Response of 13 Species of Landscape Plants to Altered Photoperiods[1]

Gary J. Keever and Gary S. Cobb[2]
Department of Horticulture and
Ornamental Horticulture Substation
Alabama Agricultural Experiment Station
Auburn University, AL 36849

Abstract

Thirteen species of temperate landscape trees and shrubs grown outdoors in Mobile, Alabama from March 26, 1985, until June 5, 1986, were exposed to natural (NP), night interrupted (NI), or extended (EP) photoperiods from June 21 until November 15. Shoot growth measured in December varied among species but was either greater under long day conditions or similar to growth under NP, whereas root development was greater with NP or unaffected by photoperiod. By June 1986 shoot growth was either greater under NP or similar to growth under EP or NI. Root growth patterns were similar to those observed in December. Six species exposed to long day conditions exhibited extensive twig dieback, following subfreezing winter temperatures.

Index words: nursery crops, growth and development, cold hardiness, cold injury

Introduction

Daylength is one of the most important factors influencing the duration of shoot growth and affecting the onset of dormancy in woody plants. Generally, the rate and duration of shoot growth are increased under long day conditions, while short day conditions decrease the rate of growth and hasten the onset of dormancy. Dormancy can be delayed by exposing plants to supplemental light (7); however, the effects may not be clearcut due to photoperiod-temperature interactions or to wide variation in photoperiodic sensitivity among species (5, 7).

Daylength-sensitive species exposed to long photoperiods produce continuous growth if temperatures are favorable, extended growth with dormancy eventually occurring, or an alteration of growth flushes with a shortened period of dormancy between successive flushes (2, 7). By providing long day conditions, dormancy may be delayed and the growing season extended into the fall, thus shortening the overall production cycle. However, winter injury may be increased if plants are exposed to winter conditions before they become fully dormant (5). This study was undertaken to determine how several species of temperate landscape trees and shrubs respond to photoperiod.

Materials and Methods

Thirteen species of temperate landscape trees and shrubs were evaluated for their growth responses to extended (EP) and night interrupted (NI) photoperiods in southern Alabama (zone 9a). Test species included *Abelia* x 'Edward Goucher' (abelia); *Buxus microphylla* 'Wintergreen' (boxwood); *Cercis canadensis* (redbud); *Euonymus japonica* 'Microphylla' (euonymus); *Ilex crenata* 'Compacta' (compacta Japanese holly); *Ilex cornuta* 'Burfordii Nana' (dwarf Burford holly); *Ilex vomitoria* 'Stokes Dwarf' (dwarf yaupon); *Lagerstroemia indica* x *fauriei* 'Basham's Party Pink' (crapemyrtle); *Magnolia grandiflora* (Southern magnolia); *Nandina domestica* (nandina); *Rhododendron austrinum* (Florida azalea); Rhododendron x 'Fashion' (Fashion azalea); and *Ternstroemia gymnanthera* (cleyera).

Uniform liners of most species were potted March 26, 1985 in 2.8 l (#1) containers; nandina and Florida azalea were potted in 7.6 l (#2) containers and Southern magnolia in 11.4 l (#3) containers. A 100% milled pine bark growth medium was amended with 3.6 kg/m^3 (6 lb/yd^3) dolomitic limestone, 1.2 kg/m^3 (2 lb/yd^3) gypsum, 0.9 kg/m^3 (1.5 lb/yd^3) Micromax micronutrient fertilizer (Sierra Chemical Co., Milpatas, CA 95035), and 7.1 kg/m^3 (12 lb/yd^3) Osmocote 17N-3P-10K (17-7-12). Plants were placed outdoors in full sun and maintained following standard nursery practices until June 21, 1985, at which time photoperiodic treatments were begun. An extended photoperiod (EP) was provided from 0300 until 2 hours after sunrise and from 2 hours before sunset until 2100 hours using 100 watt incandescent bulbs (1420 lumen output) spaced 122 cm (48 in) apart and 122 cm (48 in) above the plant. A night interrupted photoperiod (NI) was provided between 2200 and midnight. Natural photoperiod (NP) ranged from 14 hours 8 minutes on June 21 to 10 hours 37 minutes on November 15, at which time plants were completely randomized and natural photoperiods were resumed for all plants. Black polyethylene-covered partitions 2 m (6.6 ft) high separated the photoperiodic treatments. There were 10 single-plant replicates within each treatment.

