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Growth Response of Crapemyrtle to Geographical Area and Production Light Level[1]

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Abstract

The effects of geographic location and production light level on vegetative growth and flowering were evaluated as a means of accelerating the development of tree-form crapemyrtles. By the end of the first year of the experiment, Dynamite™, 'Muskogee', 'Natchez', and 'Tuscarora' grown in Oregon were as much as 42, 51, 43, and 92% taller, respectively, than plants in Alabama, while plants generally had less trunk diameter in Oregon. 'Muskogee' and 'Natchez' in both locations and 'Tuscarora' in Alabama were generally taller when grown under 50% shade than plants in full sun, while height of Dynamite™ was not affected by production light level. Trunk diameter of 'Natchez' in both locations and of Dynamite™ in Alabama was less when plants were grown under shade, while trunk diameter of 'Muskogee' and 'Tuscarora' was not affected by production light level. Flowering of plants grown under shade in Alabama was delayed, while no plants in Oregon flowered the first year. In the second year of the experiment when all plants were grown in full sun, all cultivars continued to be taller in Oregon, while trunk diameter remained greater in Alabama. The height advantage gained from growing plants under shade the previous year was not evident in any cultivar by the end of the second year, while trunk diameter was similar for all cultivars previously grown in full sun and under 50% shade. There was no difference in flowering of plants in Alabama previously grown under 50% shade and in full sun, while 50 to 100% of the four cultivars in Oregon flowered with no obvious difference due to prior production light level.

Index words: container production, climatic comparisons, *Lagerstroemia*, flowering trees.

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

Significance to the Nursery Industry

Growth rate of most crapemyrtle cultivars is vigorous under nursery conditions; however, some cultivars begin flowering by early summer, resulting in suppressed vegetative growth, particularly height growth. Crapemyrtles prefer hot, sunny climates where flowering is profuse and, thus, are ideally suited for southern and southwestern regions of the United States (USDA Cold Hardiness Zones 7–9). Western regions of Oregon and Washington are in USDA Zones 7 and 8; however, crapemyrtles are not widely planted in landscapes and flower sporadically, if at all. Growing crapemyrtles in Oregon or similar USDA zones in the Northwest and under lower production light levels may suppress flowering and promote more height growth, beneficial in the development of tree-form. All four cultivars of crapemyrtle tested were taller by the end of the growing seasons when grown in Oregon, although trunk diameter was greater in Alabama. 'Muskogee' and 'Natchez' in both locations and 'Tuscarora' in Alabama were generally taller when grown under 50% shade than plants in full sun, while height of Dynamite™ was not affected by production light level. Trunk diameter of 'Natchez' in both locations and Dynamite™ in Alabama was less when plants were grown under shade, while trunk diameter of 'Muskogee' and 'Tuscarora' was not affected by production light level. By growing all plants in full sun the sec-

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ond year it was possible to regain trunk diameter lost when grown under shade the previous year, although some of the height advantage gained from growing under shade decreased. However, plants had developed sufficient clear trunk height the first season so that head development, rather than additional height, would be more important during the second season.

Introduction

Crapemyrtles, grown in the southern and southwestern U.S. as shrubs or small trees, are valuable landscape species recognized for their exceptional seasonal ornamental characteristics. Lengthy summer flowering and a diversity of flower colors, plant sizes, and growth habits are appreciated by horticulturalist and gardeners (3, 5). Breeding programs over the last 30 years have produced 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 (9).

