Instrata Fungicide Evaluated for Control of Cercospora Leaf Spot on Crapemyrtle[1]

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Abstract

Efficacy of Instrata™ 3.61E at rates of 0.54, 0.74, and 1.11 g ai·liter^{-1} was compared with recommended rates of the its component fungicides Daconil Ultrex 82.5WDG (chlorothalonil), Banner MAXX 1.3MEC (propiconazole), and Medallion 50W (fludioxonil) as well as Eagle 40W, Heritage 50WDG, and 3336 4.5F fungicide standards for the control of Cercospora leaf spot (*Cercospora lythracearum*) on field grown 'Byer's Wonderful White' crapemyrtle (*Lagerstroemia indica*) in 2007 and 2008. Efficacy of Instrata 3.61E for the control of Cercospora leaf spot on crapemyrtle was significantly impacted by application rate. Cercospora leaf spot intensity and defoliation AUDPC values as well as final disease ratings usually were lower for the 1.11 compared with the 0.54 g ai·liter^{-1} rates of Instrata 3.61E, while those of the 0.74 g ai·liter^{-1} rate were intermediate. The 1.11 g ai·liter^{-1} but not lower rates of Instrata 3.61E gave superior Cercospora leaf spot control in both study years when compared with the Daconil Ultrex 82.5WDG, Banner MAAX 1.3MEC, and Medallion 50W component fungicides with the two former fungicides providing some control in one of two years and the latter failing to reduce disease intensity or defoliation. Eagle 40W, Heritage 50WDG, and 3336 4.5F proved equally effective as the 1.11 g ai·liter^{-1} rate of Instrata 3.61E in controlling Cercospora leaf spot in 2007 but only Eagle 40W gave comparable disease control in 2008, while Heritage 50WDG and 3336 4.5F were generally less efficacious than all rates of Instrata 3.61E. In one of two years, better disease control was obtained with Eagle 40W when compared with the 3336 4.5F and Heritage 50WDG standards. Overall, efficacy of the 1.11 g ai·liter^{-1} rate of Instrata 3.61E for the control of Cercospora leaf spot on crapemyrtle was superior to not only the label rate of each component fungicide but also to the fungicide standards in one of two study years.

Index words: *Lagerstroemia indica*, *Cercospora lythracearum*, fungicide, Daconil Ultrex 82.5WDG, chlorothalonil, Banner MAXX 1.3MEC, propiconazole, Medallion 50W, fludioxonil, Eagle 40W, myclobutanil, Heritage 50WDG, azoxystrobin, 3336 4.5F, thiophanate-methyl, disease control.

Species used in this study: *Lagerstroemia indica* 'Byer's Wonderful White'.

Chemicals used in this study: Instrata 3.61E [chlorothalonil (tetrachloroisophthalonitrile) + propiconazole (1-[[2(2,4-dichlorophenyl)-4-propyl-1,3-dioxolan-2-yl]methyl]1-H-1,2,4-triazole) + fludioxonil (4-(2,2-difluoro-1,3-benzodioxol-4-yl)-1*H*-pyrrole-3-carbonitrile)]; Daconil Ultrex 82.5WDG (chlorothalonil, tetrachloroisophthalonitrile); Banner MAXX 1.3MEC (propiconazole, 1-[[2(2,4-dichlorophenyl)-4-propyl-1,3-dioxolan-2-yl]methyl]1-H-1,2,4-triazole); Medallion 50W (fludioxonil, 4-(2,2-difluoro-1,3-benzodioxol-4-yl)-1*H*-pyrrole-3-carbonitrile); Eagle 40W (myclobutanil, a-butyl-a-(chlorophenyl)-1*H*-1,2,4 triazole-1-propanenitrile); Heritage 50WDG (azoxystrobin, methyl (*E*)-2-(2-[6-(2-cyano-phenoxy)pyrimidin-4-yloxy]phenyl)-3-methoxyacrylate); 3336 4.5F (thiophanate-methyl, dimethyl 4,4′-(*o*-phenylene)bis(3-thioallophanate)).

