Woody Ornamental Disease Management Research Reports

Boxwood, Crapemyrtle, Daylily, Flowering Dogwood, Hydrangea, Lilac, Maple and Rose

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TENNESSEE STATE UNIVERSITY

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BOXWOOD (*Buxus sinica var. insularis* × *B. sempervierens* 'Green Velvet')
Boxwood blight; *Calonectria pseudonaviculata*

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Evaluation of fungicides for the control of boxwood blight, 2021.

Boxwood 'Green Velvet' plants in 4 sq. inch nursery containers filled with Morton's Nursery mix (processed pine bark (55-65%), Canadian sphagnum peat, and sand). Each plant was fertilized with 1.7 fl oz of 24-8-16 Miracle-Gro® All Purpose Plant Food and 0.2 oz of 18-6-8 Nutricote controlled release fertilizer on 12 Apr and 26 Apr, respectively. Plants were placed in a BSL2 (Biosafety Level 2) room. Six single-plant replications per treatment were arranged in a completely randomized design. Plants were treated using hand-held sprayer until runoff on 27 May, 10 and 24 Jun for a total of three applications on a 14-day schedule. *Calonectria pseudonaviculata* was used for inoculation on 28 May. Boxwood plants were inoculated with conidial suspension (3.0×10^5 conidia/ fl oz) until run-off using a hand-held sprayer. Transparent plastic bags were placed over plants overnight and were removed the following morning. Plants were watered once a week or as needed. Boxwood blight disease severity (the percentage of the entire plant showing symptoms such as leaf lesions), defoliation and phytotoxicity were assessed on 27 May, 3, 10, 17, and 24 Jun, and 1 and 8 Jul by using a scale of 0-100%. The area under disease progress curve (AUDPC) was calculated according to the formula: $\sum([(x_i + x_{i-1})/2](t_i - t_{i-1}))$, where x_i is the rating at each evaluation time and $(t_i - t_{i-1})$ is the number of days between evaluations. Plant heights and widths were measured on 19 May and 15 Jul. The temperature in the BSL2 room was a constant 72.0ºF. One-way analysis of variance was performed using the general linear models procedure using SAS v. 9.4 statistical software and means were separated using Fisher's LSD test.

Boxwood blight disease pressure was low by the end of the trial with non-treated, inoculated control plants showing 18.3% disease severity by 8 Jul. All treatments significantly reduced mean boxwood blight disease severity and progress compared to the non-treated, inoculated control plants. Defoliation was low (< 6%) in all treated plants and non-treated, non-inoculated control plants; however, the non-treated, inoculated control plants had a significantly higher defoliation rate of 5.2%. Non-treated inoculated and non-inoculated control plants had lower plant height increases, although plants treated with Heritage 50WG and KleenGrow + Daconil Weather Stik were statistically similar. Phytotoxicity was not observed in any of the treated boxwood plants.

		Boxwood blight			
Treatment and rate	Application dates[z]	Mean severity (%) (8 Jul)	AUDPC	Defoliation (%)	Height increase (in.)
Heritage 50WG 4 oz/100 gal	1, 2, 3	2.4 b[zz]	63.3 b	1.3 b	0.3 bc
Mural 45WG 4 oz/100 gal	1, 2, 3	2.7 b	64.8 b	1.3 b	0.7 a
KleenGrow 0.25 fl oz/gal	1, 2, 3	3.8 b	100.0 b	0.9 b	0.5 ab
Daconil Weather Stik 22 fl oz/100 gal	1, 2, 3	2.4 b	60.4 b	1.1 b	0.6 a
KleenGrow + Daconil Weather Stik 0.25 fl oz/gal + 22 fl oz/100 gal	1, 2, 3	2.3 b	58.0 b	0.9 b	0.5 abc
Non-treated, inoculated control		18.3 a	285.8 a	5.2 a	0.2 c
Non-treated, non-inoculated control		2.0 b	49.6 b	1.3 b	0.2 c
P-value		<0.0001	<0.0001	0.01	0.002

[z]Application dates: 1 = 27 May; 2 = 10 Jun; 3 = 24 Jun.
[zz]Values are the means of six replications; treatments followed by the same letter within a column are not significantly different at $P \leq 0.05$.

