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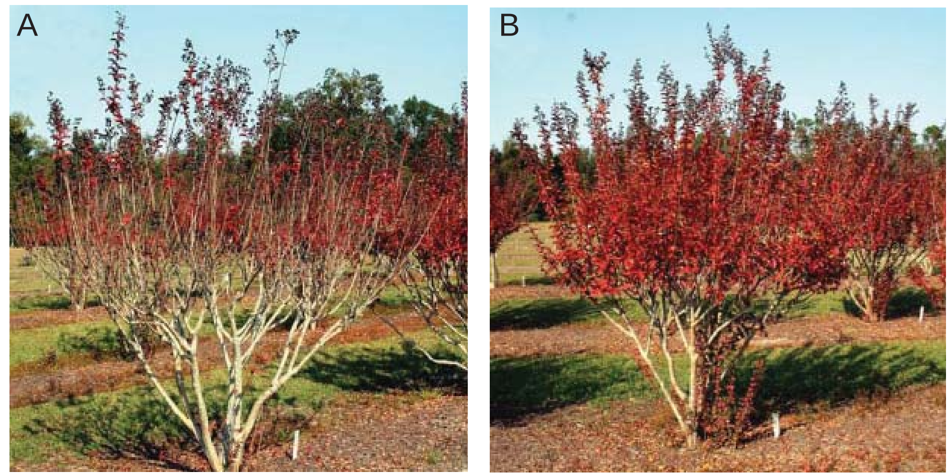
Richard Guthrie, Director
Auburn University, Auburn, Alabama

Cercospora Leaf Spot and Growth of Crapemyrtle as Influenced by Nitrogen Rate

A. K. Hagan



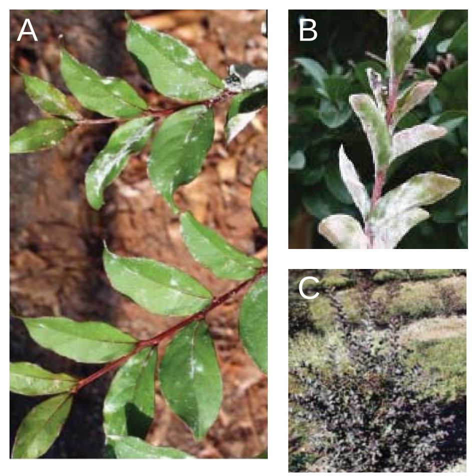


Figure 1, top row above, Cercospora leaf spot. A) Brown leaf spots and reddish leaf discoloration on 'Carolina Beauty' crapemyrtle and B) 'Wonderful White' crapemyrtle defoliated by Cercospora leaf spot.

Figure 2, middle row above, 'Carolina Beauty' crapemyrtle. A) Absence of a fall color display on a defoliated, non-fungicide treated tree compared with B) vibrant reddish-orange fall color display due to increased leaf retention on a Heritage 50WDG-treated tree.

Figure 3, left, Powdery mildew. A) Early sign is circular white colonies of causal fungus on leaves that B) may intensify until entire leaf surface and shoots are colonized and C) the diseased plants turn almost white.

Introduction

Brilliant fall color, handsome bark, and showy flowers have made crapemyrtle (*Lagerstroemia indica* L., *L. indica* x *faurei*) a fixture in Southern landscapes (32,33). While the diseases powdery mildew (*Erysiphe lagerstroemia*) and Cercospora leaf spot (*Cercospora lythracearum*) are not serious health threats to established crapemyrtle (1,2,11), both can greatly detract from the beauty of crapemyrtle in landscape plantings as well as the value of field and container-grown nursery stock (16).

Cercospora leaf spot, which is characterized by tan to dark brown spots randomly scattered on yellow to red discolored leaves (Figure 1), can ruin the fall color display of crapemyrtle (16) (Figure 2); however, impact of this disease as well as that of powdery mildew (Figure 3) on the growth and flowering of crapemyrtle has not been assessed. Recently, damaging outbreaks of Cercospora leaf spot, spot anthracnose, and powdery mildew have been associated with reduced tree growth and/or trunk diameter on flowering dogwood (14,18,25). Similarly, growth of hybrid tea and shrub roses partially defoliated by black spot (4,19) or Cercospora leaf spot (19) was greatly reduced. Bowen et al. (4) also noted that the number of flowers on hybrid tea roses declined as the severity of black spot increased.

