Influence of Nitrogen Rate on Cercospora Leaf Spot and Growth of Crapemyrtle

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Abstract
The impact of N rate on development of Cercospora leaf spot on field grown ‘Carolina Beauty’ crapemyrtle and the impact of this disease, as well as N rate, on plant growth was assessed in Alabama. From 2002 to 2005, ammonium nitrate was applied at an N rate of 2, 4.1, 8.3, 16.5, 33.0, and 66.0 g/m². Heritage 50W fungicide was applied to one tree in each plot, while the second tree was not treated. Powdery mildew was very sporadic and was not related to N rate. An N rate-related reduction in Cercospora leaf spot intensity and defoliation was noted on the non-fungicide and fungicide treated trees in 2005 but not in 2003 and 2004. In 2005, reductions in disease intensity and defoliation were obtained at the three highest N rates of 16.5, 33, and 66 g/m² compared to the two lowest N rates of 2 and 4.1 g/m². Regardless of N rate, Heritage 50W suppressed Cercospora leaf spot. Despite considerable leaf spotting and premature defoliation, Cercospora leaf spot did not impact crapemyrtle growth. Increasing N rates was less effective than Heritage 50W fungicide in controlling Cercospora leaf spot and also failed to enhance tree growth.

Introduction
Brilliant fall color, handsome bark, and showy flower panicles have made crapemyrtle (Lagerstroemia indica L., L. indica × faurei) a fixture in Southern landscapes (21,22). While the diseases powdery mildew (Erysiphe lagerstroemia E. West) and Cercospora leaf spot (Cercospora lythracearum Heald & F. A. Wolf) are not considered significant health threats to established crapemyrtle (1,6), both can greatly detract from their beauty in landscape plantings as well as the value of nursery stock (10).

Cercospora leaf spot, which is characterized by tan to brown leaf lesions, yellow to red leaf discoloration (Fig. 1A) and premature defoliation (Fig. 1B), can ruin the fall color display of crapemyrtle; however, impact of this disease as well as that of powdery mildew on growth and flowering of crapemyrtle has not been assessed. Recently, outbreaks of Cercospora leaf spot, spot anthracnose, and powdery mildew have been associated with reduced growth and/or trunk diameter on flowering dogwood (8,9,11,17).
Nitrogen rate can influence the severity of diseases of landscape shrubs and trees. Elevated N rates increase fire blight severity on apple (20), Phytophthora dieback on rhododendron (13), and powdery mildew on flowering dogwood (9). In contrast, resistance of black walnut to anthracnose was enhanced with supplemental N (18). Severity of Alternaria leaf spot as well as leaf spot diseases incited by bacteria in the genera *Xanthomonas* and *Pseudomonas* on herbaceous and woody plants declined with increasing N rates (4). With flowering dogwood, increasing N rates may reduce dogwood anthracnose intensity when weather patterns are less than ideal for disease development (2). Intensity of Cercospora leaf spot and to a lesser extent spot anthracnose on flowering dogwood declined when N rates increased from 4.1 to 33 g/m² (9).

Few crapemyrtle cultivars are resistant to powdery mildew and Cercospora leaf spot (10,14). While fungicides are a control option (6,7), considerable time and resources are required for maintaining a preventative fungicide program in a landscape or nursery setting. While not as efficacious as a fungicide, adjusting N rates may be an alternative 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 determine their effects on plant growth.

**Assessing Impact of N on Cercospora Leaf Spot and Growth of Crapemyrtle**

**Plant management.** Less than one year old rooted liners of ‘Carolina Beauty’ crapemyrtle (*Lagerstroemia indica*), which is susceptible to powdery mildew and Cercospora leaf spot (10), were potted in June 2001 into 3-gal containers filled with a 3:1 mix of pine bark and peat moss amended with 4.9 kg of Osmocote 17-7-12, 2.1 kg of dolomitic limestone, 0.7 kg of gypsum, and 0.5 kg of Micromax per m³ of potting mixture. On 5 February 2002, crapemyrtles were planted into a Benndale (A) fine sandy loam (< 1% organic matter) at the Brewton Agricultural Research Unit in Brewton, AL. According to a pre-plant soil fertility assay, Mehlich 1 extractable concentrations of phosphorus, potassium, magnesium, and calcium were 33, 33, 70, and 260 mg/kg of soil, respectively (5). Prior to planting, 1.65 metric tons/ha of dolomitic limestone and 495 kg/ha of 5-10-5 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 0.3 m² square of approximately 2.5 cm of aged pine bark mulch was maintained around the base of each tree and was kept weed-free. Centipedegrass (*Eremochola ophiuroides*) alleys separating each row of trees were mowed but not fertilized during the study period. Separate applications of 85 g of murate of potash (0-0-60 K₂O) and super-phosphate (0-46-0 P₂O₅) were made over the mulched area around each tree on 3 March 2003 and 9 March 2004. Directed applications of 0.68 kg ai/ha of Gallery DF plus 2.2 kg ai/ha of Surflan T/O were made to the mulched area on 5 March 2003, 3
November 2003, 22 April 2004, and 18 March 2005 for pre-emergence weed control. Hand weeding and spot applications of Finale 1E at 1.9 g ai/liter were used to control escaped weeds.