Growth rate of most crapemyrtle cultivars is vigorous under nursery conditions; however, some cultivars begin flowering as early as May and continue into the fall (2, 9), leading to suppressed vegetative growth, particularly height growth. Height suppression is often compounded by heavy fruit set following flowering. 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 to 183 cm (4 to 6 ft) of clear trunk, pruning exacerbates the problem by stimulating new shoot formation, often from the main trunk. Fain et al. (7) determined the effect of two plant growth regulators, Pistill [(ethephon) Monterey Chemical, Fresno, CA] and Atrimmec [(dikegulac-sodium) PBI/Gordon, Kansas City, MO] on flower abortion, fruit set, and shoot growth of 'Tuscarora' crapemyrtle when applied to open inflorescences. As low as 2% fruit set was achieved with a single application of 1000 ppm Pistill applied at full flower. Applications of Pistill also increased lateral branching, but not plant height. In a later study, foliar applications of 1000 ppm Pistill applied at 7-day intervals to developing inflorescences of 'Tuscarora' crapemyrtle resulted in up to 96% flower abortion and greatly increased axillary shoot formation (11). These results suggested multiple applications of Pistill may be useful in enhancing quality of crapemyrtles by promoting shoot development and concomitant fuller plants, but overall plant height was minimally affected.

There are three major mechanisms that can control the development of tree-form: apical dominance, which can affect both the pattern and orientation of axes development, allocation mechanisms that maintain feedbacks between leaf and wood production for transport capacity and mechanical support, and shading that reduces light intensity (17). Apical dominance, the control exerted by the apical portions of the shoot over the outgrowth of lateral buds (4), can be dramatically influenced by light; the lower the light intensity the stronger the apical dominance (1, 10). Leaf shading enriches the far-red component of transmitted light and causes a reduction of the fluence rate (irradiance) and light quality (6). Shading reduces photosynthesis and eventually reduces leaf production and growth. However, plants in shade tend to grow upward to reach the canopy surface where they will be able to collect more light (17). Far-red light inhibits the initiation of bud outgrowth, but also enhances subsequent bud elongation after it has been initiated (12, 16). This upward growth is useful in developing tree-form crapemyrtles.

Crapemyrtles prefer hot, sunny climates where flowering is profuse and, thus, are ideally suited for southern and southwestern regions of the United States (USDA Cold Hardiness Zones 7–9). Western regions of Oregon and Washington are in USDA Zones 7 and 8; however, crapemyrtles are not commercially grown to any extent and are rarely planted in landscapes because flowering is sporadic, if at all. The consensus is although these environments have high irradiance levels during the growing season, moderate winters, and adequate moisture, they lack the high summer temperatures typical of the South where flowering is prolific (2). Vegetative growth and flowering of crapemyrtles are thought to be regulated by photoperiod, accumulated light intensity, and temperature (13). High temperatures favor rapid floral bud initiation and development in dwarf crapemyrtles (8). While detrimental from a landscape perspective, lack of flowering in these regions may create growing opportunities for wholesale nurseries. Therefore, the objective of this study was to evaluate how geographic location and production light level affect vegetative growth and flowering during nursery production of tree-form crapemyrtle.

Materials and Methods

Research was conducted outdoors at Auburn University's Paterson Horticultural Complex in Auburn, AL (32°36' N × 85°29' W) and at Oregon State University's North Willamette Research & Extension Center in Aurora, OR (45°14' N × 122°45' W) using same-source, uniform liners [15–20 cm (6–8 in) in height] of *Lagerstroemia indica* L. 'Whitt II' (Dynamite™) and *Lagerstroemia indica* L. ×*fauriei* Koehne 'Muskogee', 'Natchez', and 'Tuscarora'. Dormant plants in Alabama were repotted on March 18, 2004, from 10.2 cm (4 in) liner 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. Dormant plants in Oregon were repotted on the same date into same-size containers using 100% Douglas fir bark substrate screened through a 2.2 cm (0.8 in) sieve and amended as in Alabama. One-half of the plants of each cultivar at each location were placed in either full sun or under 50% shade cloth, 0.6 m (2 ft) apart, and watered with overhead impact sprinklers as needed. All trees were held upright by 152 cm (60 in) bamboo stakes, and all lateral branches below 91 cm (36 in) were removed weekly to promote shoot elongation. Height and trunk diameter were recorded during the last week of each month from June to October. Height was measured from the substrate surface to the uppermost part of the plant, and trunk diameter was measured 2.5 cm (1 in) from the substrate surface. In March 2005 dormant plants were transplanted into 26.5 liter (#7) containers using the same amended substrates, and all plants were grown in full sun. Height and trunk diameter were recorded the last week of June, August, and October 2005, and flowering (the presence of at least one inflorescence per plant) was determined periodically. Meteorological variables of daily maximum and minimum air temperatures and rainfall were recorded at weather stations at the two geographic locations.