Nitrogen (N) rate can influence the severity of diseases of landscape shrubs and trees. Increasing N rates intensify fire blight severity on apple (30), Phytophthora dieback on rhododendron (21), and powdery mildew on flowering dogwood (14). In contrast, resistance of black walnut to anthracnose increased with supplemental N applications (26). Severity of Alternaria leaf spot as well

Hagan is a professor in the Department of Entomology and Plant Pathology, Auburn University.

as leaf spot diseases incited by plant pathogenic bacteria in the genera *Xanthomonas* and *Pseudomonas* on several tropical herbaceous and woody plants fell with increasing N rates (6). With flowering dogwood, increasing N rates may reduce dogwood anthracnose intensity when weather patterns are less than ideal for disease development (3). Intensity of Cercospora leaf spot and to a lesser extent spot anthracnose on flowering dogwood declined when N rates increased from 37.7 pounds to 300 pounds N per acre per year (14).

Few crapemyrtle cultivars are resistant to powdery mildew and Cercospora leaf spot (16,22); therefore, most may be damaged by one or both of these diseases. While fungicides are a control option for both diseases (10,12), considerable time and resources would be needed to maintain a preventive fungicide program in a landscape or nursery setting. While not as effective, adjusting nitrogen rates may be an alternative to fungicides for managing these diseases on crapemyrtle.

The objectives of this study were to evaluate the impact of N rate on the development of powdery mildew and Cercospora leaf spot on crapemyrtle in a simulated landscape planting and to determine the effects of N rate and fungicide applications on plant growth.

Materials and Methods

Plant management. On February 5, 2002, 72 'Carolina Beauty' crapemyrtles (*Lagerstroemia indica)* were planted into a Benndale (A) fine sandy loam at the Brewton Agricultural Research Unit in Brewton, Alabama. According to the results of a pre-plant soil fertility assay, extractable concentrations of phosphorus, potassium, magnesium, and calcium were 66, 66, 140, and 520 pounds per acre, respectively (7). Prior to planting, 1.5 tons per acre of dolomitic limestone and 450 pounds per acre of 5-10-5 analysis fertilizer were broadcast and incorporated. A drip irrigation system with a single emitter per tree was installed before planting and the trees were watered as needed. A 9-foot^2 area of approximately 1 inch of aged pine bark mulch was maintained around the base of each tree and kept weed-free. Centipedegrass (*Eremochola ophiuroides*) alleys separating each row of trees were periodically mowed but not fertilized during the study period. Separate applications of 3.6 ounces of murate of potash (0-0-60 K_2O) and super-phosphate (0-46-0 P_20_4) were made over the mulched area around each tree on March 3, 2003, and March 9, 2004. Directed applications of 1 pound per acre of Gallery® DF plus 2 quarts per acre of Surflan® T/O were made to the mulched area on March 5, 2003, November 3, 2003, April 22, 2004, and March 18, 2005 for pre-emergence weed control. Hand weeding and spot applications of Finale® 1E at 2 fluid ounces per gallon were used to control escaped weeds.

Design. The experimental design was a split plot arranged in six replications with nitrogen (N) rate as the main plot and Heritage 50WDG fungicide treatment as the split plot. Ammonium nitrate (33N-0P_2O_5-0K_2O) was applied at 18.8, 37.5, 75, 150, 300, and 600 pounds N per acre per year for each of the six replications. A quarter of each N rate was evenly distributed over a 2-foot^2 area around the base of each plant in March, April, May, and June of each year. Heritage 50WDG was applied at a rate of 4 ounces per 100 gallons of spray volume to one of two 'Carolina Beauty' crapemyrtle in each replicate, while the second tree was not treated with the fungicide. The fungicide was applied to drip with a CO^2-pressurized sprayer at two-week intervals from May 2 to July 10, 2003, May 5 to July 14, 2004, and May 4 to July 29, 2005. Applications were timed to control powdery mildew.