**Design.** The experimental design was a split plot consisting of 72 trees arranged in six replications with nitrogen rate as the main plot and Heritage 50W fungicide treatment as the split plot. Ammonium nitrate was applied at 2, 4.1, 8.3, 16.5, 33, and 66 g of nitrogen per m² per year. A quarter of each N rate was evenly distributed over a 0.2 m² area around the base of each plant in March, April, May, and June of each year. Heritage 50W (azoxystrobin, Syngenta Professional Products, Greensboro, NC) at a rate of 1.6 g ai/liter of spray volume was applied to one of two crapemyrtles in each replicate, while the second tree was non-treated. Fungicide applications were made until runoff with a CO₂-pressurized sprayer at 2-week intervals from 2 May to 10 July 2003, 5 May to 14 July 2004, and 4 May to 29 July 2005.

**Data collection and analysis.** Cercospora leaf spot intensity was rated using the Horsfall and Barratt rating scale (15) where 0 = 0%, 1 = 0 to 3%, 2 = 3 to 6%, 3 = 6 to 12%, 4 = 12 to 25%, 5 = 25 to 50%, 6 = 50 to 75%, 7 = 75 to 87%, 8 = 87 to 94%, 9 = 94 to 97%, 10 = 97 to 100%, and 11 = 100% disease and/or prematurely shed leaves. Defoliation was also rated using the above scale. In 2003, 2004, and 2005, disease ratings were recorded at 3- to 4-week intervals beginning in June or July and ending in November shortly before the first frost. Powdery mildew incidence was assessed using the above rating scale (15) on these same dates. Horsfall and Barratt rating values for Cercospora leaf spot intensity and defoliation were transformed back to percentages for presentation and calculation of AUDPC values.

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

Area under the disease progress curve (AUDPC) was calculated for Cercospora leaf spot intensity (AUDPCI) and defoliation (AUDPCD) (19). Outliers of AUDPC values (defined as ± three standard deviations from the mean) were removed from data sets. AUDPC and GI values were transformed using natural logarithm to normalize data before conducting analysis of variance (ANOVA) then back-transformed for presentation. ANOVA was done according to a split-plot design of treatments using the GLM procedure (SAS 9.1: SAS Institute Inc., Cary, NC). The main factor was N application rate and the split plot was fungicide treatment. Significance of interactions was first evaluated. Means of transformed data were separated using the least significant difference (LSD) test at \( P \leq 0.05 \).

### N Rate and Powdery Mildew

While ‘Carolina Beauty’ crapemyrtle is susceptible to powdery mildew (10), disease incidence was minimal. In 2003 and 2004, no signs of powdery mildew were noted on the leaves, shoots, flower peduncle, or flower bud scales. On 27 June 2005, light colonization of the flower peduncle and bud scales by *E. lagerstroemia* was noted on some trees. Powdery mildew incidence was not influenced by N rate (data not shown).

### N Rate Impact on Cercospora Leaf Spot

In 2003 and 2004, N rate did not have a significant impact on Cercospora leaf spot intensity (AUDPCI) or premature defoliation (AUDPCD) on crapemyrtle. The non-significant N rate × fungicide interaction for AUDPCI and AUDPCD values in 2003 (\( P = 0.08 \) and 0.66, respectively) and 2004 (\( P = 0.85 \) and 0.85, respectively) showed that the impact of N rate on disease development was the same regardless of fungicide treatment.