On December 10, 1985, height and caliper of crapemyrtle, redbud, and Southern magnolia were measured and growth indices (height + width + width/3) calculated for all species. Three single-plant replicates of each species were randomly selected for top dry weight deter-

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[2]Assistant Professor of Horticulture and former superintendent, Ornamental Horticulture Substation, Mobile, Ala., resp. Current address of junior author: Cottage Hill Nursery, 9960 Padgett Switch Rd., Irvington, AL 36544. AAES Journal No. 11-871240.

mination and relative root density ratings. On June 5, 1986, following the spring growth flush, height, caliper, and relative root density of the tree species were determined. Growth indices and relative root density ratings were made on all shrub species.

Results and Discussion

On December 10, 1985, all species, except nandina, receiving EP and NI were actively growing. Abelia was flowering, while recently emerged leaves of crapemyrtle and redbud had been burned during a light freeze in November. Only euonymus and boxwood were actively growing under the NP.

Plant growth through December 1985 varied among species and photoperiodic treatments (Tables 1 and 2). Growth indices of Florida and Fashion azaleas, yaupon, compacta holly, Southern magnolia, crapemyrtle, and redbud were greater for plants grown under EP and NI compared to NP. Plants of Florida azalea and redbud also had significantly greater dry weights under EP and NI. Growth of other species, as indicated by growth indices and dry weight, was similar under the 3 photoperiodic treatments. Height of both redbud and crapemyrtle was greater with the EP and NI compared to the NP. Caliper of crapemyrtle was greater with EP than with NI or NP, while caliper of redbud and Southern magnolia did not differ among photoperiodic treatments.

Root density ratings of species whose top growth was unaffected by photoperiod (abelia, dwarf Burford holly, and cleyera) were higher under NP compared to EP and NI. In contrast, with species whose top growth was increased with EP and NI (Japanese holly, yaupon, Florida and Fashion azaleas, redbud, crapemyrtle, and Southern magnolia), root rating was unaffected by photoperiod. Neither shoot nor root growth of boxwood, euonymus, and nandina was affected by photoperiod manipulation (data now shown).

During the winter of 1985-86 subfreezing temperatures were experienced 24 times, beginning on December 3 and ending March 22. The total number of hours below freezing was 206 and the minimum temperature was -16 °C (3 °F). Plants of abelia, Florida and Fashion azaleas, cleyera, and redbud exposed to EP and NI during fall 1985 exhibited extensive twig dieback on June 5, 1986. Shoots of crapemyrtle were either killed to the ground with new growth emerging from the base or the entire plant killed (57% mortality under EP, 29% under NI). Fourteen percent of cleyera and redbud receiving EP and 14% of cleyera under NI were also killed. Similar injury has been reported with abelia exposed to long

Table 1. Response of 7 species of woody landscape shrubs to 3 photoperiods.

	December, 1985			June, 1986		
Species/photoperiod	Growth index[z]	Top dry weight (gm)	Root rating[y]	Growth index[z]	Root rating[y]	Dead plants (no.)
Abelia 'Edward Goucher'						
Natural day length	70.3	74.4	4.2a	122.4a	4.9a	0
Extended day length (18 hr/day)	73.3	66.1	3.8b	68.0b	4.1b	0
Night interrupted (2200-2400 hr)	76.5ns[x]	63.8ns	3.9b	77.0b	4.2b	0
Ilex crenata 'Compacta'						
Natural day length	39.8b	63.8	3.8	43.7	4.9	0
Extended day length	47.6a	78.0	3.8	49.9	4.9	0
Night interrupted	46.3a	69.3ns	3.9ns	48.2ns	4.9ns	0
Ilex cornuta 'Burfordii Nana'						
Natural day length	30.9	29.5	3.5a	42.1	4.2	0
Extended day length	33.8	31.2	3.2b	43.2	4.1	0
Night interrupted	30.9ns	22.8ns	3.2b	40.5ns	4.2ns	0
Ilex vomitoria 'Stokes Dwarf'						
Natural day length	31.4c	27.4	2.7	35.2	4.9	0
Extended day length	37.0a	31.4	2.6	38.1	4.9	0
Night interrupted	34.1b	27.7ns	2.6ns	35.4ns	4.8ns	0
Rhododendron austrinum						
Natural day length	38.8b	52.9b	2.4	67.6	2.6	0
Extended day length	69.8a	79.8a	2.5	55.0	2.3	0
Night interrupted	75.3a	95.8a	2.7ns	62.4ns	2.6ns	0
Rhododendron x 'Fashion'						
Natural day length	42.1b	67.5	4.6	55.8a	5.0	0
Extended day length	54.2a	84.4	4.2	49.6b	4.8	0
Night interrupted	54.7a	82.9ns	4.4ns	49.1b	5.0ns	0
Ternstroemia gymnanthera						
Natural day length	46.7	63.9	2.8a	57.0	4.7a	0
Extended day length	46.1	82.6	2.3b	50.5	3.8b	1
Night interrupted	50.3ns	69.3ns	2.3b	47.4ns	4.0b	1

[z]Growth index: (height + width + width)/3; in cm.