Data collection and analysis. Cercospora leaf spot intensity was rated using the Horsfall and Barratt rating scale (23) where 0 = 0 percent, 1 = 0 to 3 percent, 2 = 3 to 6 percent, 3 = 6 to 12 percent, 4 = 12 to 25 percent, 5 = 25 to 50 percent, 6 = 50 to 75 percent, 7 = 75 to 87 percent, 8 = 87 to 94 percent, 9 = 94 to 97 percent, 10 = 97 to 100 percent, and 11 = 100 percent of diseased and/or prematurely shed leaves. Cercospora leaf spot-induced defoliation was also rated using the above scale. Ratings for Cercospora leaf spot were recorded on July 16, August 19, September 13, October 2, October 15, October 28, and November 15, 2003; July 29, August 24, September 30, October 27, and November 9, 2004; and June 27, July 27, August 24, October 10, October 25, November 5, and November 16, 2005. Powdery mildew incidence was also assessed using the Horsfall and Barratt rating scale (23) on the above dates. Disease ratings were not recorded in 2002.

Tree height and canopy diameter were measured on January 14, 2004, January 31, 2005, and January 12, 2006. Growth index (GI) was calculated using the following formula: GI = (height + width 1 + width 2)/3. Within one to two weeks after their measurement, each tree was lightly pruned primarily to remove the spent bloom clusters.

In each year, area under the disease progress curve (AUDPC) was calculated for total leaf spot intensity and defoliation attributed to Cercospora leaf spot on crapemyrtle (28). Outliers of AUDPC values were removed from data sets. AUDPC and GI values were transformed to normalize data before conducting analysis of variance (ANOVA) then back-transformed for presentation. ANOVA was done according to a split plot design arrangement of treatments using the GLM procedure. The main factor was N rate and the split plot was fungicide treatment. Significance of interactions was first evaluated. Means were separated using Fisher's protected least significant difference at $P \leq 0.05$.

Results

N rate and powdery mildew. While 'Carolina Beauty' crapemyrtle is susceptible to powdery mildew (16), development of the disease was minimal throughout the study period. In 2003 and 2004, no signs of powdery mildew were noted on the leaves, shoots, flower peduncle, or flower bud scales. On June 27, 2005, light powdery mildew development on the flower peduncle and bud scales was seen on some trees. Powdery mildew incidence was not influenced by N rate (data not shown).

N rate and Cercospora leaf spot. In 2003 and 2004, N rate did not have a significant impact on Cercospora leaf spot total disease intensity or premature defoliation on crapemyrtle. The non-significant N rate x fungicide interaction for total leaf spot density and defoliation values in 2003 and 2004 showed that the impact of N rate on disease development on the fungicide and non-fungicide treated trees was similar.

In 2005 a significant decline in total leaf spot intensity and defoliation was linked with increasing N rates (Figure 4). At 300 and 600 pounds of N per acre, total leaf spot intensity and defoliation values were significantly lower than at 18.8, 37.5, and 75 pounds N per acre. While total leaf spot intensity and defoliation values at 75 and 150 pounds N per acre were similar, trees receiving the higher N rate suffered less leaf spotting and premature defoliation compared with those receiving 18.8 and 37.5 pounds N per acre. As indicated by a non-significant interaction for total leaf spot intensity and defoliation, influence of N rate on Cercospora leaf spot development on the fungicide and non-fungicide treated trees was similar.

Previous studies have shown that increasing N rates are associated with a reduction in the incidence of Cercospora leaf spot on flowering dogwood (14), walnut anthracnose (26), and Alternaria and bacteria-incited diseases of tropical herbaceous and woody foliage plants (6). In the current study, the non-fungicide-treated crapemyrtles receiving the three highest N rates had 50 pecent less leaf spotting and premature defoliation than the crapemyrtles receiving the three lowest N rates on the late October and November rating dates in 2005 (Figures 5 and 6).

Heritage fungicide, Cercospora leaf spot intensity, and crapemyrtle growth. Heritage 50WDG, which was applied from mid-spring through early summer in all study years, greatly reduced the level of Cercospora leaf spot-related leaf spotting and premature defoliation into November (Figure 6). Overall, Heritage 50WDG reduced the level of leaf spotting due to Cercospora leaf spot by 92 percent, 79 percent, and 93 percent in 2003, 2004, and 2005, respectively, compared to non-fungicide treated trees (Table 1). In all three years, similar reductions in Cercospora leaf spot-related defoliation were also obtained.