Significance to Nursery Industry

In Alabama, Cercospora leaf spot is the most common and damaging disease of crapemyrtle in the landscape and nursery. Instrata™ 3.61E was screened along with each of its component fungicides, Daconil Ultrex® 82.5WDG, Banner MAXX® 1.3MEC, and Medallion® 50W, as well as 3336® 4.5F, Eagle® 40W, and Heritage® 50WDG for the control of Cercospora leaf spot on field grown 'Byer's Wonderful White' crapemyrtle (*L. indica*). With Instrata 3.61E, superior disease control was often obtained with the 1.11 as compared with 0.54 and to a lesser extent the 0.74 g ai·liter^{-1} rates. In addition, significant reductions in the season-long leaf spotting and premature defoliation were obtained with the 1.11 g ai·liter^{-1} rate of Instrata 3.61E than with the label rate of the Daconil Ultrex 82.5WDG, Banner MAXX 1.3MEC, and Medallion 50W component fungicides. Of the latter fungicides, Daconil 82.5WDG and Banner MAXX 1.3MEC but not Medallion 50W significantly reduced Cercospora leaf spot intensity and defoliation in both study years when compared with the non-treated control. While the Eagle 40W, Heritage 50WDG, and 3336 4.5F standards significantly reduced disease when compared with the non-treated control, only the former fungicide proved as efficacious in controlling Cercospora leaf spot as Instrata 3.61E at the 1.11 g ai·liter^{-1} rate in both study years as compared with one of two years with the latter two fungicides. The above fungicide standards also controlled Cercospora leaf spot better than the component fungicides Daconil Ultrex 82.5WDG and Banner MAXX 1.3MEC in one of two years and Medallion 50W in both years. Overall, the most effective disease control was obtained with the 1.11 g ai·liter^{-1} rate of Instrata 3.61E and to a lesser extent with the 0.74 g ai·liter^{-1} rate of the same fungicide as well as Eagle 40W, Heritage 50WDG, and Banner MAXX 1.3MEC. While a protective fungicide program for managing Cercospora leaf spot on crapemyrtle has a place in a commercial nursery as a means of maintaining crop marketability, establishment of disease-resistant cultivars is the preferred method of avoiding disease outbreaks in residential and commercial landscapes. Currently, Instrata 3.61E has a federal registration for the control of diseases of amenity turf but not on herbaceous and woody ornamentals.

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).

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While powdery mildew (*Erysiphe lagerstroemia* E. West) is most recognized (1), Cercospora leaf spot [*Pseudocercospora lythracearum* (Heald & F.A. Wolf) X.J. Liu & Y.L. Guo (syn. Cercospora lythracearum Heald & F. A. Wolf)] is the dominant disease on crapemyrtle in Alabama landscapes and nurseries (6, 7). Cercospora leaf spot on crapemyrtle, which is characterized by tan to brown leaf lesions along with cultivar specific yellow to red leaf discoloration and premature defoliation, often ruins the fall color display of most crapemyrtle cultivars but does not impact the growth or survival of established trees (2, 11). While elevated nitrogen rates slowed Cercospora leaf spot development, superior disease control on field-grown 'Carolina Beauty' crapemyrtle was obtained with the fungicide Heritage 50WDG (11). A number of crapemyrtle cultivars are resistant to powdery mildew; few are resistant Cercospora leaf spot (12, 14).

Instrata™ 3.61E is a formulated product consisting of chlorothalonil (359.5 g ai·liter^{-1}) (Daconil Ultrex® 82.5WDG), propiconzaole (56.3 g ai·liter^{-1}) (Banner MAXX® 1.3 MEC), and fludioxonil (14.5 g ai·liter^{-1}) (Medallion® 50W). All Instrata component fungicides are labeled for the control of *Cercospora* spp.-incited leaf spot diseases on herbaceous or woody ornamentals. Efficacy of Instrata 3.61E as well as the component fungicides for the control of Cercospora leaf spot on crapemyrtle is not well established. Effective control of Cercospora leaf spot on field-grown 'Byer's Wonderful White' crapemyrtle was obtained with a retail formulation of propiconazole (ferti-loam® Systemic Fungicide) (9). Heritage® 50WDG, and Bayer Advanced Disease Control for Roses, Flowers, and Shrubs (tebuconazole). Banner MAXX 1.3 MEC, Eagle 40W, and 3336 4.5F provided effective in controlling Cercospora leaf spot on field-grown flowering dogwood (10). Cercospora leaf spot on Fuchsia Meidiland® landscape rose was controlled with Daconil Ultrex 82.5WDG, Eagle® 40W, and Heritage 50WDG (8). While 3336™ 50W reduced Cercospora leaf spot intensity on 'Nikko Blue' bigleaf hydrangea, disease development was suppressed with recommended rates of Heritage 50WDG applied at one- to three-week intervals as well as Eagle 40W applied on a two-week schedule (13). The objective of this study was to compare the effectiveness of selected rates of Instrata 3.61E, as well as the individual fungicide components Daconil Ultrex 82.5WDG, Banner MAXX 1.3MEC, and Medallion 50W, and the selected fungicide standards 3336® 4.5F, Eagle 40W, and Heritage 50WDG at label rates for the control of Cercospora leaf spot on established crapemyrtle.