The experiment was an unreplicated split plot design with geographic location (Alabama and Oregon) as the main plot

and light (full sun and 50% shade) as a split-plot. Treatments were randomized within cultivar with 10 single-plant replicates per cultivar. Data were analyzed using analysis of variance (ANOVA) to test main effects and interactions (15).

Results and Discussion

Dynamite™. Dynamite™ was 172 and 40% taller when grown in Alabama in June and July, but was surpassed in August and later data collection dates by plants grown in Oregon (Table 1). By the end of the growing season, plants in Oregon were 42% taller than those in Alabama. The greater height growth of plants in Alabama in June may be due in part to higher spring temperatures. In April and May, average monthly minimum temperatures in Alabama were 10.9 and 17.8C (51.6 and 64.0F) compared to 5.8 and 9.3C (42.4 and 48.7F) in Oregon (Table 2). Previous research has shown that growth of dwarf crapemyrtles was greater at higher minimum night temperatures (8). However, between June and October, plants in Oregon increased in height by 444% compared to 41% for plants in Alabama. Differences in growth rate are thought to be linked to terminal flowering of shoots which slowed vegetative growth, especially height growth. Forty, 50, 80, and 100% of Dynamite™ in Alabama were flowering or had flowered in July, August, September, and October, respectively, while none flowered in Oregon. Between July and October, plants in Alabama did not change in height, while those in Oregon increased by 64 cm (25.2 in). Plants in Oregon continued to grow vegetatively until they were exposed to several hard freezes in the fall. Plant height was not affected by production light level.

Trunk diameter of Dynamite™ in full sun was greater in Alabama than Oregon throughout the season, but the difference decreased from 102 to 10% greater between June and October. Trunk diameter of plants grown under 50% shade in Alabama was 146, 61, and 25% greater than their Oregon counterparts in June, July, and August, respectively, but similar thereafter. Similar to height, the greater trunk diameter in Alabama in June can be attributed to the higher temperatures in Alabama than in Oregon in April and May. The trunk diameter advantage of plants in Alabama decreased as plant height in Oregon increased due to a lack of flowering of plants. Trunk diameter of plants grown in Alabama in full sun was greater than that of plants under 50% shade at all data collections, while trunk diameter of Oregon-grown plants was not affected by production light level.

Similar to 2004, higher spring minimum temperatures in Alabama and concomitant earlier start of the second grow-

Table 1. Effect of geographic location and production light level on two container-grown crapemyrtle cultivars, 2004[z].