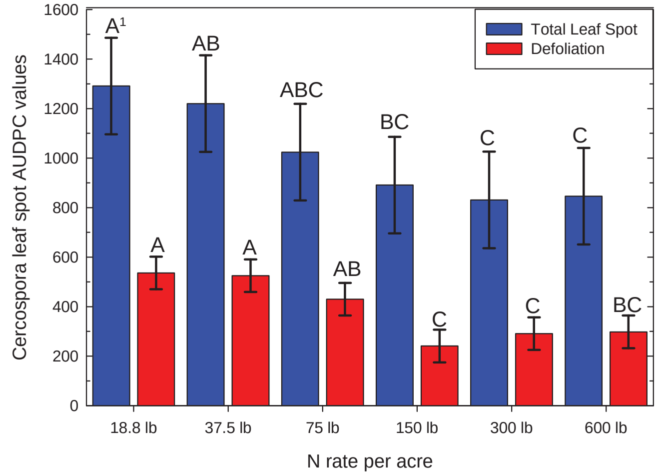


Figure 4, top left. Areas under disease progress curves for Cercospora leaf spot intensity and defoliation in response to N rate in 2005. Values were recorded between July 23 and November 16, 2005. [1]Means for the total leaf spot or defoliation values that are followed by the same letters are not significantly different according to Fisher's protected least significant difference (LSD) test ($P \leq 0.05$).

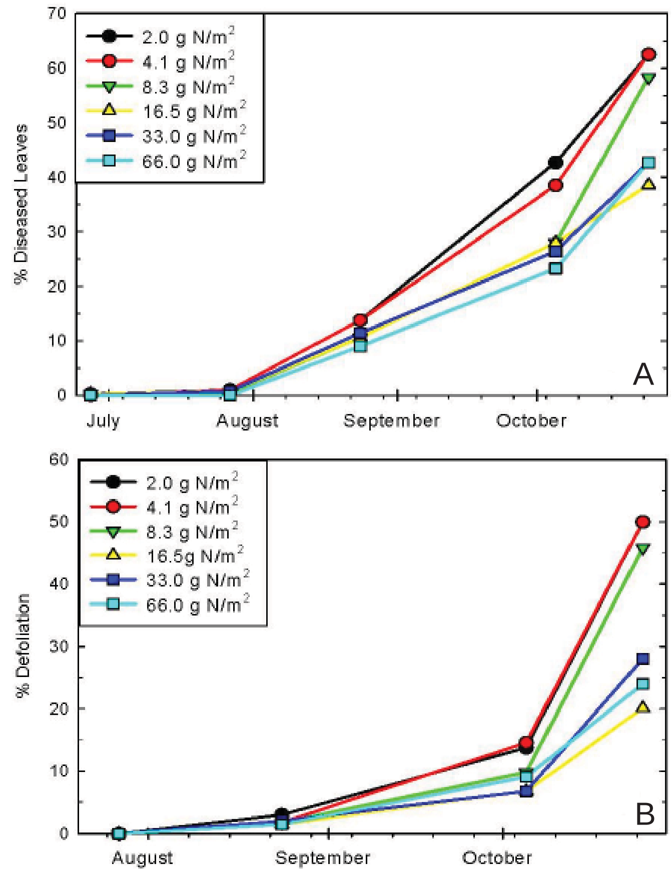


Figure 5, left. A) Influence of N rate on Cercospora leaf spot intensity and B) defoliation during the 2005 growing season.

