Influence of Photoperiod and Minimum Overwintering Temperature on Growth of Nursery Liners[1]

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Abstract

Ten woody plant species were rooted during the summer with half of each species overwintered at 4 °C (40 °F) and half at 18 °C (65 °F) minimum night temperature. Half of the plants in each temperature regime received long day conditions while half received short day conditions. By May 1 all species except Snow azalea (*Rhododendron obtusum* 'Snow'), Emerald 'n Gold euonymus (*Euonymus fortunei* 'Emerald 'n Gold'), and deutzia (*Deutzia gracilis*) had greater dry weights with the 18 °C (65 °F) long day regime. Deutzia was heavier under the 4 °C (40 °F) regime with no difference between photoperiod treatments. At 4 °C (40 °F) only Judd viburnum (*Viburnum x juddii*) was heavier with the long day regime. Plants grown until June 1, after two flushes of vegetative growth, showed less overwintering treatment effect, but Hetzi holly (*Ilex crenata* 'Hetzi'), blue rug juniper (*Juniperus horizontalis* 'Wiltoni'), crapemyrtle (*Lagerstroemia indica* 'Centennial'), and Judd viburnum (*Viburnum x juddii*) were larger when grown under the 18 °C (65 °F) long day regime.

Index words: nursery crops, photoperiod, overwintering

Introduction

Liner production frequently takes from 1/3 to 1/2 the time required to produce many container grown nursery crops. The most common propagation system involves the use of polyethylene covered Quonset greenhouses with mist facilities and cuttings in ground beds. Broadleaf species are propagated from cuttings taken in the spring and summer with rooting usually occurring by fall. Coniferous evergreens are usually propagated by cuttings taken in late fall and winter with rooting occurring in the spring. During winter months these propagation facilities are maintained just warm enough to prevent the plumbing from freezing, but not warm enough to induce vegetative growth. If a larger liner could be produced through environmental modification at low cost during the overwintering period, the grower would benefit.

Photoperiod has a significant influence on the onset of dormancy in temperate woody plants. The rate of dormancy development and the degree of dormancy are influenced and modified by temperature, but photoperiod is critical (2, 6). Long day conditions increase vegetative growth while short day conditions decrease growth and begin the dormancy process by inducing the formation of resting buds. These overwintering buds usually will not resume growth until exposed to a cold regime.

Increased temperature has been found to delay the onset of bud dormancy in red maple (a short day response) by several weeks (6). In weigela short days cause dormancy and long days (over 18 hours) cause continuous growth, when night temperatures are above 21 °C (70 °F) (9). At 10 °C (50 °F), only 21 and 24 hour photoperiods resulted in increased growth (6). Waxman (9) reported that weekly growth rate of weigela grown at 18 °C (65 °F) minimum night temperatures under continuous light nearly doubled the rate produced at 12 °C (54 °F).

Heide (2) reported that critical photoperiods of Norway spruce were only slightly changed by temperatures in a range of 12-24 °C (54-77 °F). But at 4 °C (40 °F) growth ceased in continuous light. Growth cessation took 3-4 times as long to occur at 4 °C (40 °F) with long day conditions as it did with short days at 21 °C (70 °F), indicating that the plant did have a photoperiodic response under cold night conditions.

Waxman (9) found a tenfold increase in growth with long days over short days in the greenhouse, but found little difference in growth under field conditions. His conclusion was that in the field, night temperatures of 10-15 °C (50-59 °F) were too cold for plants to respond with continuous growth. However, most species given additional lighting were injured or killed during the following winter, while the group under natural daylength conditions had no serious winter damage. Long day treatments had an effect on the plants, but low temperature prevented immediate expression.

This study was undertaken to determine species response to long day treatments at the cool temperatues encountered in overwintering structures.

Materials and Methods

Three hundred uniform terminal cuttings of 10 species were rooted under intermittent mist during the summer of 1979. Test plants were: *Abelia x grandiflora* (Glossy Abelia); *Deutzia gracilis* (Slender Deutzia); *Euonymus fortunei* 'Emerald 'n Gold'; *Ilex cornuta* 'Burfordii' (Burford Holly); *Ilex crenata* 'Helleri' (Helleri Japanese Holly); *Ilex crenata* 'Hetzii' (Hetzi Japanese Holly); *Juniperus horizontalis* 'Wiltoni' (Blue Rug Juniper); *Lagerstroemia indica* 'Centennial'

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Table 1. Average dry weight (g) of 10 test species grown with 4°C and 18°C night temperatures with long and short photoperiod treatment (May harvest date).

