Growth and Flowering of Crapemyrtle in Response to Tree Shelters[1]

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Abstract

Tree shelters were evaluated as a means of accelerating height growth of tree-form crapemyrtles. In two experiments, Dynamite™ grown in shelters were 124 and 48% taller at the end of the growing season, while shelter-grown 'Potomac' were 61 and 50% taller. Height of 'Tuscarora' was not affected by tree shelters. In the first experiment calipers of sheltered and non-sheltered 'Tuscarora' and Dynamite™ were similar at the end of the season, while caliper of 'Potomac' was 35% less when grown in shelters. In the second experiment there were no caliper differences between sheltered and unsheltered Dynamite™ or 'Potomac' at the end of the growing season. All plants grown in tree shelters flowered later than unsheltered plants and had visibly straighter, more upright trunks with minimal lateral shoot development.

Index words: nursery production, Blue-X shelters, flowering ornamental tree.

Taxa used in this study: 'Potomac' and 'Whitt II' Dynamite™ crapemyrtle (*Lagerstroemia indica* L.), 'Tuscarora' crapemyrtle (*Lagerstroemia indica* L. ×*fauriei* Koehne).

Significance to the Nursery Industry

Most cultivars of crapemyrtle are vigorous growers under nursery conditions; however, some cultivars begin flowering by early summer, resulting in less vegetative growth, particularly height growth. Pruning of inflorescences is labor-intensive and results in rapid re-bloom. For production of standard (single trunk) or multi-trunk (usually three) tree-forms of crapemyrtle with 112 cm (4 ft) to 183 cm (6 ft) of clear trunk, pruning exacerbates the problem by stimulating new shoot formation, often from the main trunk. The use of tree shelters in the production of tree-form crapemyrtles increased height growth and delayed flowering without affecting caliper growth of most cultivars tested, although all cultivars did not respond to the shelters. Tree shelters may provide growers with a low-input way to accelerate production of tree-form crapemyrtles.

Introduction

Crapemyrtles are an economically important nursery crop in both container and field production, and along with other deciduous flowering trees, accounted for $276 million or 7% of the total gross sales for U.S. nursery production in 2003 (13). Lengthy summer flowering and a diversity of flower colors, plant sizes, and growth habits contribute to the widespread use of crapemyrtles as shrubs or small trees in the southern U.S. and along the West Coast (2). Breeding programs over the last 30 years have fueled demand by producing superior forms with a wide range of plant sizes and habits, improved flowering, new flower colors, ornamental bark, ornamental foliage, disease resistance and increased vigor (7).

Cultivars of crapemyrtle begin flowering as early as May and may continue into the fall (1, 7). This early flowering characteristic is desirable in the landscape, but can suppress vegetative growth, particularly height growth, during production. Height suppression is often compounded by heavy fruit set later in the growing season. Pruning of inflorescences is labor-intensive and results in rapid re-bloom. For production of standard (single trunk) or multi-trunk (usually three) tree-forms of crapemyrtle with 112 cm (4 ft) to 183 cm (6 ft) of clear trunk, pruning exacerbates the problem by stimulating new shoot formation, often from the main trunk.

Tree shelters, translucent tubes placed around tree seedlings, create a beneficial microclimate within the shelter of increased humidity and CO_2 levels and reduced drying and mechanical injury from wind (4). In addition, tree shelters tend to prolong the growing season for plants, giving them more degree-days in which to grow (8). First available in the United States in 1989, tree shelters have increased survival and accelerated height growth of many species (12, 15), although effects differed among species (10). Kjelgren et al. (6), in studying water relations of container-grown Kentucky coffee tree (*Gymnocladus dioica*) in translucent plastic shelters, reported increased air temperature, vapor pressure, and 70% less solar radiation, suggesting that trees respond to shelters because they shade. Height increases of 60 to 600% from using tree shelters have been reported (12). Shelters can typically increase height growth but reduce the rate of trunk diameter growth which may result in trees without enough structural support to stand upright. Effects on diameter growth are species specific and can be positive or negative (10). West et al. (15) reported that after three growing seasons in shelters there was no difference in diameter growth between sheltered and unsheltered trees for all ten tree species tested. Similarly, Jones et al. (5), in studying the use of plastic tree shelters for low-cost establishment of street trees, found that survival and growth of all species tested in shelters equaled or exceeded that of plants grown without shelters. Tree shelters have been widely used in Great Britain and other countries to cut costs of establishing small forest trees, and Svihra et al. (12) speculated they could be broadly used in nurseries and landscapes.