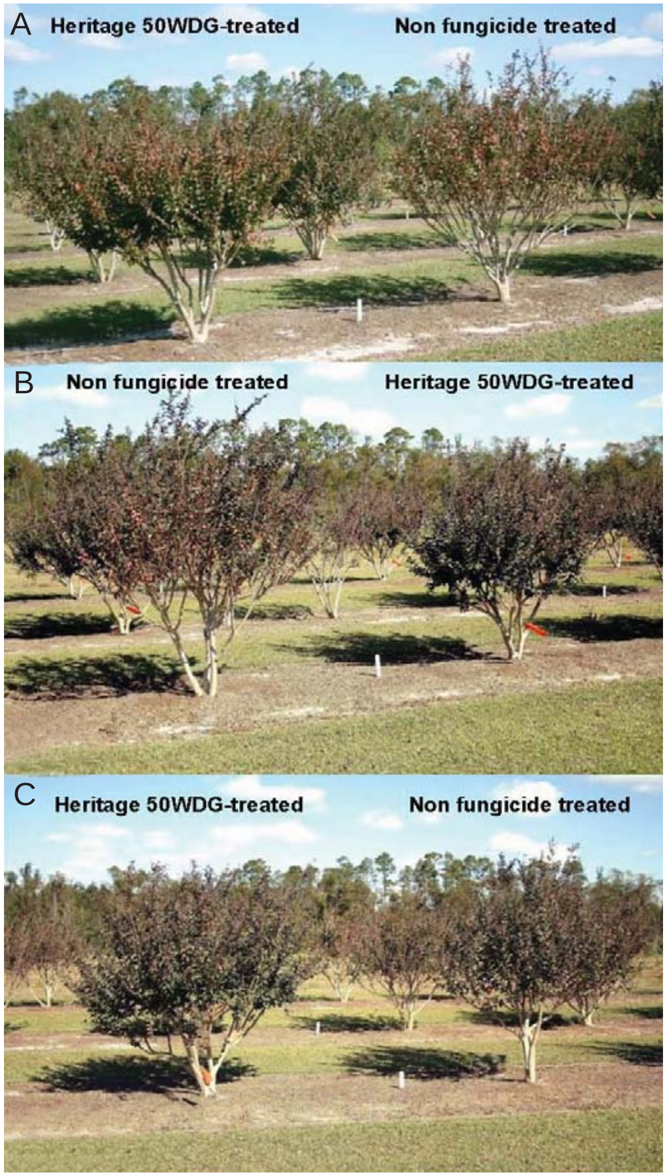


Figure 6. Cercospora leaf spot-incited defoliation on October 25, 2005, on 'Carolina Beauty' crapemyrtle that received A) 18.8 pounds N per acre per year, B) 37.5 pounds N per acre per year, and C) 600 pounds N per acre per year.

Despite sizable reductions in the level of disease-related leaf spotting and premature leaf loss with Heritage 50WDG, growth indices (GI) for the non-fungicide and fungicide-treated crapemyrtle were similar in 2004, 2005, and 2006 (Table 2). Although the control of Cercospora leaf spot with Heritage 50WDG did not result in an increase in tree growth, fungicide-treated trees in October and November, particularly at the lower N rates, had a denser leaf canopy compared with the adjacent non-fungicide treated crapemyrtle (Figure 6A and B). In contrast, little visible difference in leaf canopy density on the Heritage 50WDG- and the non-fungicide-treated trees was seen at the highest N rate (Figure 6C).

While applications of Heritage 50WDG ended in mid- to late-July when Cercospora leaf spot usually begins, this fungicide noticeably slowed disease spread into November (Figure 7). Previously, Heritage 50WDG controlled Cercospora leaf spot on field-grown 'Wonderful White' crapemyrtle (12) and on container-grown bigleaf hydrangea (17). In all years, the GI for the non-treated and fungicide-treated crapemyrtle were similar. This result was especially surprising in 2004, when the level of leaf spotting and defoliation at the November rating dates was noticeably higher than in 2003 and 2005. In a previously published study, damaging outbreaks of Cercospora leaf spot on flowering dogwood were correlated with reduced tree height and trunk diameter (14). In a concurrent study, control of leaf spot, powdery mildew, and spot anthracnose with several fungicides on established 'Rubra' flowering dogwood did not translate into in-

Table 1. Cercospora leaf spot intensity and defoliation on Heritage 50WDG fungicide-treated and non-fungicide-treated crapemyrtle

	2003		2004		2005	
Treatment	Leaf spot[1]	Defoliation	Leaf spot	Defoliation	Leaf spot	Defoliation
No fungicide	3565 a[2]	2018 a	5115 a	3972 a	1905 a	683 a
Treated[3]	275 b	87 b	1063 b	704 b	129 b	23 b

[1]Cumulative leaf spot intensity and defoliation values calculated from total leaf spot and defoliation ratings recorded between July 16 to November 15, 2003, July 29 to November 9, 2004, and July 23 to November 16, 2005.
[2]Means in each column that are followed by the same letters are not significantly different according to Fisher's protected least significant difference (LSD) test ($P \leq 0.05$).
[3]Heritage 50WDG fungicide was applied at approximately two-week intervals between May 2 to July 10, 2003, May 5 to July 14, 2004, and May 4 to July 29, 2005.

Table 2. Impact of Heritage 50WDG fungicide on the growth of 'Carolina Beauty' crapemyrtle

	Growth Index[1]		
Treatment	2004	2005	2006
No fungicide	172[2]	196	202
Heritage 50WDG-treated	167	197	200

[1]Growth Index = (height + width 1 + width 2)/3.
[2]Means did not differ significantly according to Fisher's protected least significant difference (LSD) test $P \leq 0.05$.