Species	Dry Weight[z]			
	Cool Temp (4°C)		Warm Temp (18°C)	
	Short Days	Long Days	Short Days	Long Days
Abelia x grandiflora	1.18 b	2.72 ab	2.69 b	5.28 a
Deutzia gracilis	2.11 ab	2.71 a	1.72 b	1.49 b
Euonymous fortunei 'Emerald 'n Gold'	2.24 b	2.82 ab	3.03 ab	4.41 a
Ilex cornuta 'Burfordii'	1.97 b	1.84 b	2.02 b	2.28 a
Ilex crenata 'Helleri'	1.57 b	1.95 b	2.14 b	3.45 a
Ilex crenata 'Hetzii'	2.34 b	2.36 b	2.06 b	3.84 a
Juniperus horizontalis 'Wiltoni'	0.54 b	0.61 b	0.55 b	0.89 a
Lagerstroemia indica 'Centennial'	0.98 b	1.97 b	1.67 b	3.76 a
Rhododendron obtusum 'Snow'	1.27 b	1.41 b	2.22 ab	3.33 a
Viburnum x juddii	0.42 c	0.74 b	0.64 bc	1.32 a

[z]Mean separation within rows followed by the same letters are not significantly different at the 5% level using Duncan's Multiple Range Test.

(Crapemyrtle); *Rhododendron obtusum* 'Snow' (Snow Azalea); and *Viburnum x juddii* (Judd Viburnum).

Rooted cuttings were potted in 7.6 cm (3 in) peat pots in a pine bark/vermiculite medium (Choice 70/30 Nursery Mix).[3] Plants were pruned periodically to encourage side branching. Following potting, liners were kept in a shaded greenhouse during the summer. Soluble 20N-8.2P-14.9K (20-19-18) fertilizer was applied weekly at 300 ppm nitrogen through September. A slow release 18N-2.6P-10K fertilizer (Osmocote 18-6-12) was applied as a topdressing at 4g per pot at planting and again on January 2.

Long day conditions were provided for liners beginning on August 1 by 100 watt incandescent bulbs with a 1420 lumen output spaced 45 cm (18 in) apart and 60 cm (24 in) above the plants. A night break was used between 2200 and 0200 hours to provide a 16-hr long day treatment. The overwintering structure was a fiberglass greenhouse partitioned into 2 sections; one with a minimum night temperature at 4°C (40°F) and the other held at 18°C (65°F). Minimum night temperatures were maintained by introducing ambient air by means of a fan-jet/poly-tube system into the low temperature section until the temperature reached 4°C (40°F). The average minimum temperatures for the low temperature section were plus or minus 3°C (5°F): October 7°C (45°F), November through March 4°C (40°F), April 5°C (42°F). At each temperature plants were grown under either a short day regime (8 hours light/16 hours darkness), provided by manual blackclothing or a long day regime (16 hr light/8 hr dark) provided by night-break lighting as described above. The experiment was arranged as a split-split plot with temperature as the main plot and daylength as the sub-plot. Four replicates of each cultivar with 12 plants per replicate were arranged in the sub-plot treatments. The main and sub-plot effects were not replicated because primary interest was placed on the 3-factor interaction of cultivar-temperature-daylength.

[3]Provided courtesy of Strong-Lite Corporation, Pine Bluff, Arkansas.

On May 1, 1980 half of the plants from each replicate were cut to the soil line and dried for shoot growth determination. Photoperiod treatments were discontinued at this time for the remaining plants. Plants were grown with an 18°C(65°F) minimum night temperature with natural daylength conditions until June 1 when shoots of the remaining plants were harvested for dry weight measurements.

Results and Discussion

Table 1 gives the dry weight of the 10 test species on May 1, 1980 following the overwintering treatments and the first flush of vegetative growth. Abelia, Emerald 'n Gold euonymus, Burford holly, Helleri holly, Hetzi holly, blue rug juniper, crapemyrtle, Snow azalea and Judd viburnum produced the greatest growth with the 18°C(65°F) treatment. At 18°C (65°F) 7 of the 10 species were significantly larger as determined by their increased dry weight with long day treatments. For deutzia, best growth was obtained with the 4°C (40°F) treatment with little photoperiod effect. Only with Judd viburnum was there a significant increase in dry weight with the long day treatment at both temperatures. At 4°C (40°F) the magnitude of increase ranged from a low of 13% increase for blue rug juniper to 103% for glossy abelia.