Materials and Methods

Plant culture. In February 2004, 'Byer's Wonderful White' crapemyrtle (*Lagerstroemia indica*) were transplanted into a Benndale sandy loam soil (≤ 1% organic material) at the Brewton Agricultural Research Unit (USDA Hardiness Zone 8a) on 3 m (10 ft) centers with 3.7 m (12 ft) between rows. Prior to planting, soil fertility and pH were adjusted according to the recommendations of the Auburn University Soil Fertility Laboratory. A drip irrigation system was installed at planting and the trees were watered as needed. During the study period, a 1 to 2 cm (0.5 to 1.0 in) layer of aged pine bark mulch was maintained around each tree. Centipedegrass (*Eremochola ophiuroides*) alleys separating each row of trees were periodically mowed but not fertilized during the study period. An application of 16-4-8 analysis fertilizer at 495 kg·ha^{-1} (450 lb·A^{-1}) on May 1, 2007, and April 7, 2008, was followed by an application of ammonium nitrate at 165 kg·ha^{-1} (150 lb·A^{-1}) on June 15, 2007, and June 11, 2008. Directed applications of 2.2 kg ai·ha^{-1} (2 qt·A^{-1}) of Surflan (oryzalin, United Phosphorus, 423 Riverview Plaza, Trenton, NJ) plus 0.68 kg ai·ha^{-1} (1.0 lb·A^{-1}) of Gallery (isoxaben, Dow AgroSciences LLC, Indianapolis, IN) were made for pre-emergent weed control on February 1, 2007, and March 6, 2008.

Fungicide comparison. A randomized complete block design with four single-plant replications was used. Instrata 3.61E (chlorothalonil + propiconazole + fludioxonil, Syngenta Crop Protection, Greensboro, NC) at 0.54, 0.74, and 1.11 g ai·liter^{-1}, as well as Instrata components Daconil Ultrex 82.5WDG (chlorothalonil, Syngenta Crop Protection, Greensboro, NC) at 1.38 g ai·liter^{-1}, Banner MAXX 1.3MEC (propiconazole, Syngenta Crop Protection, Greensboro, NC) at 0.10 g ai·liter^{-1}, and Medallion 50W (fludioxonil, Syngenta Crop Protection, Greensboro, NC) at 0.075 g ai·liter^{-1}, along with fungicide standards Eagle 40W (myclobutanil, Dow AgroSciences LLC, Indianapolis, IN) at 0.24 g ai·liter^{-1}, Heritage 50WDG (azoxystrobin, Syngenta Crop Protection, Greensboro, NC) at 0.15 g ai·liter^{-1}, and 3336 4.5F (thiophanate-methyl, Cleary Chemical Corp., Dayton, NJ), at 0.75 g ai·liter^{-1} were applied to drip with a tractor-mounted sprayer using a hand wand with a single flood-type nozzle tip on at approximately two-week intervals on July 3, July 17, July 31, August 7, and August 21, 2007, as well as on June 18, July 1, July 16, July 29, August 14, and September 9, 2008.

Disease assessment and statistical methods. Cercospora leaf spot (CLS) intensity (symptomatic + prematurely shed leaves) and defoliation (prematurely shed leaves) were visually rated in 2007 on July 31, August 31, September 15, October 3, October 17, and October 27, and in 2008 on July 1, July 22, August 21, September 3, September 11, September 25, and October 15 using the 0 to 11 Horsfall and Barratt rating scale (15) where 0 = no disease, 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% of symptomatic and prematurely shed leaves. Horsfall and Barratt (15) numerical values for Cercospora leaf spot intensity and defoliation at each rating date were transformed to percentage values for analysis and presentation. Area under disease progress curves (AUDPC) values for Cercospora leaf spot intensity and defoliation were calculated for each year from the percentage value data (20), which were then compared among years using PROC MIXED procedure in SAS 9.1.3. Due to differences in summer weather patterns between study years, subsequent analyses were segregated by year. Pairwise comparisons were made between Instrata 3.61E rates as well as individual component fungicides, fungicide standards, and the non-fungicide treated control. All statistical analyses on leaf spot intensity and defoliation percentage values were done on rank transformations of data. For presentation, data are back transformed to percent values. Means of transformed data were separated using Fisher's least significant difference (LSD) test ($P \leq 0.05$).