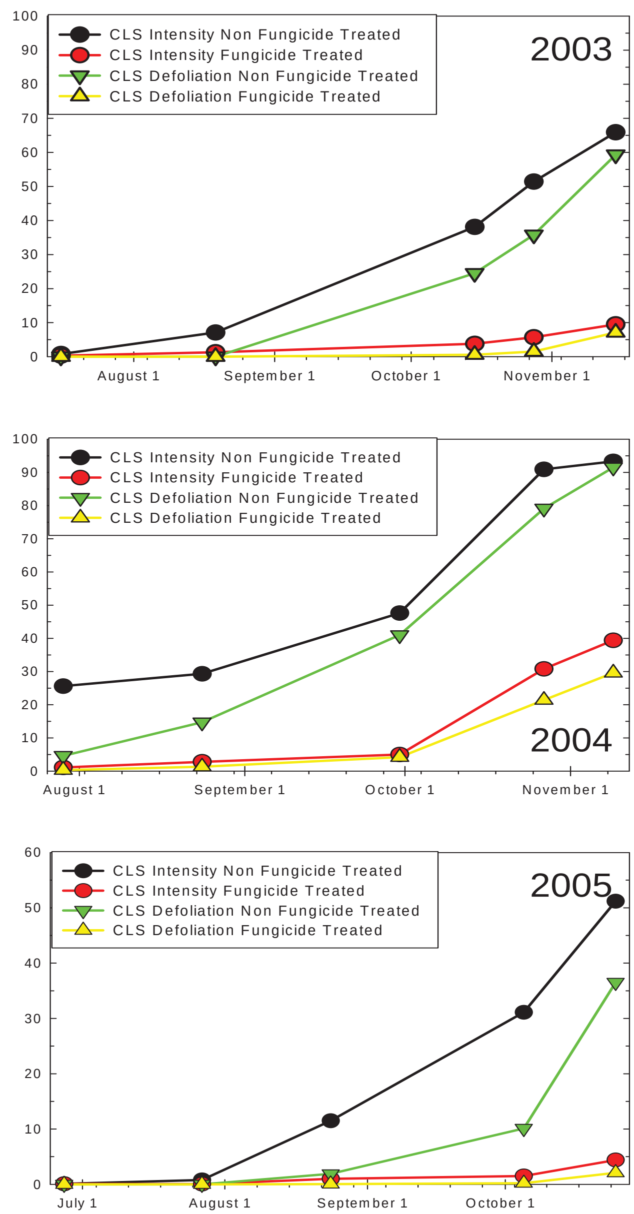


Figure 7. Impact of fungicide treatment on Cercospora leaf spot (CLS) intensity and defoliation on 'Carolina Beauty' crapemyrtle in 2003, 2004, and 2005. (Six fungicide applications were made each year, beginning the first week of May and ending the second week of July, except in 2005 when seven fungicides applications were made, ending the fourth week of July).

creased shoot elongation or trunk diameter (13). In contrast, control of severe powdery mildew on container-grown 'First Lady' flowering dogwood with one of several fungicides resulted in a sizable increase in canopy spread and trunk diameter (18). In addition, increased shoot growth and flower bud numbers on hybrid tea and shrub roses have resulted from the control of black spot and Cercospora leaf spot with protective fungicides (4,19).

N rate and crapemyrtle growth. Since the N rate GI values for the non-treated and fungicide-treated crapemyrtle, as indicated by a non-significant N rate x fungicide interaction, were similar, growth data for the non-treated and fungicide-treated crapemyrtle from the January 2004, 2005, and 2006 rating dates were pooled. In all three years, crapemyrtle growth was not impacted by N rate.

