Manipulating DAHLIAS

Photoperiod scheduling can inhibit tuberous root growth in 'Sunny Rose' plugs and promote optimal flowering and height of 'Sunny Yellow' pot plants.

By Garry Legnani and William B. Miller

Tuberous root development and flower induction of dahlia are controlled by photoperiod; however, photoperiod manipulation is generally not used in their production. Seed-propagated plug production typically takes place under the short days of late autumn and early winter. The critical day length for tuberous root formation is approximately 11-12 hours (Moser and Hess, 1969). When the day length is shorter than this critical period, it signals the plant to store energy in tuberous roots at the expense of shoot growth. Many growers may have experienced difficulty when extracting plugs using mechanical transplanters because the tuberous roots have outgrown the plug tray.

Growers may have also experienced delays in flowering. Short days induce flowering in dahlia. This effect may be quantitative or qualitative, depending on the cultivar; however, longer day lengths are required for proper flower development. Konishi and Inaba (1964 and 1966) found the optimum day length for flower induction to be 10 hours or less; however, they determined that a day length of 12 hours ➧

Top: Dahlia 'Sunny Yellow' plugs grown under LD (left) and SD (right) following six weeks of photoperiod treatment. Bottom: Dahlia 'Sunny Yellow' plants 48 days following transplanting of plugs to 5-inch standard pots. Top row (left to right): LD plugs, 0 weeks of SD then LD; 1 week of SD then LD; 2 weeks of SD then LD; 3 weeks of SD then LD; 5 weeks of SD then LD. Bottom row (left to right): SD plugs, 0 weeks of SD then LD; one week of SD then LD; 2 weeks of SD then LD; 3 weeks of SD then LD; 5 weeks of SD then LD. Above left: Dahlia Sunny Yellow plant produced from an LD plug that was given two weeks of SD and finished under LD following transplanting. Left: Dahlia Sunny Yellow plants 14 days following transplanting of plugs to 5-inch standard pots and growing under LD. SD plugs (top) and LD plugs (bottom). (Above photos courtesy of Garry Legnani) or greater was required for proper flower development. They observed that plants grown under continuous, 10-hour photoperiods had a high percentage of aborted flower buds. Halburton and Payne (1978) showed that while long days delayed bud set and flowering, the flowering percentage and overall flower and foliage quality of Dahlia 'Redskin' actually improved with long days. Plants grown under short day lengths were shorter than those grown under longer day lengths, suggesting that photoperiod could be used as a method of height control. Durso and De Hertogh (1977) observed that natural springtime photoperiods increasing from 10-14 hours were optimal for forcing of the tuberous rooted cultivars 'Kolchelsee' and 'Park Princess'. Brondum and Heins (1993) determined that the optimum photoperiodic conditions for the production of 'Royal Dahlietta Yellow' were 12-14 hours at approximately 20° C.

In this article, we will share the results of two studies we have conducted involving the use of photoperiod manipulation during plug and pot production of Dahlia 'Sunny Rose' and 'Sunny Yellow'. The first study demonstrates how night interruption lighting can be used to inhibit tuberous root formation during plug production (Legnani and Miller, 2000). The second study investigates the use of photoperiod manipulation for optimal flowering and height of plugs after transplanting into 5-inch standard pots.

MATERIALS AND METHODS — EXPERIMENT 1

Night interruption lighting inhibits tuberous root formation in Dahlia 'Sunny Rose' plugs.

Dahlia 'Sunny Rose' seeds (donated by Ball Seed Co., West Chicago, Ill.) were sown February 7 (two seeds per cell) in 288 plug trays filled with Fafard Superfine Germinating Mix. The flats were covered with clear plastic wrap and placed in a growth chamber with 24-hour fluorescent lighting at 18° C. Germination occurred in approximately 4-5 days. Seven days after sowing, flats were thinned to one seedling per cell and moved to a glass greenhouse for photoperiod treatments. Greenhouse night temperatures were maintained at 17° C, with maximum day temperatures reaching 27° C. During the second week of production, flats were subirrigated and fertilized by immersion in a tray containing 50 ppm nitrogen and potassium. Following the second week of production, as

Table 1. Effects of photoperiod on dry weight of roots and shoots of Dahlia 'Sunny Rose' plugs following two, four and six weeks of photoperiod treatment in experiment 1. SD = nine hours natural irradiance; LD = identical photoperiod with a 4-hour incandescent night interruption.