Results and Discussion

With the exception of the 0.54 g ai·liter^{-1} rate of Instrata 3.61E in 2007, Cercospora leaf spot intensity and defolia-

Table 1. Pairwise comparison of area under the disease progress curve (AUDPC) values for Cercospora leaf spot intensity and defoliation on 'Byers Wonderful White' crapemyrtle in 2007 between non-treated control, rates of Instrata, component fungicides, and fungicide standards.

Fungicide	Rate g ai·l^{-1}	Non-treated control	Instrata rate[z]			Instrata components			Fungicide standards		
			0.54	0.74	1.11	Banner Maxx	Daconil Ultrex	Medallion 50W	Eagle 40W	Heritage 50WDG	3336 4.5F
Intensity											
Non-treated control	—	**4614**	—	—	—	—	—	—	—	—	—
Instrata 3.61E	0.54	NS[y]	**3312**	—	—	—	—	—	—	—	—
Instrata 3.61E	0.74	***[x]	NS	**2761**	—	—	—	—	—	—	—
Instrata 3.61E	1.11	***	***	**	**1358**	—	—	—	—	—	—
Banner Maxx 1.3MEC	0.10	NS	NS	NS	***	**3143**	—	—	—	—	—
Daconil Ultrex 82.5 WDG	1.38	NS	NS	*	***	NS	**4011**	—	—	—	—
Medallion 50W	0.08	NS	NS	NS	***	NS	NS	**3724**	—	—	—
Eagle 40W	0.24	***	***	*	NS	***	***	***	**1545**	—	—
Heritage 50WDG	0.15	***	**	NS	NS	**	***	**	NS	**1675**	—
3336 4.5F	0.75	***	**	NS	NS	**	***	***	NS	NS	**1630**
Defoliation											
Non-treated control	—	**2575**	—	—	—	—	—	—	—	—	—
Instrata 3.61E	0.54	NS	**1382**	—	—	—	—	—	—	—	—
Instrata 3.61E	0.74	**	NS	**984**	—	—	—	—	—	—	—
Instrata 3.61E	1.11	***	*	NS	**589**	—	—	—	—	—	—
Banner Maxx 1.3MEC	0.10	NS	NS	NS	**	**1466**	—	—	—	—	—
Daconil Ultrex 82.5 WDG	1.38	NS	NS	*	***	NS	**2118**	—	—	—	—
Medallion 50W	0.08	NS	NS	*	***	NS	NS	**1941**	—	—	—
Eagle 40W	0.24	***	*	*	NS	**	***	***	**660**	—	—
Heritage 50WDG	0.15	***	**	*	NS	**	***	***	NS	**517**	—
3336 4.5F	0.75	***	*	NS	NS	NS	**	**	NS	NS	**771**

[z]Application rate for each fungicide is in grams active ingredient(s) per liter of spray volume.

[y]NS = not significant.

[x]Significance at 0.05, 0.01, and 0.001 is indicated by *, **, or ***, respectively.

tion AUDPC values were significantly higher in both study years for the non-treated control than with other rates of Instrata 3.61E (Tables 1 and 2). When compared with the 0.54 g ai·liter^{-1} rate, better season-long Cercospora leaf spot control, as indicated by significantly lower intensity and defoliation AUDPC values, was obtained in 2007 and 2008 with the 1.11 but not the 0.74 g ai·liter^{-1} rate of Instrata 3.61E. Season-long intensity and defoliation AUDPC values were significantly lower for the 1.11 compared with 0.74 g ai·liter^{-1} rates of Instrata 3.61E in one of two and both study years, respectively.

In 2007, Instrata 3.61E at 1.11 g ai·liter^{-1} provided superior Cercospora leaf spot control as indicated by lower AUDPC values for intensity and defoliation compared with component fungicides Daconil Ultrex 82.5WDG (chlorothalonil), Banner MAXX 1.3MEC (propiconazole), and Medallion 50W (fludioxonil). Intensity and defoliation AUDPC values for the low 0.54 g ai·liter^{-1} rate of Instrata 3.61E and the component fungicides were equally high (Table 1). When compared with the 0.74 g ai·liter^{-1} rate of Instrata 3.61E, higher Cercospora leaf spot intensity and defoliation AUCPC value were noted for Daconil Ultrex 82.5WDG along with higher defoliation AUDPC values for Medallion 50W.