Blue-X tree shelters (McKnew Enterprises, Elk Grove, CA) are fabricated from partially transparent blue-tinted polyes-

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ter film which reportedly gives them the unique characteristic of amplifying blue light and reducing UV light within the shelter. According to the manufacturer, the amplified blue light increases photosynthetically active radiation resulting in increased trunk diameter, in addition to enhanced transplant survival and accelerated growth in height. Our objective was to determine the effects of Blue-X tree shelters on height and caliper growth and flowering of tree-form crapemyrtle, with a goal of shortening production time.

Materials and Methods

Experiment 1. Liners of three cultivars of commonly grown crapemyrtles, *Lagerstroemia indica ×fauriei* 'Tuscarora' [23 cm (9 in) tall] and *Lagerstroemia indica* 'Whitt II' Dynamite™ [10 cm (4 in) tall] and 'Potomac' [7 cm (3 in) tall] were transplanted on February 16, 2004, from 10.2 cm (4 in) pots into 11.4 liter (#3) pots containing an 8:1 (by vol) pinebark:sand substrate amended per m^3 (yd^3) with 8.3 kg (14 lb) of 17N–2.2P–9.1K (Polyon 17–5–11, Pursell Industries, Sylacauga, AL), 0.9 kg (1.5 lb) Micromax (The Scotts Company, Marysville, OH) and 3 kg (5 lb) dolomitic limestone. Plants were placed in full sun under overhead irrigation. Unsheltered plants were held upright with a single 152 cm (60 in) bamboo stake, two bamboo stakes were used to support the plant and the shelter in the Blue-X treatment. Lateral branches were removed from all plants prior to placing 122 cm (48 in) tall Blue-X tree shelters over one half of the plants of each cultivar on March 26, 2004. The two treatments were replicated with 10 plants each and were completely randomized within cultivar. Height and caliper were measured and the presence of flowers noted monthly from April until October. Height was measured from the substrate surface to the highest point of the plant. Caliper was measured 2.5 cm (1 in) above the substrate surface with a digital caliper. On February 10, 2005, the three cultivars were repotted into 37.9 liter (#10) pots containing the previously described substrate. The Blue-X tree shelters were removed and all plants were spaced in full sun under overhead irrigation. Height and caliper were recorded in April, June, August, and October. Data were subjected to analysis of variance (ANOVA) using SAS statistical software (11).

Experiment 2. Liners of *Lagerstroemia indica* 'Whitt II' Dynamite™ [68 cm (26 in) tall] and 'Potomac' [57 cm (22 in) tall] were transplanted on February 16, 2005, into 11.4 liter (#3) pots containing the same 8:1 (by vol) amended pinebark:sand substrate. Plants were placed in full sun under overhead irrigation and staked similarly to experiment 1. Blue-X tree shelters, 122 cm (48 in), were installed on half of the plants of each cultivar on March 21, 2005. The two treatments were replicated with 10 plants each and were completely randomized within cultivar. Height, caliper, and flowering condition were recorded in April, June, August, and October. Floral characteristics of each plant were rated using a four part scale in which 1 = no visible floral development, 2 = visible floral development but no flower color, 3 = flower color present, and 4 = post color. Data were subjected to analysis of variance (ANOVA).

Results and Discussion

Dynamite™. Blue-X tree shelters promoted early and rapid shoot elongation of Dynamite™ in 2004 (Table 1). Sheltered plants were 95 and 86% taller in May and June than unsheltered plants. Accelerated shoot elongation continued after trees emerged from the top of the shelters (95, 118, and 128% greater than unsheltered plants in July, August, and September, respectively), probably because of a shelter-induced delay in flowering. In July, 30% of unsheltered plants were in flower, while none of the sheltered plants were in flower. By August, 60% of sheltered plants had flowered compared to 100% of unsheltered plants. Terminal flowering in crapemyrtle effectively ends shoot elongation (3, 9) as evidenced by the lack of height increase in unsheltered plants between July and October. By September, all sheltered as well as unsheltered plants were flowering and little further increase in height occurred. Caliper growth also appeared

Table 1. Height and caliper of three container-grown crapemyrtle cultivars grown in Blue-X tree shelters in Auburn, AL, experiment 1, 2004.

