Response of *Lagerstroemia* x 'Tuscarora' to Multiple Applications of Pistill[1]

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Abstract

Profuse flowering, followed by heavy fruit set and cessation of vegetative growth, extends the production cycle of many crapemyrtle cultivars, particularly 'Tuscarora'. A study was conducted in 2002 to determine the effect of multiple applications of 1000 ppm Pistill (ethephon) on flower abortion and subsequent axillary shoot growth in *Lagerstroemia indica* x *fauriei* 'Tuscarora' when applied to open flowers in July and August before fruit set. In one experiment, Pistill was applied 0, 1, 2, 3, 4, or 5 times during the two flowering periods, and at 7-, 14-, and 21-day intervals (DI) during each period in a second experiment. In the first experiment, two applications made during the July flush led to 48% flower abortion, whereas by the fifth application, made during the August flush, the abortion rate had increased to 58%. Axillary shoot formation occurred predominantly following the July flush, with 34 and 60 new shoots developing on plants receiving one and two applications, respectively. Pistill applications every 7, 14, or 21 days to open flowers during the first floral flush prompted flower abortion of 81, 51, and 18%, respectively, compared to no abortion in untreated trees. The same Pistill treatments applied during the August flush resulted in 96, 96, 54, and 0% abortion, respectively. Trees receiving Pistill at 7 DI, 14 DI, and 21 DI, respectively, formed 96, 108, and two new shoots following the July flower flush and 13, 27, and two new shoots following the August flush.

Index words: plant growth regulator, flower abortion, lateral shoots.

Growth regulator used in this study: Pistill (ethephon), [(2-chloroethyl)phosphonic acid]*.

Species used in this study: 'Tuscarora' crapemyrtle (*Lagerstroemia indica* L. x *fauriei* Koehne. 'Tuscarora').

Significance to Industry

Crapemyrtle is a fast-growing, ornamental tree in the southern and portions of the western United States; however, it blooms in early summer, directing plant energy into flowering, effecting a reduction in vegetative growth. With some cultivars, such as 'Tuscarora', a proliferation of flowering followed by extensive fruit set reduces or eliminates additional vegetative growth for the remainder of the growing season. Rather than manually prune flowers, which is labor-intensive and usually yields minimal vegetative re-growth followed by re-flowering, growth regulators may be used to abort flowers and elicit shoot formation. Foliar applications of 1000 ppm Pistill applied at 7-day intervals during flowering and directed towards developing inflorescences resulted in up to 96% flower abortion and greatly increased axillary shoot formation. Plants were noticeably fuller, however overall plant size was minimally affected by Pistill. These results suggest multiple applications of Pistill may be useful in enhancing quality of crapemyrtle and perhaps shortening nursery production time.

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Introduction

Crapemyrtle (*Lagerstroemia* spp.) is a fast-growing, ornamental tree and a major nursery crop in the southern and portions of the western United States; however, it blooms in early summer, directing plant energy into flowering, which suppresses vegetative growth. With some cultivars, such as 'Tuscarora', a proliferation of flowering followed by extensive fruit set reduces or eliminates additional vegetative growth for the remainder of the growing season. In addition, panicles are often large and top-heavy, which causes overweighted branches during irrigation that may split trunks and promote blowover of container-grown trees. Manual flower removal may alleviate some of these problems, but it is labor-intensive and costly, and plants quickly initiate new inflorescences on short shoots that suppress vegetative growth.

The plant growth regulator (PGR) ethephon, a compound that releases ethylene, has been used on mango (*Mangifera indica* L.) flowers at 400 and 800 ppm to cause 98 to 100% wilting and necrosis of flower panicles (4). Woolf et al. (5) selectively removed flower buds on *Camellia* L. using applications of 1000 to 2000 ppm ethephon, with minimal abscission of other plant organs. Applied at full bloom, 1000 ppm ethephon eliminated fruit set in *Pyrus calleryana* Decne. (flowering pear) and 99% fruit set in *Liquidambar styraciflua*

L. (sweetgum) (3). Ethephon also caused 89 to 100% flower abortion and 91 to 96% reduction in seed formation in three cultivars of *Kalmia latifolia* L., simultaneously stimulating shoot production and elongation (2).