[y]Root rating: 1 = no roots on rootball surface; 2 = 25% coverage; 3 = 50% coverage; 4 = 75% coverage; 5 = 100% coverage.

[x]Mean separation within columns and species by Duncan's Multiple Range Test, 5% level; ns = not significant.

Table 2. Response of 3 species of woody landscape trees to 3 photoperiods.

	December, 1985					June, 1986			
Species/photoperiod	Growth index[z]	Top dry weight (gm)	Height (cm)	Caliper[y] (cm)	Root rating[x]	Height (cm)	Caliper[y] (cm)	Root rating[x]	Dead plants (no.)
Cercis canadensis									
Natural day length	47.9b[w]	36.6b	81.5c	1.2	1.9	120.8	1.7	3.1a	0
Extended day length (18 hr/day)	83.1a	91.3a	165.3a	1.4	2.1	107.2	1.7	2.7b	1
Night interrupted (2200-2400)	69.8a	86.5a	111.1b	1.4ns	2.2ns	126.1ns	1.4ns	3.3a	0
Lagerstroemia indica x fauriei 'Basham's Party Pink'									
Natural day length	125.2b	406.8b	116.6b	2.8b	4.3	157.4	3.0	5.0a	0
Extended day length	184.6a	700.9a	177.1a	3.2a	4.8	157.0	2.9	4.0b	4
Night interrupted	169.6a	536.7ab	167.6a	2.6b	4.8ns	123.4ns	2.7ns	3.2c	2
Magnolia grandiflora									
Natural day length	72.8b	268.2	89.1	2.6	4.9	133.9	2.6	4.9a	0
Extended day length	91.3a	370.1	102.6	2.7	4.6	134.6	2.7	4.4b	0
Night interrupted	90.9a	307.3ns	100.1ns	2.8ns	4.7ns	137.8ns	2.8ns	4.1b	0

[z]Growth index: (height + width + width)/3; in cm.

[y]Caliper: taken 5 cm above container medium surface.

[x]Root rating: 1 = no roots on rootball surface; 2 = 25% coverage; 3 = 50% coverage; 4 = 75% coverage; 5 = 100% coverage.

[w]Mean separation within columns and species by Duncan's Multiple Range Test, 5% level; ns = not significant.

day conditions followed by freezing temperatures (4). No injury occurred to plants of the remaining species.

Growth by June 1986, as determined by growth indices, height, caliper, and relative root density, was either greater under NP compared to EP and NI or similar except for caliper growth of crapemyrtle and relative root density of redbud (Tables 1 and 2). These results may be explained by the winter injury sustained by many species exposed to long day lengths or by a negative influence of long days in the fall on growth during the spring months, a phenomenon observed by other researchers (1).

Numerous species, including crapemyrtle (3), Japanese holly (5), and azalea (6), have been reported to increase vegetative growth under long day conditions provided temperatures are conducive for growth. Our data support these findings. However, the lack of growth increases or reduced growth by some species, coupled with twig dieback or plant death of others, lends serious doubt to the use of photoperiod manipulation without protection in zone 9a. Perhaps by ending the photoperiod treatments earlier than November 15, responsive species would have benefited from long day conditions in the fall and still have had time to harden before winter conditions. However, the winter of 1985-1986 was not exceptionally severe (minimum temperature -16°C/3°F), so the potential for greater injury was also present.

Significance to the Nursery Industry

Growth of several species of woody landscape trees and shrubs was enhanced during the fall with exposure to extended (EP) and night interrupted photoperiods (NI) compared to natural photoperiods (NP). However, the benefits of long day conditions were not present following the spring flush of growth, either because of greater growth under NP or winter injury under EP and NI. If photoperiodic manipulations are to be used to increase growth of photoperiodic sensitive woody landscape plants in southern climates, sufficient winter protection must be provided to prevent cold injury to actively growing and non-dormant tissues.

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