DRY WEIGHT (GRAMS)						
Week	Photoperiod	Shoot	Root	Tuberous root	Fibrous root	Total plant
2	LD	0.11	0.04	0.00	0.04	0.15
	SD	0.10	0.04	0.00	0.04	0.14
4	LD	0.51	0.17	0.06	0.11	0.68
	SD	0.41	0.24	0.17	0.07	0.65
6	LD	1.02	0.45	0.28	0.18	1.46
	SD	0.59	0.76	0.67	0.09	1.35

Table 2. Effects of photoperiod on leaf area, shoot length and number of leaf pairs in Dahlia 'Sunny Rose' plugs following two, four and six weeks of photoperiod treatment in experiment 1. SD = nine hours natural irradiance; LD = identical photoperiod with a 4-hour incandescent night interruption.

Week	Photoperiod	Leaf area (cm^2)	Shoot length (cm)	No. leaf pairs
2	LD	35.5	4.1	2.0
	SD	35.6	3.7	2.0
4	LD	101.4	5.7	3.0
	SD	84.3	4.8	3.2
6	LD	169.0	7.2	5.2
	SD	109.4	5.0	4.5

Table 3. Effects of different photoperiod regimes following transplanting of Dahlia 'Sunny Yellow' plugs to 5-inch pots in experiment 2. SD = nine-hour natural irradiance; LD = identical photoperiod with a 4-hour incandescent night interruption.

SD (Weeks)	LD (Weeks)	Visible Bud (Days)	First Flower (Days)	Percent Flowering	Flower diameter (cm)	Flowering Height (cm)	Shoot Dry Weight (g)
PLUGS GROWN UNDER LONG DAYS (LD)							
0	10	25.4	53.3	90	7.4	30.3	36.4
1	9	18.2	43.7	100	7.0	25.4	39.0
2	8	15.6	41.0	100	7.1	21.9	30.9
3	7	17.7	40.9	100	6.5	19.6	20.4
5	5	16.4	38.0	90	6.4	18.1	5.2
10	0	17.6	38.4	80	6.6	18.0	5.0
PLUGS GROWN UNDER SHORT DAYS (SD)							
0	10	23.2	58.3	100	7.1	30.1	31.0
1	9	17.8	60.9	90	6.2	26.8	21.0
2	8	0.0	50.1	90	5.9	19.8	17.9
3	7	25.2	56.5	80	5.9	19.9	14.1
5	5	22.5	54.8	60	6.6	20.5	8.0
10	0	25.2	52.7	30	5.5	13.3	3.2

seedlings became established enough for overhead watering, they were fertilized at each watering with 150 ppm nitrogen and potassium. Weekly sprays (to runoff) of 33 ppm A-Rest were applied beginning on February 28 for height control.

On day 7 in the greenhouse, five flats were placed under LD (nine hours of natural daylight + night interruption lighting with two 60-watt incandescent lamps between 10 p.m. and 2 a.m.) while the other five received SD (nine hours of natural daylight from 9:00 a.m. to 6:00 p.m.). Seedlings were randomly harvested at two, four and six weeks following the start of photoperiod treatments and growth measurements were made.

RESULTS EXPERIMENT 1

Although photoperiod treatments had no effect on total plant dry weight, SD increased tuberous root development at the expense of shoot growth (See Table 1). These differences in dry weight of shoots and roots were first observed at week 4 (See Table 1). By week 6, LD plugs showed a 63-percent increase in shoot dry weight over SD plugs, but the dry weight of their tuberous root was less than half that of SD plugs.

No tuberous root formation was evident at week 2. By week 4 there was noticeable swelling at the stem bases on both LD and SD plugs, although this swelling was greater on the SD plugs. Adventitious tuberous roots originated from the swollen base of the stems independent of fibrous roots and were greater in diameter than the latter. These tuberous roots were noticeably larger on SD than on LD plugs. At week 6, SD plugs had developed large, rounded, tuberous roots while LD plugs had produced slender, elongated structures. Tuberous root dry weight was 2.4-fold as great in SD than in LD plugs at week 6. In contrast, LD plugs had a more extensive fibrous root system; dry weight of the roots was twofold as great in LD as in SD plugs (See Table 1).

Week 4 plants had greater leaf area under LD than under SD without a substantial increase in the average number of leaf pairs. At week 6, LD plugs showed a 55-percent increase in leaf area over SD plugs and had approximately one more pair of leaves (See Table 2). Leaf number may affect the time when the plug is capable of responding to photoperiod for flower induction, and thus the time to flower. Barrett and De Hertogh (1978) found that non-pinched, tuberous-rooted cultivars ‘Miramar’ and ‘Park Princess’ became reproductive following the unfolding of 4-6 true-leaf pairs under inductive photoperiods.