In 2005, a significant reduction in Cercospora leaf spot intensity (AUDPCI) and defoliation (AUDPCD) was associated with increasing N rates (Table 1). At 33 and 66 g of N per m², AUDPCI and AUDPCD values were significantly lower than at 2, 4.1, and 8.3 g of N per m². While AUDPCI and AUDPCD values at 8.3...
and 16.5 g of N per m² were similar, trees receiving the latter N rate suffered less leaf spotting and defoliation compared with 2 and 4.1 g of N per m². As indicated by a non-significant interaction for AUDPCI and AUDPCD ($P = 0.44$ and 0.92, respectively), influence of N rate on Cercospora leaf spot on the fungicide and non-fungicide treated trees was similar.

Table 1. Areas under disease progress curve for Cercospora leaf spot intensity (AUDPCI) and defoliation (AUDPCD) in response to N rate in 2005.

<table>
<thead>
<tr>
<th>Nitrogen rate (g/m²)</th>
<th>Cercospora leaf spot x</th>
<th>AUDPCI</th>
<th>AUDPCD</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.0</td>
<td>1291 a&lt;sup&gt;y&lt;/sup&gt;</td>
<td>187 a&lt;sup&gt;y&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>4.1</td>
<td>1220 ab</td>
<td>178 a</td>
<td></td>
</tr>
<tr>
<td>8.3</td>
<td>1024 ab</td>
<td>144 ab</td>
<td></td>
</tr>
<tr>
<td>16.5</td>
<td>891 bc</td>
<td>101 c</td>
<td></td>
</tr>
<tr>
<td>33.0</td>
<td>831 c</td>
<td>80 c</td>
<td></td>
</tr>
<tr>
<td>66.0</td>
<td>846 c</td>
<td>91 bc</td>
<td></td>
</tr>
</tbody>
</table>

<sup>x</sup> AUDPCI and AUDPCD calculated from leaf spot intensity and defoliation ratings, respectively, between 23 July and 16 November 2005.

<sup>y</sup> Means followed by the same letter(s) in a column are not significantly different according to LSD ($P \leq 0.05$).

Previously, studies showed that increasing N rates were associated with a reduction in the incidence of Cercospora leaf spot on flowering dogwood (9), walnut anthracnose (18), as well as Alternaria and bacterial diseases of herbaceous and woody foliage plants (4). The October and November disease ratings in 2005 in the current study showed an often sizable reduction in disease intensity and defoliation on non-fungicide-treated trees between the three highest and the three lowest N rates (Fig. 2).
Fig. 2. Influence of N rate on Cercospora leaf spot intensity (A) and defoliation (B) in 2005 on the non-treated crapemyrtle.
Impact of Fungicide Treatment on Cercospora Leaf Spot and Tree Growth

Heritage 50W applied from early May through mid to late July reduced Cercospora leaf spot and premature defoliation into November (Fig. 4). Overall, Heritage 50W reduced Cercospora leaf spot intensity (AUDPCI) by 92%, 79%, and 93% in 2003, 2004, and 2005, respectively, compared to non-treated trees (Table 2). In all 3 years, similar reductions in AUDPCD for defoliation were obtained with Heritage 50W. Despite sizable reductions in leaf spotting and premature defoliation with Heritage 50W, growth indices (GI) for fungicide-treated and non-treated crapemyrtle were similar in 2004, 2005, and 2006 (Table 3). In October and November, fungicide-treated trees had a denser leaf canopy with vivid orange-yellow fall color compared to non-treated crapemyrtle (Fig. 3).

Table 2. Cercospora leaf spot intensity (AUDPCI) and associated defoliation (AUDPCD) on crapemyrtle treated with and without the fungicide Heritage 50W.

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-treated</td>
<td>3565 a</td>
<td>2018 a</td>
<td>5115 a</td>
<td>3972 a</td>
<td>1905 a</td>
<td>683 a</td>
</tr>
<tr>
<td>Treated</td>
<td>275 b</td>
<td>87 b</td>
<td>1063 b</td>
<td>704 b</td>
<td>129 b</td>
<td>23 b</td>
</tr>
</tbody>
</table>


y Mean separation was done on transformed data [ln(AUDPC)]; data present were back-transformed. Means followed by the same letters in a column are not significantly different according to LSD ($P \leq 0.05$).

z Heritage 50W fungicide was applied at approximately 2-week intervals between 2 May and 10 July 2003, 5 May and 14 July 2004, and 4 May and 29 July 2005.

Table 3. Impact of Heritage 50W fungicide on the growth of ‘Carolina Beauty’ crapemyrtle.