Treatment	Height (cm)							Caliper (mm)						
	Apr	May	June	July	Aug	Sept	Oct	Apr	May	June	July	Aug	Sept	Oct
	Dynamite™													
(–) Shelter	12.7	31.9	48.8	74.5	76.7	76.2	78.0	3.6	4.8	6.2	9.8	10.4	10.6	11.2
(+) Shelter	14.3	62.3	90.7	145.2	167.2	174.0	174.5	3.8	4.7	4.8	6.9	9.3	10.8	11.9
Significance[z]	*	**	*	**	***	***	***	NS	NS	**	**	*	NS	NS
	'Potomac'													
(–) Shelter	6.6	25.2	41.4	84.7	87.7	88.2	87.4	3.2	3.0	4.7	8.9	9.7	10.1	10.4
(+) Shelter	7.7	21.9	37.0	69.1	98.9	124.7	140.4	3.2	3.2	3.2	4.0	6.3	6.7	7.7
Significance	NS	NS	NS	NS	NS	*	**	NS	NS	***	***	**	**	*
	'Tuscarora'													
(–) Shelter	32.6	71.1	116.3	139.8	137.2	137.3	146.5	3.8	8.3	11.6	14.6	15.1	16.3	16.3
(+) Shelter	38.4	55.8	78.8	122.7	161.1	169.5	169.9	3.6	4.8	5.8	7.6	9.8	11.8	13.5
Significance	NS	NS	**	NS	NS	NS	NS	NS	***	***	***	**	**	NS

[z]NS, *, **, and *** represent non-significant and significant effects where P ≤ 0.05, 0.01, and 0.001, respectively.

Table 2. **Height and caliper of three container-grown crapemyrtle cultivars in the year following growth in Blue-X tree shelters in Auburn, AL, experiment 1, 2005[z].**

Treatment	Height (cm)				Caliper (mm)			
	Apr	June	Aug	Oct	Apr	June	Aug	Oct
					Dynamite™			
(–) Shelter	78.0	106.5	146.9	152.0	11.2	12.5	18.1	19.1
(+) Shelter	174.5	169.0	184.7	185.8	11.9	13.8	16.9	18.0
Significance[y]	***	***	***	***	NS	NS	NS	NS
					‘Potomac’			
(–) Shelter	87.4	122.5	169.6	171.8	10.4	12.8	17.4	18.7
(+) Shelter	146.3	162.2	198.2	199.6	7.9	10.5	14.0	16.1
Significance	**	***	***	***	NS	**	NS	NS
					‘Tuscarora’			
(–) Shelter	146.5	177.9	221.9	225.5	16.3	18.3	22.7	24.7
(+) Shelter	169.9	188.6	212.4	228.1	13.2	15.7	22.0	24.0
Significance	NS	NS	NS	NS	*	NS	NS	NS

[z]Tree shelters were removed in March 2005.

[y]NS, *, **, and *** represent non-significant and significant effects where $P \leq 0.05$, 0.01, and 0.001, respectively.

closely linked to shelter treatment and flowering. By June, caliper of unsheltered plants was 29% greater than that of sheltered plants. The difference increased to 42% in July when flowering occurred in unsheltered plants. By August the difference had decreased to 12% and was not significant thereafter. In addition to effects on height, caliper, and flowering, sheltered plants had visibly straighter trunks, less suckering from the base and little or no branching inside the shelters.

During the second year of the experiment, in which all plants were grown without shelters, previously sheltered Dynamite™ remained taller than unsheltered plants, although the magnitude diminished from 58% in June to 22% in October (Table 2) as branching increased at the expense of height growth. There were no differences in caliper or flowering between previously sheltered and unsheltered plants in 2005.

In the second experiment Dynamite™ performed much the same as in experiment 1, with early shoot growth promoted by the tree shelters and continued accelerated growth throughout the season. Plants grown in shelters were 58, 42, and 48% taller than unsheltered plants in June, August, and October, respectively (Table 3). By July 15, all unsheltered plants were showing flower color [floral rating (FR) 3.0a], compared to 20% of the sheltered plants (FR 1.9b), similar to the flowering delay caused by the shelters in experiment 1 (Table 4). In September, 80% of the sheltered plants had flower color present (FR 3.2b) while all unsheltered plants were post flower (FR 4.0a). There were no differences in caliper between the two treatments at any sampling in experiment 2. Comparable to experiment 1, Dynamite™ grown in shelters appeared to have straighter trunks, little to no lateral branching inside the shelters, and less suckering from the base than plants grown without shelters.