Shoots were shorter under LD than under SD at week 2 (See Table 2). Long-day plugs continued to grow taller while growth in height of SD plugs ceased at week 4. By week 6, LD plugs were 50 percent taller than SD plugs. We suspect that this increase was attributable to both increased partitioning to the shoot and increased exposure to far-red light during the night interruption.

In summary, LD promoted shoot growth, foliar development and fibrous root growth in plugs but reduced growth of tuberous roots. Long-day plugs were of salable size and quality at week 5 (six weeks after sowing) but SD plugs were not salable until week 6 (seven weeks after sowing).

MATERIALS AND METHODS — EXPERIMENT 2

Using photoperiod manipulation for optimal flowering and height of Dahlia 'Sunny Yellow' plugs after transplanting into 5-inch standard pots.

Dahlia 'Sunny Yellow' seeds were sown February 7 in 288 plug trays and moved to a glass greenhouse in Ithaca, N.Y., on February 14 for photoperiod treatment. Greenhouse temperatures were maintained at 21° C both day and night. Both LD and SD plugs received nine hours of natural daylight from 8:00 a.m. to 5:00 p.m., with LD plugs receiving a night interruption between 10:00 p.m. and 2:00 a.m. Weekly sprays of 33 ppm A-Rest were made beginning on February 20. Fertilization was as previously described. On April 7, LD and SD plugs were transplanted into 5-inch standard pots (Metro-Mix 360) and moved to another greenhouse where temperatures were maintained at 17° C both day and night with maximum daily temperatures reaching 25° C. Fertilizer rates were increased to 200 ppm nitrogen and potassium. Both LD and SD plugs were each subjected to six different photoperiod schedules after transplanting (10 plants per treatment) over a production period of 10 weeks:

1) Long days (as described above) for 10 weeks;

2) One week of short days (as described above) followed by nine weeks of long days;

3) Two weeks of short days followed by eight weeks of long days;

4) Three weeks of short days followed by seven weeks of long days;

5) Five weeks of short days followed by five weeks of long days; or

6) Short days for 10 weeks.

Data collected included days to visible bud, days to first flower, percent flowering diameter of first flower, height at flowering and dry weight of shoots after 10 weeks.

RESULTS — EXPERIMENT 2

Following transplanting into 5-inch pots, LD plugs grew faster than SD plugs. Long-day plugs reached visible bud and flowered earlier than SD plugs, and providing just one week of SD (followed by LD) after transplanting accelerated flowering in LD plugs by 10 days (See Table 3). Two weeks of SD following transplanting accelerated flowering in SD plugs; however, five or more weeks of SD after transplanting greatly decreased the flowering percentage (See Table 3). Short days slightly decreased flower size and resulted in shorter, more compact plants when compared to plugs receiving only LD after transplanting. Plugs receiving five or more weeks of SD following transplanting were stunted, showing poor foliar and shoot development (See Table 3).

The data show that LD or SD plugs benefited from 1-2 weeks of short days (followed by LD) after transplanting. These benefits include faster flowering (7-10 days), slightly larger flowers and shorter, more compact plants. In our study, the highest-quality plants were produced by growing plugs in LD, giving two weeks of SD immediately after transplanting, then finishing the pots under LD.

CONCLUSIONS

Night interruption lighting during dahlia plug production can shorten crop time and inhibit tuberous root growth. It is important to keep in mind that the critical day length for tuberous root formation is 11-12 hours. If the natural day length is greater than this critical period, the night interruption light will likely provide little benefit; however, crops sown in the short days of late fall and early winter should benefit greatly. It should be stressed that visible effects on inhibiting tuberous root growth were not observed until four weeks after beginning photoperiod manipulation. This means that real benefits will be observed on plugs with a production time of four weeks or longer.

Following plug transplanting, 1-2 weeks of SD will promote flower induction. Growing on in LD will accelerate flower development and flowering. Short days also result in a shorter, more compact plant. When the natural day length is shorter than the critical periods for flower induction (10 hours) or tuberous root formation and flower development (12 hours), we suggest the following photoperiod schedule for producing 288 plugs and then growing on in 5-inch pots:

• Use night interruption lighting during plug production;

• After transplanting, provide two weeks of natural SD to induce flowering; and ➧

• Provide a night interruption to promote shoot growth and flower development.

If the natural day length is longer than these critical day lengths, grow plugs under natural long days (less than 12 hours). After transplanting into 5-inch pots, provide two weeks of short days using black cloth and finish the crop under natural LD. In either situation, up to four SD weeks can be used after transplant for additional height control. GPN

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