Fain et al. (1) studied the effectiveness of a single application of Pistill on flower abortion in 'Tuscarora' crapemyrtle, and reported that when applied at 1000 ppm to open flowers prior to fruit set significant abortion occurred. However, Pistill was not effective in aborting flowers when applied at bud stage. Because of crapemyrtle's habit of forming new inflorescences over an extended period, a single application of Pistill was not considered to have practical benefit in nursery production of crapemyrtle. This study was initiated to address this shortcoming of single Pistill applications by exploring the efficacy of Pistill application number when applied at a predetermined interval, and application interval on whole-plant flower abortion and shoot formation in container-grown 'Tuscarora' crapemyrtle.

Materials and Methods

'Tuscarora' crapemyrtle (*Lagerstroemia indica* x *fauriei* 'Tuscarora') grown in 7.6 liter (#3) containers of a pinebark:sand substrate were repotted on May 12, 2002, into 11.4 liter (#7) containers of a pinebark:sand substrate (7:1 by vol) amended per cu m (cu yd) with 8.3 kg (14 lb) 18N–2.6P–10K (PolyOn 18–6–12, 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 spaced 1.2 m (4 ft) on center, outdoors in full sun under twice-daily, overhead sprinkler irrigation, receiving an average of 1.8 cm (0.7 in) total per day, excluding ambient rainfall.

In each of two experiments, 1000 ppm Pistill was applied as a foliar spray directed primarily toward open flowers, 100 ml (3.4 oz) per plant, using a CO_2 sprayer with a flat spray nozzle (TeeJet 8004VS, Bellspray, Inc., Opelousas, LA) at 138 kPa (20 psi). This concentration of Pistill was previously shown to be most effective in preventing fruit set in crapemyrtle (1). Applications generally were made before noon and plants were not overhead irrigated until the following morning. Dry- and wet-bulb temperatures were recorded at application of each Pistill treatment, from which relative humidity (RH) was determined. Treated plants were allowed to dry overnight before being returned to the irrigated growing area.

Application number. A group of 60 'Tuscarora' crapemyrtle were blocked by size and stage of floral development, then randomly assigned Pistill treatments. When inflorescences from the first floral flush were fully open, but prior to visible fruit set, Pistill treatments were begun. Plants received 0, 1, 2, 3, 4, or 5 applications of 1000 ppm Pistill. A previous study determined that Pistill applications were only effective in promoting flower abortions and new shoots when applied to open flowers prior to visible fruit set (1). Therefore, in this experiment, the first and second Pistill applications were made weekly during the first flush of flowering (July 16 and 25), after which there were no open flowers on any treated plants. The third, fourth, and fifth applications were made weekly during the second floral flush (August 22, 28, and September 4). Temperature and RH during Pistill applications on these five dates were 31C (88F) and 67%, 28C (83F) and 84%, 31C (87F) and 70%, 31C (87F) and 83% , and 36C (96F) and 42%, respectively. Treatments, while blocked, were completely randomized in the nursery area and replicated with 10 plants each.

Application interval. A group of 40 plants were blocked by size and stage of floral development, then randomly assigned Pistill treatments. On July 10, when up to one-third of the flowers per inflorescence during the first floral flush were open, trees received their initial foliar Pistill applications. Ten plants received three applications at 7-day intervals (DI) (July 10, 16, and 25); 27 days later, at the beginning of the second floral flush, three additional applications were made at 7 DI (August 21, 28, and September 4) for a total of six applications over the two flowering periods. A second set of 10 plants received two Pistill applications at 14 DI (July 10 and 25); 27 days later, during the second floral flush, two additional applications were made at 14 DI (August 21, and September 4) for a total of four applications over the two flowering periods. A third set of 10 plants received one Pistill application on July 10, and two additional applications during the second floral flush at 21 DI (August 8 and 28) for a total of three applications over the two flowering periods. Ten plants received no treatment. Temperature and RH during treatment on July 10, 16, and 25, August 8, 21, and 28, and September 4 were 30C (86F) and 70%, 31C (88F) and 67%, 25C (77F) and 85%, 34C (94F) and 86%, 27C (80F) and 79%, 29C (85F) and 64%, and 36C (96F) and 42%, respectively.