Location	Light level	Dynamite™									
		Height (cm)					Trunk diameter (mm)				
		June	July	Aug.	Sept.	Oct.	June	July	Aug.	Sept.	Oct.
AL	Sun	62.8	91.4	82.7	86.8	86.6	7.6	9.3	10.0	10.9	10.6
	50% shade	66.8	91.1	87.9	97.5	95.8	6.4	7.9	9.0	9.1	9.3
OR	Sun	23.5	64.8	107.3	124.9	128.6	2.6	5.3	7.1	8.7	9.7
	50% shade	24.1	66.0	115.1	127.8	130.2	2.6	4.9	7.2	8.7	9.2
Effects[y]	Loc	***	***	***	***	***	***	***	***	***	*
	Light	NS	NS	NS	NS	NS	**	***	NS	***	***
	Loc × Light	NS	NS	NS	NS	NS	**	*	*	***	*
	AL v. OR FS[x]	—	—	—	—	—	***	***	***	***	**
	AL v. OR SH	—	—	—	—	—	***	***	***	NS	NS
	FS v. SH AL	—	—	—	—	—	***	***	**	***	***
	FS v. SH OR	—	—	—	—	—	NS	NS	NS	NS	NS
		'Tuscarora'									
		June	July	Aug.	Sept.	Oct.	June	July	Aug.	Sept.	Oct.
AL	Sun	65.7	80.2	72.3	72.7	70.5	10.5	11.1	11.7	12.1	12.1
	50% shade	84.2	109.6	100.4	110.1	110.2	9.6	10.9	11.9	12.2	12.2
OR	Sun	30.6	72.1	123.8	158.1	170.9	3.4	6.2	8.7	10.9	12.1
	50% shade	33.2	73.3	131.8	163.8	176.2	3.0	6.1	8.8	10.6	11.8
Effects	Loc	***	***	***	***	***	***	***	***	***	NS
	Light	***	***	**	***	***	**	NS	NS	NS	NS
	Loc × Light	**	***	*	**	**	NS	NS	NS	NS	NS
	AL v. OR FS	***	NS	***	***	***	—	—	—	—	—
	AL v. OR SH	***	***	***	***	***	—	—	—	—	—
	FS v. SH AL	***	***	***	***	***	—	—	—	—	—
	FS v. SH OR	NS	NS	NS	NS	NS	—	—	—	—	—

[z]The experiment was conducted simultaneously in Auburn, AL and Aurora, OR.

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

[x]FS = full sun, SH = 50% shade.

Table 2. Mean monthly maximum (T_{max}) and minimum (T_{min}) temperatures and monthly rainfall for Auburn, AL and Aurora, OR, respectively, during Summer 2004 and 2005[z].

	2004					
	Alabama			Oregon		
Month	T_{max} (C)	T_{min} (C)	Rain (mm)	T_{max} (C)	T_{min} (C)	Rain (mm)
April	23.6	10.9	71.4	19.2	5.8	0.9
May	28.9	17.8	94.2	19.4	9.3	1.6
June	30.2	21.0	84.6	24.1	11.9	1.4
July	32.4	22.1	87.4	28.9	13.9	0.1
August	30.6	20.8	131.3	28.4	14.8	2.1
September	27.9	19.3	197.1	21.8	11.0	1.5
October	25.6	16.2	52.6	17.9	8.2	3.6
	2005					
April	22.9	10.5	120.1	15.5	5.9	2.5
May	26.7	14.9	62.0	20.0	10.5	4.1
June	29.9	20.9	199.9	21.0	10.8	2.3
July	31.5	22.7	186.7	27.8	13.3	0.5
August	31.3	22.6	183.6	29.0	12.5	0.2
September	31.2	20.7	45.5	23.6	8.7	1.9
October	24.5	13.2	106.2	16.7	8.8	3.1

[z]Data from weather stations at Auburn, AL and Aurora, OR.

ing season, when all plants were grown in full sun, resulted in a loss of the height advantage gained by growing plants in Oregon the previous year (Table 2). However, Dynamite™ in Oregon were 44% taller than plants in Alabama by the end of the second growing season (Table 3). Similar to the first year, plants in Oregon had 76% more height growth from June to October than plants in Alabama. All plants of Dynamite™ in Alabama had flowered by October, compared to 63% in Oregon. Again, flower suppression in Oregon may have allowed for increased height growth throughout the growing season compared to Alabama. Trunk diameter of Alabama-grown Dynamite™ remained greater at each data collection than that of plants grown in Oregon, again, probably due to the higher spring temperatures in Alabama (Table 2). Throughout the second year of the experiment when all plants were grown in full sun, height and trunk diameter was similar for plants previously grown in full sun and under 50% shade. This contrasts with less trunk diameter growth of shade-grown plants in Alabama than that of sun-grown plants at the end of 2004.

