The results of this experiment were significant enough to warrant further studies on photoperiod, plant selection, growth regulators, light intensity and temperature for forcing.

References

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

(2). 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.

(3) Durso, Marcia and A. A. DeHertogh. 1977. The Influence of Greenhouse Environmental Factors on Forcing *Dahlia variabilis* Willd. *J. Amer. Soc. Hort. Sci.* 102(3):314-317.

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

(5) James, H. 1936. *Dahlias for Garden and Exhibition*. London: John Gifford Ltd., 1922, 202-209.

(6) 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.

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

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

(9) 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.