Data from both experiments were collected on the same dates. On August 7, the average percentage flower abortion in inflorescences from the first floral flush, new axillary shoot counts, average length of the three longest new shoots per plant, and growth index [GI = (height + widest width + width 90° to widest width) / 3] were recorded. On September 12, average percentage flower abortion in inflorescences from the second floral flush, new shoot counts (those emerged since the first rating), average length of the three longest new shoots (from both flushes), and GI were recorded. At both evaluations, flower abortion ratings were made by the same two persons and averaged.

Analyses of variance of the data from each flower flush evaluation were carried out individually using the SAS General Linear Model procedure. Single degree of freedom orthogonal contrasts were used to determine the regression response to Pistill application number and interval (control not included as an interval), and to compare the control to each application interval treatment. Due to numerous missing values for shoot length taken following the second floral flush in the application number test, Duncan's Multiple Range Test was used to make treatment comparisons.

Results and Discussion

Application number. The first flower flush produced the majority of inflorescences, approximately three-fourths of the total during the 2002 growing season. In the first flush flower abortion rates rose linearly from zero for the control plants to 17% in trees treated once and 48% for trees treated twice (Table 1). These results concur with those of previous studies using mango (4), camellia (5), sweetgum (3), mountain laurel (2) and crapemyrtle (1). Following the third, fourth, and fifth applications, which were made during the second floral flush, flower abortion increased linearly by 26, 32, and 58%, respectively. Of interest is the rating made after the

Table 1. Reproductive and vegetative response of *Lagerstroemia* x 'Tuscarora' treated with different numbers of applications of 1000 ppm Pistill applied at weekly intervals during two flowering periods.

Number of Pistill applications[v]	Flower abortion[z] (%)		New shoot counts		Shoot length[y] (cm)		Plant height (cm)		Plant width[x] index (cm)		Growth index[w] (cm)	
	1st Flush	2nd Flush	1st Flush	2nd Flush	1st Flush	2nd Flush	1st Flush	2nd Flush	1st Flush	2nd Flush	1st Flush	2nd Flush
0	0	0	8	0	8.9	—	193	190	74	92	114	125
1	17	2	34	0	16.3	—	201	194	81	101	121	132
2	48	10	60	1	13.3	7.2b[u]	200	187	90	100	126	129
3	—[v]	26	—	7	—	14.1a	—	198	—	96	—	130
4	—	32	—	7	C	7.0b	—	206	—	101	—	136
5	—	58	—	8	C	9.2ab	—	202	—	89	—	127
Significance[t]	L***	L***	L***	L***	Q*		NS	L*	L*	NS	L*	NS

[z]Average of percent flower abortion assessment made independently by two researchers.

[y]Average length of the 3 longest shoots per plant.

[x]Plant width = (width$_1$ + width 90° to width$_1$) / 2.

[w]Growth index = (height + width$_1$ + width 90° to width$_1$) / 3.

[v]At the first flower flush evaluation (August 7, 2002) only the 1st and 2nd Pistill applications had been made. By the second floral flush evaluation (September 12, 2002) the 3rd, 4th, and 5th Pistill applications had been made; missing values are due to treatment not being applied prior to data collection.

[u]Mean separation by Duncan's Multiple Range Test ($P = 0.05$).

[t]Nonsignificant (NS) or significant linear (L) or quadratic (Q) regression response at $P = 0.05$ (*) or 0.001 (***); control included in analysis.

second floral flush where flower abortion occurred in plants treated with Pistill only during the first floral flush. While 2 and 10% abortion in plants treated once or twice during the first flush is much less than abortion percentages in plants treated only during the second floral flush, results do indicate a slight carryover effect.

Linear increases in flower abortion in response to multiple applications of Pistill were followed by linear increases in axillary shoot formation. The majority of new shoots formed following the first floral flush and Pistill treatments with increases of 325 and 650% with one and two applications compared to the control. No more than eight shoots formed in response to the third, fourth and fifth Pistill applications, probably due to the lateness in the growing season when these treatments were applied. Increases in shoot formation visibly increased plant density.

The average length of the three longest shoots per plant changed quadratically with increasing application number following the first floral flush. Shoots on plants receiving one and two Pistill aplications were 83 and 49% longer than those on control plants, and contributed to the appearance of increased plant density. Following the second floral flush, no new shoots formed on controls or plants receiving one Pistill application during the first flush. Plants receiving two applications during the first flush formed an average of one new shoot 7.2 cm (2.8 in) long. Average new shoot length of

Table 2. Reproductive and vegetative response of *Lagerstroemia* x 'Tuscarora' receiving 1000 ppm Pistill at 7-, 14-, or 21-day intervals during two flowering periods.