'Tuscarora'. There were interactions between geographic location and production light level for height of 'Tuscarora' at all data collection dates (Table 1). Location effects were similar in sun and shade and similar to those of Dynamite™. Height of 'Tuscarora' in full sun was greater in Alabama in June, similar to that of Oregon-grown plants in July, and greater in plants in Oregon thereafter. Alabama plants in full sun were 115% taller in June, while plants in Oregon were 71, 117, and 142% taller in August, September, and October, respectively. Similar to Dynamite™, greater height growth of Oregon-grown plants from June to October, can be attributed to a lack of flowering. Alabama-grown plants in full sun had all flowered by August, while none flowered in Oregon. Similar to plants in full sun, plants grown under shade were taller in Alabama until surpassed by Oregon plants in August. By the end of the growing season, 'Tuscarora' grown under shade were 60% taller in Oregon than in Alabama. Likewise, 'Tuscarora' grown in Alabama were taller under 50% shade than in full sun, increasing from 28% greater in June to 56% greater in October. Increased height growth under shade may be due to enriched far-red light, which enhanced shoot elongation (6, 12, 16). In Alabama 80 and 100% of plants in full sun were flowering by July and August, compared to 50 and 75% of plants under shade. Greater flowering of the terminal shoots, which suppresses shoot elongation (7, 11), may have further contributed to height differences observed in full sun and under shade. Similar to Dynamite™, production light level in Oregon had no effect on plant height.

Trunk diameter of 'Tuscarora' in Alabama was greater than that of plants in Oregon at all data collection dates until October, when trunk diameters were similar. Trunk diameter differences decreased from 216% greater in June to 13% greater in September, a trend similar to Dynamite™. The large differences in trunk diameter in June may be explained by the higher spring temperatures in Alabama allowing for more growth early in the season than in Oregon.

In the second year of the experiment, when all plants were grown in full sun, 'Tuscarora' in Oregon was 32 and 18% taller in June and October, respectively, than plants in Alabama but similar in August (Table 3). By August, all plants

Table 3. Effect of geographic location and production light level on two container-grown crapemyrtle cultivars, 2005[z].

		Dynamite™						'Tuscarora'					
		Height (cm)			Trunk diameter (mm)			Height (cm)			Trunk diameter (mm)		
Location	Light level	June	Aug.	Oct.	June	Aug.	Oct.	June	Aug.	Oct.	June	Aug.	Oct.
AL	Sun	115.3	163.3	168.0	11.2	15.0	17.4	109.5	184.2	186.0	12.8	18.0	19.6
	50% shade	123.9	157.3	160.5	11.0	15.9	18.0	139.1	195.9	205.5	13.6	18.9	21.2
OR	Sun	135.4	170.7	273.1	8.5	10.2	11.5	162.6	200.7	230.3	11.4	12.1	14.3
	50% shade	132.9	167.4	200.4	9.3	10.5	12.7	166.4	184.1	231.7	11.2	12.9	15.7
Effects[y]	Loc	NS	NS	**	***	***	***	***	NS	*	**	***	***
	Light	NS	NS	NS	NS	NS	NS	**	NS	NS	NS	*	*
	Loc × Light	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

[z]All plants grown in full sun for the second season. The experiment was conducted simultaneously in Auburn, AL and Aurora, OR.

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

in Alabama and 83% in Oregon had flowered. Similar to the previous year, less flowering may have resulted in increased height growth of plants in Oregon. There was no obvious difference in flowering between plants previously grown under the two production light levels in either Alabama or Oregon. Only in June were plants previously grown under shade taller than plants in sun. Trunk diameter of 'Tuscarora' remained greater in Alabama than in Oregon, as much as 36% by the end of the growing season. Interestingly, trunk diameter of plants previously grown under shade in both locations was 5 and 8% greater than that of plants grown in full sun in October.