For 2008, significantly lower intensity and defoliation AUDPC values were again noted for Instrata 3.61E at the 1.11 g ai·liter^{-1} rate as compared with the component fungicides Daconil Ultrex 82.5WDG, Banner MAXX 1.3MEC, and Medallion 50W (Table 2). While Medallion 50W gave poorer control of Cercospora leaf spot than the two lower rates of Instrata 3.61E, similar AUDPC intensity and defoliation values for the 0.54 and 0.74 g ai·liter^{-1} Instrata 3.61E rates and Banner MAXX 1.3MEC were recorded. Daconil Ultrex 82.5WDG and Instrata 3.61E at 0.74 g ai·liter^{-1} had similar intensity and defoliation values; lower intensity but not defoliation values were recorded for Instrata at 0.54 g ai·liter^{-1} than Daconil Ultrex 82.5WDG.

Cercospora leaf spot intensity and defoliation AUDPC values for Medallion 50W and the non-treated control did not significantly differ in 2007 (Table 1) or 2008 (Table 2). When compared with the non-treated control, significant reductions in Cercospora leaf spot intensity and defoliation were obtained with Daconil Ultrex 82.5WDG and Banner MAXX 1.3 MEC in 2008, but not in 2007. Cercospora leaf spot intensity and defoliation AUDPC values were significantly higher in both years for the non-treated control than Eagle 40W, Heritage 50WDG, and 3336 4.5F fungicide standards.

In both years, Eagle 40W significantly reduced Cercospora leaf spot intensity and defoliation when compared with the 0.54 and 0.74 but not the 1.11 g ai·liter^{-1} rate of Instrata 3.61E (Tables 1 and 2). In 2007, Heritage 50WDG had lower intensity and defoliation AUDPC values than the 0.54 but not the 1.11 g ai·liter^{-1} rate of Instrata 3.61E. When compared with Instrata 3.61E at 0.74 g ai·liter^{-1}, a significant reduction in season-long defoliation but not intensity was obtained with Heritage 50WDG. For the following year, poorer disease

Table 2. Pairwise comparison of area under the disease progress curve (AUDPC) values for Cercospora leaf spot intensity and defoliation on 'Byers Wonderful White' crapemyrtle in 2008 between non-treated control, rates of Instrata, component fungicides, and fungicide standards.

Fungicide	Rate g ai·l^{-1}	Non-treated control	Instrata rate[z]			Instrata components			Fungicide standards		
			0.54	0.74	1.11	Banner Maxx	Daconil Ultrex	Medallion 50W	Eagle 40W	Heritage 50WDG	3336 4.5F
Intensity											
Non-treated control	—	**5235**	—	—	—	—	—	—	—	—	—
Instrata 3.61E	0.54	***	**1716**	—	—	—	—	—	—	—	—
Instrata 3.61E	0.74	***	NS	**2182**	—	—	—	—	—	—	—
Instrata 3.61E	1.11	***	**	***	**907**	—	—	—	—	—	—
Banner Maxx 1.3MEC	0.10	***	NS	NS	**	**1832**	—	—	—	—	—
Daconil Ultrex 82.5 WDG	1.38	***	**	NS	***	*	**2965**	—	—	—	—
Medallion 50W	0.08	NS	***	***	***	***	**	**4636**	—	—	—
Eagle 40W	0.24	***	*	***	NS	**	***	***	**1051**	—	—
Heritage 50WDG	0.15	***	NS	NS	***	NS	NS	***	***	**2307**	—
3336 4.5F	0.75	**	***	**	***	**	NS	*	***	*	**3275**
Defoliation											
Non-treated control	—	**2320**	—	—	—	—	—	—	—	—	—
Instrata 3.61E	0.54	***	**466**	—	—	—	—	—	—	—	—
Instrata 3.61E	0.74	***	NS	**453**	—	—	—	—	—	—	—
Instrata 3.61E	1.11	***	**	***	**182**	—	—	—	—	—	—
Banner Maxx 1.3MEC	0.01	***	NS	NS	*	**376**	—	—	—	—	—
Daconil Ultrex 82.5 WDG	1.40	***	NS	NS	***	*	**360**	—	—	—	—
Medallion 50W	0.08	NS	***	***	***	***	**	**799**	—	—	—
Eagle 40W	0.24	***	*	**	NS	NS	***	***	**265**	—	—
Heritage 50WDG	0.15	***	NS	NS	***	*	NS	***	***	**576**	—
3336 4.5F	0.75	*	***	***	***	***	*	NS	***	**	**929**

[z]Application rate for each fungicide is in grams active ingredient(s) per liter of spray volume.

[y]NS = not significant.