Pistill application interval[z] (days)	Flower abortion[y] (%)		New shoot counts		Shoot length[x] (cm)	
	1st Flush	2nd Flush	1st Flush	2nd Flush	1st Flush	2nd Flush
Control	0	0	0	1	—	3.1
7	81	96	96	13	19.5	7.1
14	51	96	108	27	10.8	6.7
21	18	54	2	2	21.5	8.8
Significance[w]	L***	Q***	Q***	Q***	Q***	NS
Contrast statements[v]						
Control vs 7 day interval	***	***	***	**	—	*
Control vs 14 day interval	***	***	***	***	—	NS
Control vs 21 day interval	***	***	NS	NS	—	*

[z]By the 1st flush evaluation 1, 2, and 3 Pistill applications had been made to plants in the 21-, 14-, and 7-day interval (DI) treatments, respectively. By the 2nd flush evaluation an additional 2, 2, and 3 applications had been made to plants in the 21-, 14- and 7-DI treatments. Total Pistill applications made during the experiment were 6 for 7-day interval, 4 for 14-day interval, and 3 for 21-day interval treatments.

[y]Average of percent flower abortion assessment made independently by two researchers.

[x]Mean length of the 3 longest shoots per plant.

[w]Nonsignificant (NS) or significant linear (L) or quadratic (Q) regression response at $P = 0.05$ (*); control not included in analysis.

[v]Contrast nonsignificant (NS) or significant at P = 0.05 (*), 0.01 (**) or 0.001 (***).

plants receiving a third Pistill applications (one application during second flush) was about twice that of plants receiving two applications during the first flush and those receiving a total of four applications, but similar to plants receiving five applications. While significant, these differences contributed less to the appearance of increased density than shoot length following the first floral flush due to the low number of new shoots formed. The number of Pistill applications significantly impacted plant height following the second floral flush, and plant width and GI following the first floral flush; increases of up to 8% in plant height , 22% in plant width, and 11% in GI were noted.

Application interval. Following the first floral flush, the abortion rate increased linearly as interval between Pistill applications decreased (and number of applications increased) (Table 2). Following the first flush, three applications at 7 DI led to 81% flower abortion, whereas two applications at 14 DI and one application at 21 DI led to 51 and 18% abortion, respectively; no flower abortion occurred in control plants. The percentages of flower abortion were higher following the second floral flush. In response to three and two Pistill applications at 7 and 14 DI, respectively, 96% of flowers were aborted, whereas 54% abortion occurred in trees treated twice at 21 DI and none occurred in control plants. Thus, an application interval of 7 or 14 days appears most effective in aborting flowers in crapemyrtle. Regardless of the interval between Pistill applications, results tended to agree with those from the first experiment in which flower abortion increased with an increasing number of Pistill applications.

Following Pistill application during the first floral flush, shoot formation response was quadratic, with 96, 108, and two new shoots forming after 7 DI, 14 DI, and 21 DI Pistill treatment applications, respectively; no new shoots formed on plants in the control treatment. The quadratic response persisted during the second floral flush, with only 13, 27, and two new shoots forming in response to increasing Pistill application interval; again, no new shoots developed on control plants.

The length of the three longest shoots in trees treated at 14 DI were about half that of trees treated at 7 and 21 DI, suggesting that metabolytes to each of its many shoots was more limiting in those trees than in trees with fewer shoots. However, this interpretation doesn't consider that most of the new shoots on the trees were shorter than the three longest, were younger and weaker metabolytes sinks. The average length of the three longest shoots was numerically less following the second floral flush than the first. The interval between Pistill applications did not significantly impact tree height, widths, or overall GI (data not shown).

In summary, profuse flowering, with resultant heavy fruit set and cessation of vegetative growth of 'Tuscarora' crapemyrtle was effectively counteracted by multiple applications of 1000 ppm Pistill. In a previous crapemyrtle study (1), single applications of Pistill effectively aborted flowers present at the time of application but had no effect on subsequently formed inflorescences. Repeat applications at 7-day intervals during flowering were necessary for maximum floral abortion and new shoot stimulation. Although overall plant size was not greatly affected by multiple applications of Pistill in the current season, trees were noticeably denser and considered more marketable.

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