'*Natchez*'. Similar to Dynamite™ and 'Tuscarora', 'Natchez' in Alabama responded to higher spring temperatures with increased shoot growth. 'Natchez' in Alabama was 133 and 42% taller than plants in Oregon in June and July (Table 4). However, as the growing season progressed, height growth of 'Natchez' in Oregon accelerated and plants were taller than those in Alabama in August and at later data collections dates. By the end of the growing season, plants in Oregon were 43% taller than those in Alabama, and plants grown under shade in both locations were 16% taller than plants in full sun. Similar to Dynamite™ and 'Tuscarora', no plants in Oregon flowered, which may have led to increased shoot growth. There was an interaction between location and production light level for plant height in August and September. Oregon plants grown in full sun were taller in August and September than plants in Alabama, while plants in shade were 23% taller in Oregon than in Alabama in September. In August, 65% of Alabama-grown plants in full sun and 10% of plants under shade were flowering, while no flowering occurred in Oregon. Plants in Alabama grown under shade in August and September were 43 and 40% taller, respectively, than plants in full sun, while plants in Oregon were similar in height in both light regimes.

Trunk diameter was greater throughout the growing season for plants grown in Alabama than in Oregon, regardless of production light level, although differences lessened as the season progressed. Plants in full sun in Alabama had 27, 25, and 12% greater trunk diameter in June, July, and August, respectively, than plants grown under shade, while there was no trunk diameter differences between production light levels in Oregon. In September and October plants grown in full sun had 9 and 10% greater trunk diameter, respectively, than plants grown under shade at the two locations.

In the second year of the experiment, 'Natchez' in Oregon continued to be taller than plants in Alabama. Prior produc-

Table 4. Effect of geographic location and production light level on two container-grown crapemyrtle cultivars, 2004[z].

Location	Light level	'Natchez'									
		Height (cm)					Trunk diameter (mm)				
		June	July	Aug.	Sept.	Oct.	June	July	Aug.	Sept.	Oct.
AL	Sun	83.5	124.3	111.8	133.4	156.2	10.4	12.6	13.8	14.2	14.5
	50% shade	84.6	138.7	159.7	185.3	201.7	8.2	10.1	12.4	12.6	12.5
OR	Sun	34.3	93.3	174.2	222.0	247.4	3.7	6.6	9.3	11.5	13.0
	50% shade	37.9	92.6	175.2	228.8	265.7	4.0	6.7	9.2	10.8	12.2
Effects[y]	Loc	***	***	***	***	***	***	**	***	***	*
	Light	NS	NS	***	**	**	**	**	**	***	**
	Loc × Light	NS	NS	***	**	NS	***	***	*	NS	NS
	AL v. OR FS[x]	—	—	***	***	—	***	***	***	—	—
	AL v. OR SH	—	—	NS	***	—	***	***	***	—	—
	FS v. SH AL	—	—	***	***	—	***	***	***	—	—
	FS v. SH OR	—	—	NS	NS	—	NS	NS	NS	—	—
		'Muskogee'									
		June	July	Aug.	Sept.	Oct.	June	July	Aug.	Sept.	Oct.
AL	Sun	91.3	127.3	122.7	120.9	124.1	10.7	12.8	14.8	14.7	14.7
	50% shade	109.0	161.8	153.3	196.6	184.5	9.8	11.4	12.9	14.2	14.7
OR	Sun	40.6	95.4	165.4	200.8	217.0	3.9	7.3	9.7	12.0	13.2
	50% shade	41.7	103.2	187.0	229.9	248.9	4.0	7.4	9.9	11.7	13.5
Effects	Loc	***	***	***	***	***	***	***	***	***	NS
	Light	NS	**	**	***	***	NS	NS	*	NS	NS
	Loc × Light	NS	NS	NS	*	NS	NS	NS	*	NS	NS
	AL v. OR FS	—	—	—	***	—	—	—	***	—	—
	AL v. OR SH	—	—	—	**	—	—	—	***	—	—
	FS v. SH AL	—	—	—	***	—	—	—	***	—	—
	FS v. SH OR	—	—	—	**	—	—	—	NS	—	—

[z]The experiment was conducted simultaneously in Auburn, AL and Aurora, OR.

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

[x]FS = full sun, SH = 50% shade.