‘*Potomac*’. In contrast to Dynamite™, ‘Potomac’ had less rapid shoot elongation, with plants grown in shelters not surpassing unsheltered plants until August 2004. Sheltered plants were 41 and 61% taller than unsheltered plants in September and October, respectively (Table 1). This continued shoot growth of sheltered plants in the latter part of the growing season is similar to that observed earlier in the season in Dynamite™ and appeared due to a shelter induced delay in flowering. By July, 50% of unsheltered ‘Potomac’ had flowered compared to no flowering of sheltered plants. All sheltered and unsheltered plants had flowered by September 2004. Similar to Dynamite™, no plants flowered inside the shelters. Caliper growth appeared closely linked to shelter treatment and flowering with plants grown in shelters having 35, 34, and 25% less caliper than unsheltered plants in August, September, and October, respectively (Table 1). Less caliper growth of sheltered plants suggests claims by the manufacturer of increased trunk diameter in Blue-X shelters may be inaccurate or at least not true for all taxa. Plants grown in shelters appeared to have trunks that were straighter than unsheltered plants, little to no lateral branching inside the shelter, and less suckering from the base of the plant.

In the second year of the experiment in which all plants were grown without shelters, previously sheltered ‘Potomac’ continued to be taller than unsheltered plants at each sampling date. Similar to Dynamite™, ‘Potomac’ height differences diminished over the growing season with previously sheltered plants being 67% taller in April but only 16% taller in October (Table 2). There were no visible treatment-related differences in flowering of ‘Potomac’ in the second year. Caliper of plants in the two treatments was similar throughout the second year except for a 22% increase in unsheltered plants in June (Table 2). Plants grown in shelters the previous year continued to exhibit noticeably straighter trunks.

Treatment effects on height of ‘Potomac’ were evident earlier in experiment 2 than in experiment 1, possibly due to initially taller liners [7 cm (3 in) vs. 57 cm (22 in)]. Sheltered plants were 50, 55, and 50% taller than unsheltered plants in June, August, and October, respectively (Table 3). As with

Table 3. Height and caliper of two container-grown crapemyrtle cultivars grown in Blue-X tree shelters in Auburn, AL, experiment 2, 2005.

Treatment	Height (cm)				Caliper (mm)			
	Apr	June	Aug	Oct	Apr	June	Aug	Oct
				Dynamite™				
(–) Shelter	66.4	89.0	126.8	126.5	5.1	7.0	12.6	14.6
(+) Shelter	72.0	140.4	179.7	187.8	5.3	6.3	12.9	15.1
Significance[z]	**	***	***	***	NS	NS	NS	NS
				'Potomac'				
(–) Shelter	58.0	67.8	133.6	141.7	5.3	5.7	13.7	15.5
(+) Shelter	57.2	101.8	207.2	213.2	5.2	5.7	13.0	13.5
Significance	NS	**	**	**	NS	NS	NS	NS

[z]NS, **, and *** represent non-significant and significant effects where $P \leq 0.01$ and 0.001, respectively.

Dynamite™ in experiment 2 and in contrast to 'Potomac' in the first experiment, there were no differences in caliper between sheltered and unsheltered plants at any sampling date, possibly due to the larger liners used. On August 15, 50% of 'Potomac' grown in shelters were showing flower color (FR 2.0b) compared to 100% of unsheltered plants (FR 3.0a) (Table 4). By October, all plants were at post-color (FR 4.0).