[x]Significance at 0.05, 0.01, and 0.001 is indicated by *, **, or ***, respectively.

control was obtained with Heritage 50WDG than with the 1.11 g ai·liter^{-1} rate but not the lower rates of Instrata 3.61E, which had similar intensity and defoliation AUDPC values. With the exception of poorer disease control at the lowest rate, the two higher rates of Instrata 3.61E and 3336 4.5F had similarly low intensity and defoliation AUDPC values in 2007, while all rates of Instrate 3.61E gave superior Cercospora leaf spot control in 2008.

Significant reductions in Cercospora leaf spot intensity and defoliation were obtained in both study years with Eagle 40W as compared with Daconil Ultrex 82.5WDG, Medallion 50W, and Banner MAXX 1.3MEC except in 2008 when Eagle 40W and Banner MAXX 1.3 MEC had similar defoliation AUDPC values. Although Banner MAXX 1.3MEC, Daconil Ultrex 82.5WDG, and Medallion 50W gave poorer season-long disease control than Heritage 50WDG in 2007, only Medallion 50W had higher intensity and defoliation AUDPC values in 2008. In addition, similar disease control was obtained in 2008 with Daconil Ultrex 82.5WDG and Heritage 50WDG, while a significant reduction in Cercospora leaf spot defoliation but not intensity was noted with Banner MAXX 1.3MEC when compared with the latter fungicide standard. With the exception of defoliation on the Banner MAXX-treated crapemyrtle, 3336 4.5F had lower intensity and defoliation values in 2007 than the three component fungicides. In 2008, Banner MAXX 1.3MEC controlled Cercospora leaf spot better than 3336 4.5F, while 3336 4.5F had higher defoliation but not intensity AUDPC values than Daconil Ultrex 82.5WDG. Medallion 50W and 3336 4.5F had similarly high defoliation but not intensity AUDPC values. While Eagle 40W, Heritage 50WDG, and 3336 4.5F proved equally effective in controlling Cercospora leaf spot in 2007, the former fungicide standard proved most efficacious in 2008.

Cercospora leaf spot intensity and defoliation AUDPC values illustrate the impact of application rate on the level of season-long disease control with Instrata 3.61E as well as highlight differences in the performance among Daconil Ultrex 82.5WDG, Banner MAXX 1.3MEC, and Medallion 50W fungicide components as well as 3336 4.5F, Eagle 40W, and Heritage 50WDG standards. However, differences in the level of disease-induced leaf spotting and premature defoliation can be better illustrated by comparing the Horsfall and Barratt leaf spot scale values recorded in October in each study year.

When compared with the non-treated control, significant reductions in the level of leaf spotting and premature defoliation at the end of the season were obtained with all rates of Instrata 3.61E (Table 3). Better disease control was often obtained at the 1.11 compared with the 0.54 g ai·liter^{-1} rate of Instrata 3.61E. With the exception the intensity rating in 2007, similar control of Cercospora leaf spot was obtained with Instrata at 0.74 and 1.11 g ai·liter^{-1}, while few differences in disease control were noted between the 0.54 and 0.74 g ai·liter^{-1} rates. Over the two-year study period, Instrata 3.61E at 1.11 and to a lesser extent 0.74 g ai·liter^{-1} proved more effective in reducing the level of leaf spotting and defoliation than Medallion 50W and Daconil Ultrex 82.5WDG as

Table 3. Cercospora leaf spot intensity and defoliation levels as impacted by Instrata application rate, component fungicides, and selected fungicide standards on 'Byer's Wonderful White' crapemyrtle in October 2007 and 2008.

Fungicide	Rate[z] g ai·l^{-1}	Cercospora leaf spot[y] Intensity (%) 2007	Intensity (%) 2008	Defoliation (%) 2007	Defoliation (%) 2008
Instrata 3.61E	0.54	56bc[x]	48cde	45cde	25d
Instrata 3.61E	0.74	50cd	44de	28ef	12e
Instrata 3.61E	1.11	33e	31e	16f	9e
Banner Maxx 1.3MEC	0.10	67ab	54cd	50bcd	15e
Daconil Ultrex 82.5 WDG	1.38	72a	55cd	63ab	34cd
Medallion 50W	0.08	75a	79ab	67ab	61ab
Eagle 40W	0.24	45cd	45de	30ef	14e
Heritage 50WDG	0.15	33e	56cd	16f	28cd
3336 4.5F	0.75	38de	67bc	34de	38bc
Non-treated control	—	82a	92a	72a	82a

[z]Application rate for each fungicide is in grams active ingredient(s) per liter of spray volume.

[y]Cercospora leaf spot intensity (symptomatic + prematurely shed leaves) and defoliation (prematurely shed leaves) ratings were visually assessed using the 0 to 11 Horsfall and Barratt rating scale on October 27, 2007, and October 25, 2008. Data were transformed to percentage values for presentation.