Table 5. Effect of geographic location and production light level on two container-grown crapemyrtle cultivars[z], experiment 1, 2005.

		'Natchez'						'Muskogee'					
		Height (cm)			Trunk diameter (mm)			Height (cm)			Trunk diameter (mm)		
Location	Light level	June	Aug.	Oct.	June	Aug.	Oct.	June	Aug.	Oct.	June	Aug.	Oct.
AL	Sun	195.2	209.5	222.5	16.1	19.6	21.4	178.0	230.7	243.5	16.7	23.2	25.7
	50% shade	226.8	250.0	236.1	15.2	19.7	21.9	222.8	260.6	265.0	19.9	21.7	22.8
OR	Sun	231.5	268.1	282.7	10.9	13.6	17.3	225.4	259.4	283.0	12.5	14.5	19.9
	50% shade	240.2	286.5	305.9	13.1	15.6	19.4	231.1	273.7	298.7	13.3	16.8	20.9
Effects[y]	Loc	*	***	***	***	***	***	*	NS	**	***	***	***
	Light	NS	**	NS	*	*	NS	*	*	NS	NS	NS	NS
	Loc × Light	NS	NS	NS	**	*	NS	NS	NS	NS	NS	*	*
	AL v. OR FS[x]	—	—	—	***	***	—	—	—	—	—	***	***
	AL v. OR SH	—	—	—	**	***	—	—	—	—	—	***	NS
	FS v. SH AL	—	—	—	NS	NS	—	—	—	—	—	NS	**
	FS v. SH OR	—	—	—	**	*	—	—	—	—	—	*	NS

[z]All plants grown in full sun for the second season. The experiment was conducted simultaneously in Auburn, AL and Aurora, OR.

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

[x]FS = full sun, SH = 50% shade.

tion light level had no effect on height in 2005, except in August when plants previously grown under shade were 12% taller than plants grown in full sun (Table 5). By the end of the growing season all plants in both locations had flowered or were flowering. Similar to the previous season, trunk diameter was greater in Alabama than in Oregon for plants grown in full sun or under shade throughout the 2005 growing season. There were no trunk diameter differences between the two light regimes in June or August in Alabama. However, trunk diameter of 'Natchez' previously grown under shade in Oregon was 20 and 15% greater in June and August, respectively, than that of plants in full sun.

'*Muskogee*'. Similar to Dynamite™, 'Natchez', and 'Tuscarora', 'Muskogee' responded to higher spring temperatures in Alabama with increased growth early in the season (Table 2). Overall height of 'Muskogee' in Oregon surpassed that of plants grown in Alabama in September, with plants being as much as 66 and 75% taller in September and October, respectively (Table 4). Similar to the other cultivars, the increased height growth in Oregon is probably due to a lack of flowering. In Alabama, 20, 43, and 95% of 'Muskogee' were flowering or had flowered in August, September, and October, respectively, while none flowered in Oregon. Plants grown under 50% shade in both locations were generally taller than plants grown in full sun throughout the season and were 27% taller in October. Similar to 'Tuscarora', trunk diameter was 164% greater in Alabama than in Oregon in June, decreasing to 22% greater in September, and similar for the two locations by the end of the growing season. Trunk diameter was not affected by production light level at any data collection date, except August when there was an interaction between location and light.

Similar to 'Natchez' and 'Tuscarora', 'Muskogee' was generally taller in Oregon in the second season. All plants in Alabama and 73% of plants in Oregon had or were flowering by the end of the season. Plants previously grown under shade were 13% taller in June than plants grown in full sun at both locations and similar thereafter (Table 5). Trunk diameter of plants in Alabama was 42% greater in June than that of plants in Oregon, with an interaction between location and previous production light level in August and October. Plants grown in Alabama in full sun had 60 and 29% greater trunk diameter in August and October, respectively, than that of plants in Oregon. Similarly, trunk diameter was greater for plants previously grown under shade in Alabama in August, but similar by the end of the growing season. In Alabama, there was no difference in trunk diameter between light regimes in August, but trunk diameter of plants in full sun was 13% greater in October. Plants previously grown under shade in Oregon had 16% more trunk diameter than plants in full sun in August, but were similar thereafter.