'*Tuscarora*'. Height of 'Tuscarora' was not significantly influenced by the Blue-X tree shelters in experiment 1 except for a 32% decrease of sheltered plants in June. Although not significant, a trend of increased growth for plants grown in shelters did exist from August to October. Caliper of 'Tuscarora' was 47, 35, and 28% less in July, August, and September, respectively, when grown in shelters (Table 1). West et al. (1999) reported that shelters had a negative effect on basal diameter of flowering dogwood (*Cornus florida*) and Chinese elm (*Ulmus parvifolia*) after two years' growth in the field. However, by the end of the 2004 season, calipers of sheltered and unsheltered 'Tuscarora' were similar. The diminishing differences in caliper may be attributed to the delay in flowering caused by the tree shelters allowing more caliper growth of sheltered plants as the season progressed. 'Tuscarora' exhibited similar flowering characteristics as Dynamite™ and 'Potomac' in response to the treatments, with plants grown in shelters flowering later than the controls and no flowering occurring inside the shelters. By July, 80% of the unsheltered plants had flowered with no flowering of sheltered plants. Terminal flowering ended shoot elongation in 'Tuscarora' as evidenced by the lack of height increase from July through October, while sheltered plants with delayed flowering continued to increase in height. All plants in both treatments had flowered by September.

In the second year of the experiment in which all plants were grown without shelters, there continued to be no significant treatment effect on height of 'Tuscarora'. There were no differences in caliper from June to October and no difference in flowering characteristics between the two treatments.

All cultivars tested responded to the Blue-X tree shelters, with increased height, reduced caliper, or both. Dynamite™ and 'Potomac' but not 'Tuscarora', responded positively to the shelters. Dynamite™ and 'Potomac' are intra-specific hybrids, whereas 'Tuscarora' is an inter-specific hybrid which may have affected plant response to the tree shelters. Caliper of Dynamite™ was not affected by shelters at the end of the 2004 season, whereas 'Potomac' exhibited a slight reduction in caliper when grown in shelters (Table 1). However, caliper differences in 'Potomac' were not evident at three of the four sampling dates in the year after removing the shelters. Caliper of Dynamite™ and 'Potomac' was not affected by the shelters in the 2005 experiment (Table 3). 'Tuscarora' grown in shelters had significantly less caliper growth than unsheltered plants throughout much of the 2004 growing season. According to the manufacturer, the amplified blue light of the Blue-X tree shelters encourages diameter growth. Clear plastic tree-shelters have been shown to retard caliper growth of some species (5, 12). As previously reported (10), tree-shelters effects on caliper were taxa-specific.

Plants of all cultivars in both experiments grown inside the tree shelters had noticeably straighter, more upright trunks than unsheltered plants with little to no lateral branching inside the shelters, which could make them more marketable.

Table 4. Flower ratings[z] of two container-grown crapemyrtle cultivars grown in Blue-X tree shelters in Auburn, AL, experiment 2, 2005.

Treatment	Dynamite™						'Potomac'					
	May	June	July	Aug	Sept	Oct	May	June	July	Aug	Sept	Oct
(–) Shelter	1.0	1.1	3.0	3.8	4.0	4.0	1.0	1.0	1.9	3.0	3.2	4.0
(+) Shelter	1.0	1.0	1.9	2.8	3.2	4.0	1.0	1.0	1.0	2.0	2.8	4.0
Significance[y]	NS	NS	**	**	***	NS	NS	NS	*	*	NS	NS

[z]Flower rating scale, 1 = no visible floral development, 2 = visible floral development but no flower color, 3 = flower color present, and 4 = post color.
[y]NS, *, **, and *** represent non-significant and significant effects where $P \leq 0.05$, 0.01, and 0.001, respectively.

Dynamite™ and 'Potomac', with shelters removed at the beginning of the second growing season, lost some of the height advantage gained from being grown in shelters the previous year. However, because of the height of previously sheltered plants at the beginning of the second growing season, canopy development was considered more important than further increases in height. Of the three cultivars tested, none flowered inside the tree shelters. However, once plants reached the top of the tree shelters the flowering process appeared to be initiated. Overall each cultivar grown in tree shelters flowered at a later date than did unsheltered plants.

An assessment of costs related to container production of crapemyrtles with and without tree shelters may be helpful to nursery producers interested in using tree shelters during nursery crop production. In 2005, the cost of 122 cm (48 in) Blue-X tree-shelters, the type used in our study, ranged from $1.19 each for less than 100 to $0.79 for 5,000 or more. There also is labor associated with placing the shelters, however sucker and lateral shoot removal also requires labor. Blue-X tree shelters increased height growth in two of the three cultivars tested without affecting caliper at the end of the growing season and resulting in visibly straighter and more upright trunks with fewer basal or lateral shoots in all cultivars tested. Blue-X tree shelters may shorten production time of tree-form crapemyrtles by enhancing height growth or improving plant form.

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