On June 1 shoots of the remaining plants were harvested and dry weights determined as shown in Table 2. Abelia, deutzia, euonymus, Burford holly and Snow azalea were not significantly different after making their second strong flush of vegetative growth. Hetzi holly, blue rug juniper, crapemyrtle and Judd viburnum maintained under the 18°C (65°F) long day regime during winter produced significantly more growth. Crapemyrtle and Judd viburnum produced significantly more growth with the long day regimes with both temperature regimes. Helleri holly tended to grow less at the lower temperature and grew least with the 4°C (40°F) short day regime. Deutzia tended to produce more growth from plants in the 4°C (40°F) treatment with little apparent photoperiod effect.

Table 2. Average dry weight (g) of 10 test species grown with 4°C and 18°C minimum night temperatures with long and short photoperiod treatment (June harvest dates).

Species	Dry Weight[z]			
	Cool Temp (4°C)		Warm Temp (18°C)	
	Short Days	Long Days	Short Days	Long Days
Abelia x grandiflora	9.82 a	10.17 a	10.69 a	10.56 a
Deutzia gracilis	10.32 a	8.08 a	6.61 a	7.32 a
Euonymous fortunei 'Emerald ' Gold'	4.16 a	4.51 a	3.19 a	4.38 a
Ilex cornuta 'Burfordii'	4.66 a	3.84 a	4.01 a	4.50 a
Ilex crenata 'Helleri'	2.99 b	4.32 ab	6.96 a	6.39 a
Ilex crenata 'Hetzii'	3.96 b	5.02 b	5.96 b	8.69 a
Juniperus horizontalis 'Wiltoni'	1.36 ab	1.43 ab	1.21 b	1.92 a
Lagerstroemia indica 'Centennial'	5.36 b	6.44 a	3.61 b	6.61 a
Rhododendron obtusum 'Snow'	3.92 a	3.51 a	4.28 a	6.28 a
Viburnum x juddii	1.78 b	3.24 a	1.57 b	3.23 a

[z]Mean separation within rows followed by the same letter or letters are not signficantly different at the 5% level using Duncan's Multiple Range Test.

Abelia (9), crapemyrtle (1), blue rug juniper (6), euonymus (4), Burford holly (10), Japanese holly (4, 6), azaleas (8) and Judd viburnum (6) have been reported to show increased vegetative growth with long day conditions at temperatures in the 15-20°C (59-70°F) range. The data from the May harvest date support these findings, but after two strong flushes of growth only Japanese holly, blue rug juniper, crapemyrtle and Judd viburnum were still significantly larger as a result of the long day treatment during winter. Deutzia (4) has been shown to have no photoperiodic response and our data support that observation, but does indicate a required cold dormancy period.

Several reports have been made that temperature interacts with photoperiod (2, 5, 6, 7), but these studies have used temperatures in the 10-15°C (50-59°F) range as their minimum temperature. Reports of 4°C (40°F) temperatures have been scarce and generally indicated that little effect is produced by long day treatments (7). Our data support the observation that the photoperiodic response at low temperatures is minimal, but it does appear there is an effect with some species. The May 1 determinations showed that only Judd viburnum was significantly heavier under long day conditions at 4°C (40°F), but 9 of the 10 species had a trend towards being heavier in the long day regime. As reported by Heide (2), it was observed that plants receiving the long day treatment in the 4°C (40°F) section ceased growth later than plants under the short day regime. This, plus the earlier growth resumption under the long day regime at 4°C (40°F), could account for the slight increase in growth.

Significance to the Nursery Industry

Nurserymen wishing to maximize growth of liners should consider the use of temperature and photoperiod during winter months. If warm temperatures are used to induce winter growth, it is important that long day conditions be maintained. At cooler temperatures the long day effect is less obvious, but resulted in increased vegetative growth with two species. Plants grown under long day conditions at 4°C (40°F) were as heavy as plants grown with short day conditions at 18°C (65°F) minimum night temperatures. Night lighting at cool temperatures may be an economical way of increasing growth during winter months, but other factors will also be affected. For example, plant spacing may have to be increased in liner beds to accommodate additional growth.

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