Failure to observe differences in the growth of 'Carolina Beauty' crapemyrtle (*L. indica*) related to increasing N rates over the three-year study period was unexpected. Unfortunately, relatively little information is available concerning the growth response of container- or field-grown crapemyrtle to N inputs. Cabrera and Devereaux (5) noted that containerized crapemyrtle are known among nursery producers as being heavy feeders, i.e. the growth response of crapemyrtle is proportional to N fertilization rate. For containerized 'Tonto' crapemyrtle (*L. indica* x *fauriei*) grown in a sphagnum peat moss, vermiculite, and sand media (2:1:1 ratio by volume), shoot biomass, leaf area, and canopy diameter rose as N rate increased from 15 to 60 mg per liter and these parameters declined at higher N rates due to tree sensitivity to high soluble salt levels (5). In contrast, little difference in stem cross-section area was noted over a two-year period for established 'Natchez' crapemyrtle (*L. indica* x *fauriei*) receiving no supplemental N compared with 89 pounds N per acre per year (24). Recently, Hagan et al. (15) noted that trunk diameter and height of field-grown flowering dogwood was not impacted by N rate until three and four years, respectively, after transplanting and initial N application. Delays ranging from 18 months to four years after transplanting in responding to N inputs have previously been reported for bare-root (31), containerized (9), balled and burlaped (8,9) and established landscape trees (27). In contrast, N applications at-planting resulted in significant increases in height and shoot length within six months following the transplanting of container-grown southern magnolia (20). Treatment interference due to shared root zones, high fertility of native soils, and sod competition may increase the difficulty in assessing shade tree growth response to N inputs (29).

Summary

While we were able to demonstrate that elevated N rates slowed the development of Cercospora leaf spot on crapemyrtle in one of three years, effectiveness of using N as a tool for managing this disease, particularly on established trees in residential or commercial landscapes is doubtful. The annual application of 40 to 70 pounds N per acre per year, which is currently recommended for landscape plantings of crapemyrtle (33), is well below 300 to 600 pounds per acre per year, which noticeably reduced leaf spotting and premature defoliation due to Cercospora leaf spot. While the Heritage 50WDG fungicide proved highly effective in controlling Cercospora leaf spot and greatly enhanced leaf retention and ultimately fall color of 'Carolina Beauty' crapemyrtle, control of this disease did not translate into enhanced plant growth. Given the concerns about N contamination of surface and ground water as well as health risks and expense of a protective fungicide program, the most effective control is the establishment of a Cercospora leaf spot and powdery mildew resistant crapemyrtle cultivar such as 'Apalachee', 'Basham's Party Pink', 'Caddo', 'Fantasy', 'Sarah's Favorite', 'Tonto', 'Tuskegee', and 'Tuscarora' (16). We also showed that N rate had little effect on crapemyrtle growth. While container-grown crapemyrtle may be a heavy feeder of N, 'Carolina Beauty' crapemyrtle, with its low N requirements, fits the description of a low maintenance landscape plant.

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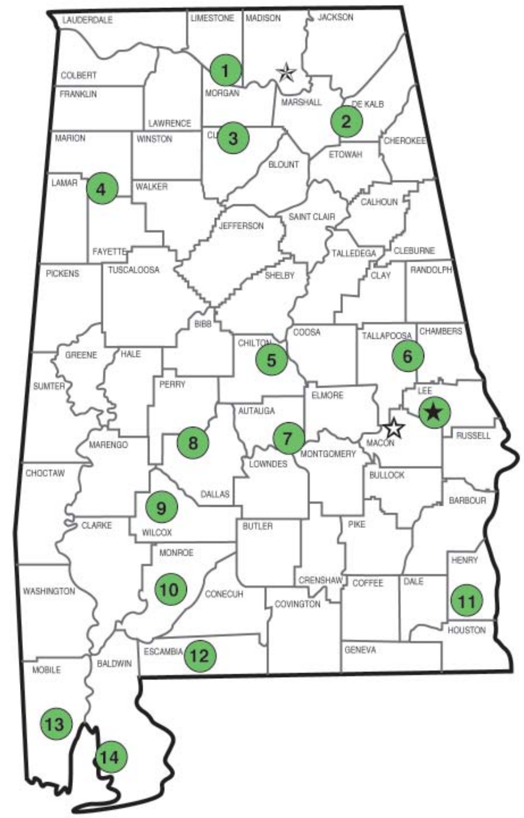

Research Unit Identification

★ Main Agricultural Experiment Station, Auburn.
☆ Alabama A&M University.
☆ E. V. Smith Research Center, Shorter.

1. Tennessee Valley Research and Extension Center, Belle Mina.
2. Sand Mountain Research and Extension Center, Crossville.
3. North Alabama Horticulture Research Center, Cullman.
4. Upper Coastal Plain Agricultural Research Center, Winfield.
5. Chilton Research and Extension Center, Clanton.
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