[x]Means followed by the same letter are not significantly different according to Fisher's protected least significant difference (LSD) test ($P \leq 0.05$).

well as providing superior Cercospora leaf spot control in one of two years when compared with 3336 4.5F, Heritage 50WDG, and Banner MAXX 1.3MEC. Eagle 40W proved as effective as the 0.74 and 1.11 g ai·liter^{-1} rates of Instrata 3.61E in reducing Cercospora leaf spot intensity and defoliation in both years.

As previously indicated by AUDPC values, final Cercospora leaf spot intensity and defoliation ratings for the non-treated control and the Medallion 50W-treated trees did not significantly differ in 2007 and 2008 (Table 3). When compared with the non-treated control, significant reductions in Cercospora leaf spot intensity and defoliation were obtained with Daconil Ultrex 82.5WDG in 2008 but not in 2007. Disease intensity and defoliation ratings for Banner MAXX 1.3MEC and the non-treated control significantly differed in one of two and both years, respectively. In contrast, significant reductions in Cercospora leaf spot intensity and defoliation levels were obtained with all rates of Instrata 3.61E along with 3336 4.5F, Heritage 50WDG, and Eagle 40W with the latter providing superior disease control.

Application rate significantly impacted the efficacy of Instrata 3.61E for the control of Cercospora leaf spot on crapemyrtle. Instrata 3.61E was most efficacious when applied at the 1.11 and to a lesser extent 0.74 but not the 0.54 g ai·liter^{-1} application rate. The level of Cercospora leaf spot control obtained with the high rate of Instrata 3.61E was comparable and sometimes superior to that provided by the Eagle 40W, 3336 4.5F, and Heritage 50WDG standards, which previously proved effective in controlling Cercospora leaf spot on crapemyrtle (9), flowering dogwood (10), hydrangea (13), and/or rose (8). Individual component fungicides Daconil Ultrex 82.5WDG, Banner MAXX 1.3MEC, and Medallion 50W failed to match the level of Cercospora leaf spot control obtained with the 0.74 and 1.11 g ai·liter^{-1} rates of Instrata 3.61E in one of two and both study years, respectively. The poor performance of Daconil Ultrex 82.5WDG and Banner MAXX 1.3MEC against this *Cercospora*-incited disease was unexpected. Previously both fungicides controlled Cercospora leaf spot on rose (8), while ferti·loam® Systemic Fungicide, which is a retail formulation of propiconazole, proved more effective than several commercial and retail fungicide standards in reducing Cercospora leaf spot intensity and premature defoliation on crapemyrtle (9) and dogwood (10). Medallion 50W, which is registered at 0.04 to 0.08 g ai·liter^{-1} (1 to 2 oz·100 gal^{-1}) for the control of Cercospora leaf spot on herbaceous and woody ornamentals, failed to reduce the level of leaf spotting and premature leaf shed when compared with the non-treated control.

Due to the concerns of control failures attributed to declining sensitivity or resistance in target fungi to fungicides with single site modes of action, particularly sterol biosynthesis inhibitor (Group 3) (16, 19) and strobilurin (Group 11) (3) fungicide classes, products similar to Instrata that contain two or more non-cross resistant fungicide partners, which is a preferred strategy for lowering resistance risks (17), are becoming increasingly common in the commercial market. While Instrata component fungicides fludioxonil (Group 12) and propiconazole (Group 3) are listed as being a low to medium and medium resistance risk, respectively, the broad-spectrum, multi-site component chlorothalonil (Group M5) enhances the resistance safety margin and product efficacy for controlling some foliar diseases (4). Other modifiers for reducing the resistance risks include sanitation and good production practices, rotating to a non-cross resistant fungicide partner, limiting the number of applications of at-risk fungicides per season along with scheduling applications just prior to or at disease onset, and monitoring target crops for declines in fungicide performance (5)

While none of the fungicides screened provided complete protection from Cercospora leaf spot, the high rate and to a lesser extent the intermediate rate of Instrata 3.61E demonstrated good efficacy against this disease on crapemyrtle. Performance of the remaining fungicides for the control of Cercospora leaf spot was at best sporadic. Banner MAXX 1.3MEC, Heritage 50WDG, and 3336 4.5F greatly reduced leaf spot and premature defoliation in only one of two years. Eagle 40W was the only fungicide that matched the effectiveness of the high rate of Instrata 3.61E in both study years. Currently, Instrata 3.61E is registered only for the control of diseases on amenity turf and not ornamental crops. When

compared with fungicides, the most effective control for Cercospora leaf spot in the landscape is the establishment of a disease-resistant crapemrytle cultivar (6, 12, 14).