Differences in meteorological conditions including higher maximum and minimum temperatures in Alabama appeared to have a direct effect on growth of plants in this experiment. Average daily maximum temperatures in 2004 in Alabama ranged from 3.4 to 5.7C (6.3 to 10.2F) higher than in Oregon, while minimum daily temperatures were 5.3 to 7.3C (9.3 to 13.2F) lower in Oregon than in Alabama (Table 2). There were similar temperature differences in 2005. The higher minimum and maximum temperatures in Alabama may explain the early growth differences. Rainfall from April to October in 2004 and 2005 totaled 719 and 904 mm (28.3 and 35.6 in), respectively, in Alabama while rainfall in Oregon for 2004 and 2005 totaled 11.2 and 14.5 mm (0.44 and 0.57 in), respectively. Oregon's Willamette River Valley receives 100 to 125 cm (40 to 50 in) of precipitation each year, however, most occurs during the dormant season (November through March). This region of Oregon is largely considered to have arid Mediterranean-like summers.

Nursery operators in the southeastern United States contend with summer temperatures which regularly exceed 32C (90F), high relative humidities, and frequent afternoon thundershowers (14). Crapemyrtles respond to high temperatures and sunny climates by flowering profusely and, thus, are ideally suited for landscapes in southern and southwestern regions of the U.S. (USDA Cold Hardiness Zones 7–9). Western regions of Oregon and Washington are in USDA Zones 7

and 8; however, crapemyrtles are uncommon in landscapes and flower inconsistently, if at all. Oregon's summers are milder than those of Alabama with lower night temperatures. The consensus is although these environments have high levels of sunlight, moderate winters, and adequate moisture, they lack the high temperatures found in the South where flowering is prolific (2). Guidry (8) reported that high temperatures favor rapid floral bud initiation and development in dwarf crapemyrtles. This may be true considering that no crapemyrtle flowered in Oregon in 2004. However, in 2005 there was a considerable increase in flowering. All 'Natchez' in Oregon flowered along with 50, 66, and 66%, of Dynamite™, 'Muskogee', and 'Tuscarora', respectively. Lower temperatures in Oregon, especially minimum temperatures, may have contributed to the decreased flowering. Cold tolerance of plants in Oregon became an issue as temperatures started to drop toward the end of the growing season. While flowering inhibited vegetative growth in crapemyrtle, the lack of flowering which may have led to increased height growth of plants in Oregon in 2004 also resulted in plants actively growing until exposed to several hard freezes, which injured shoot tips. However, all plants survived with no visible effects on vigor in 2005. In 2005, plants that flowered in Oregon ceased shoot growth before exposure to freezing temperatures and were not injured, as opposed to those that did not flower.

Height growth of plants generally was greater when grown under shade in Alabama, while trunk diameter of two cultivars was greater in full sun. Through the use of lower production light levels it was possible to accelerate height growth of 'Muskogee', 'Natchez', and 'Tuscarora' in Alabama. 'Muskogee' was the only cultivar to respond to lower production light levels with increased height in Oregon; however trunk diameter of all cultivars was similar under the two production light levels. By growing all plants in full sun the second year it was possible to regain trunk diameter lost due to growth under shade the previous year, although some of the height advantage gained from growing under shade decreased. However, plants developed sufficient clear trunk height the first season so that head or canopy development rather than additional height would be more important thereafter. Results of this study suggest growing plants in Oregon or similar USDA zones in the region can accelerate the development of tree-form crapemyrtle, compared to production in Alabama. All cultivars were taller in Oregon, although trunk diameter was greater in Alabama. The suppression or lack of flowering in Oregon can lead to increased height growth resulting in the necessary structure for further development into tree-form crapemyrtles quicker than when grown in Alabama.

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