<table>
<thead>
<tr>
<th>Fungicide treatment</th>
<th>Growth index (GI) 2004</th>
<th>Growth index (GI) 2005</th>
<th>Growth index (GI) 2006</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-treated</td>
<td>172 y</td>
<td>196 y</td>
<td>202 y</td>
</tr>
<tr>
<td>Treated</td>
<td>167</td>
<td>197</td>
<td>200</td>
</tr>
</tbody>
</table>

x Growth Index = (height + width 1 + width 2) / 3.

y Means were not significantly different according to LSD ($P \leq 0.05$).

Fig. 3. Defoliation of crapemyrtle caused by Cercospora leaf spot on 25 October 2005 in treatments with (A) 2.0 g of N per m²/year and (B) 66 g of N per m²/year. In both images, the fungicide-treated tree is on the left.
Fig. 4. Impact of fungicide treatment on Cercospora leaf spot intensity and defoliation on 'Carolina Beauty' crapemyrtle in 2003, 2004, and 2005. (Fungicide applications each year totaled six and began the first week of May and ended the second week of July, except in 2005 when sprays totaled seven and ended the fourth week of July).
While applications of Heritage 50W ceased at Cercospora leaf spot onset in mid- to late-July, this fungicide delayed disease development and spread. Previously, Heritage 50W was shown to be efficacious in controlling Cercospora leaf spot on field-grown ‘Wonderful White’ crapemyrtle (8). In all three years, the GI for non-treated and fungicide-treated crapemyrtle was similar. This result was especially surprising in 2004, when the level of leaf spotting and defoliation in November was noticeably higher compared to 2003 and 2005. Previously, reduced plant growth has been associated with outbreaks of Cercospora leaf spot on flowering dogwood (9) and rose (12).

**Crapemyrtle Growth as Influenced by N Rate**

The N rate × fungicide treatment interaction was not significant for GI in any year ($P = 0.3493$, $0.3353$, and $0.1643$ for 2004, 2005, and 2006, respectively). Growth data, pooled over fungicide treatment were not affected by N rate in any study year (Table 4).

<table>
<thead>
<tr>
<th>Nitrogen rate (g/m²)</th>
<th>Growth index$^x$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2004</td>
</tr>
<tr>
<td>2.0</td>
<td>168$^Y$</td>
</tr>
<tr>
<td>4.1</td>
<td>162</td>
</tr>
<tr>
<td>8.3</td>
<td>173</td>
</tr>
<tr>
<td>16.5</td>
<td>172</td>
</tr>
<tr>
<td>33.0</td>
<td>171</td>
</tr>
<tr>
<td>66.0</td>
<td>173</td>
</tr>
</tbody>
</table>

$^x$ Growth index = (height + width 1 + width 2) / 3.

$^Y$ Means were not significantly different according to LSD ($P \leq 0.05$).

The lack of differences in annual growth response of ‘Carolina Beauty’ crapemyrtle to increasing N-rates over the 3-year period was unexpected. Unfortunately, relatively little information is available concerning the growth response of container- or field-grown crapemyrtle to N. Cabrera and Devereaux (3) noted that containerized crapemyrtle have a reputation among nursery producers as being a ‘heavy feeder’, i.e. crapemyrtle growth response is proportional to N rate. Shoot biomass, leaf area, and canopy diameter of containerized ‘Tonto’ crapemyrtle rose as N rate increased from 15 to 60 mg/liter and a decline in these growth parameters with higher N rates was attributed to tree sensitivity to elevated soluble salt levels (3). In contrast, little difference in stem cross-section area were noted over a 2-year period for established ‘Natchez’ crapemyrtle receiving no supplemental N compared with those annually receiving 9.8 g of N per m² (16).

While we were able to demonstrate that elevated N rates slowed the development of Cercospora leaf spot on crapemyrtle in 2005, effectiveness of using N for managing this disease on established trees is doubtful. The 4.4 to 7.7 g/m² N rate, which is currently recommended for landscape plantings (22), is well below the 33 to 66 g/m² N rates where a noticeable reduction in leaf spotting and defoliation was noted in 2005. Heritage 50W fungicide proved highly effective in controlling Cercospora leaf spot, and enhancing leaf retention and fall color, but did not influence tree growth. We also showed that N rate had little effect on crapemyrtle growth. Given the concerns about N contamination of surface and ground water and the expense of a protective fungicide, the most effective control of Cercospora leaf spot is the establishment of a resistant crapemyrtle cultivar (10,14).
Literature Cited