Literature Cited

1. Aflieri, S.A. 1969. Powdery mildew on crapemyrtle. Fla. Dept. of Agric. Cons. Serv. Plant Path. Cir. 83.

2. Aflieri, S.A. 1976. Cercospora leaf spot of crapemyrtle, *Lagerstroemia indica*. Fla. Dept. of Agric. Cons. Serv. Plant Path. Cir. 171.

3. Bartlett, D.W., J.M. Clough, J.R. Godwin, A.A. Hall, M. Hamer, and R. Parr-Dobzanski. 2002. The strobilurin fungicides. Pest. Manag. Sci. 48:649–662.

4. EPPO Standard PP1/213(2). Efficacy evaluation of plant protection products. Resistance risk analysis. www.eppo.org (checked online, 6 July 2012).

5. FRAC Code List 2012: Fungicides sorted by mode of action (Including FRAC Code numbering). http://www.frac.info/frac/index.htm (checked online, 8 July 2012).

6. Hagan A.K. 2001. Crapemyrtle diseases. p 114–116. *In*: Diseases of Woody Ornamentals and Trees in Nurseries. R. Jones and M. Benson, eds. APS Press. St. Paul, MN.

7. Hagan, A.K. 2004. Common diseases of crapemyrtle. Ala. Coop. Ext. Sys. Cir. ANR-1047.

8. Hagan, A.K. and J.R. Akridge. 2005. Fungicides control Cercospora leaf spot on Fuchsia Meidiland® rose. Alabama Agri. Exp. Sta. Cir. 329. 7 pp.

9. Hagan, A.K. and J.R. Akridge. 2007. Fungicides compared for the control of Cercospora leaf spot on crapemyrtle. Proc. Southern Nurserymans Assoc. Res. Conf. 52:314–317.

10. Hagan, A.K. and J.R. Akridge. 2007. Synthetic and biorational fungicides compared for the control of three foliar diseases of flowering dogwood. J. Environ. Hort. 25:157–165.

11. Hagan, A.K., J.R. Akridge, and K.L. Bowen. 2009. Influence of nitrogen rate on Cercospora leaf spot and growth of crapemyrtle. Plant Health Progress doi:10.1094/PHP-2009-12XX-01-RS.

12. Hagan, A.K., C.H. Gilliam, G.J. Keever, and J.D. Williams. 1998. Susceptibility of crapemyrtle cultivars to powdery mildew and Cercospora leaf spot in a simulated landscape planting in Alabama. J. Environ. Hort. 16:143–146.

13. Hagan, A.K., J.W. Olive, J. Stephenson, and M.E. Rivas-Davila. 2004. Impact of application rate and interval on the control of powdery mildew and Cercospora leaf spot on bigleaf hydrangea with azoxystrobin. J. Environ. Hort. 22:58–62.

14. Holcomb, G.E. 1997. Reaction of crapemyrtle cultivars to Cercospora leaf spot and powdery mildew. Biol. & Cult. Tests 12:56.

15. Horsfall, J.G. and R.W. Barratt. 1945. An improved grading system for measuring plant disease. Phytopathology 35:655 (Abstr).

16. Köller, W. and H. Scheinpflug. 1987. Fungal resistance to sterol biosynthesis inhibitors: A new challenge. Plant Dis. 71:1066–1074.

17. Kuck, K.H. and U. Gisi. 2007. FRAC Mode of action classification and resistance risk of fungicides. p 415–432. *In*: Modern Crop Protection Compounds, Vol. 2. W. Krämer and U. Schrimer, eds. Wiley-VCH Verlag GmbH & Co. KGaA, Weinhem.

18. Madden, L.V., G. Hughes, and F. van den Bosch. 2006. The Study of Plant Disease Epidemics. APS Press. St Paul, MN.

19. McGrath, M.T. 2001. Fungicide Resistance in cucurbit powdery mildew: Experiences and challenges. Plant Dis. 85:236–245.

20. Shaner, G. and R.E. Finney. 1977. The effect of nitrogen fertilization on the expression of slow-mildewing resistance in wheat. Phytopathology 67:1051–1056.

21. Wade, G.L. and J. Williams Woodward. 2001. Crape myrtle culture. Georgia Coop. Ext. Serv. Leaflet 331.

22. Williams, D., K. Tilt, and S. Valenti-Windsor. 1998. Common crapemyrtle. Ala. Coop. Ext. Cir. ANR-1083.