BOXWOOD (*Buxus sinica var. insularis* × *B.* sempervierens 'Green Velvet')
Boxwood blight; *Calonectria pseudonaviculata*

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Evaluation of fungicides for the control of boxwood blight, 2021.

Boxwood 'Green Velvet' plants were potted in 4 sq in nursery containers filled with Morton's Nursery mix (processed pine bark (55-65%), Canadian sphagnum peat, and sand). Each plant was fertilized with 1.7 fl oz of 24-8-16 Miracle-Gro® All Purpose Plant Food and 0.2 oz of 18-6-8 Nutricote controlled release fertilizer on 12 Apr and 26 Apr, respectively. Plants were placed in a BSL2 (Biosafety Level 2) room. Six single-plant replications per treatment were arranged in a completely randomized design. Plants were treated via hand-held sprayer until runoff on 27 May, 10 and 24 Jun for a total of three applications on a 14-day schedule. *Calonectria pseudonaviculata* was used for inoculation on 28 May. Boxwood plants were inoculated with conidial suspension (3.0×10^5 conidia/ fl oz) until run-off using a hand-held sprayer. Transparent plastic bags were placed over plants overnight and were removed the following morning. Plants were watered once a week or as needed with 3.4 fl oz of water. Boxwood blight disease severity (the percentage of the entire plant showing symptoms such as leaf lesions), defoliation and phytotoxicity was assessed on 27 May, 3, 10, 17, and 24 Jun, and 1 and 8 Jul by using a scale of 0-100%. The area under disease progress curve (AUDPC) was calculated according to the formula: $\sum([(x_i + x_{i-1})/2](t_i - t_{i-1}))$ where x_i is the rating at each evaluation time and $(t_i - t_{i-1})$ is the number of days between evaluations. Plant heights and widths were measured on 19 May and 15 Jul. The temperature in the BSL2 room was a constant 72.0ºF. One-way analysis of variance was performed using the general linear model procedure using SAS v. 9.4 statistical software and means were separated using Fisher's LSD test.

Boxwood blight disease pressure was low, with non-treated, inoculated control plants showing 18.3% disease severity by 8 Jul. All treatments significantly reduced mean disease severity and disease progress compared to the non-treated, inoculated control plants. Defoliation was low in all treated plants and non-treated, non-inoculated control plants; however, the non-treated, inoculated control plants had a significantly higher defoliation rate of 5.2%. All treated and non-treated control plants were similar in plant height increase. Phytotoxicity was not observed in any of the treated boxwood plants.

		Boxwood blight			
Treatment and rate/100 gal	Application dates[z]	Mean severity (%) (8 Jul)	AUDPC	Defoliation (%)	Height increase (in)
A23089B 325 SC 8 fl oz	1, 2, 3	2.8 b[zz]	54.8 b	1.6 b	0.2 a
A23089B 325 SC 16 fl oz	1, 2, 3	2.0 b	45.5 b	1.0 b	0.4 a
A23089B 325 SC 24 fl oz	1, 2, 3	1.6 b	42.9 b	1.8 b	0.3 a
Postiva 200 SC 24 fl oz	1, 2, 3	2.3 b	55.1 b	1.8 b	0.3 a
Heritage 50 WG 4 oz	1, 2, 3	2.4 b	63.3 b	1.3 b	0.3 a
Non-treated, inoculated control	-	18.3 a	285.8 a	5.2 a	0.2 a
Non-treated, non-inoculated control	-	2.0 b	49.6 b	1.3 b	0.2 a
P-value	-	≤0.0001	≤0.0001	0.04	0.9

[z]Application dates: 1 = 27 May; 2 = 10 Jun; 3 = 24 Jun.

[zz]Values are the means of six replications; treatments followed by the same letter within a column are not significantly different at $P \leq 0.05$.

CRAPEMYRTLE (*Lagerstroemia indica* x *L. fauriei* 'Hopi')
Powdery mildew; *Erysiphe lagerstroemia*

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Evaluation of fungicides for the control of powdery mildew of crapemyrtle, 2021.

Crapemyrtle 'Hopi' plants were potted in 3-gallon containers filled with Morton's Nursery mix (processed pine bark [55-65%], Canadian sphagnum peat, and sand). Each plant was fertilized with 6.8 fl oz of 24-8-16 Miracle-Gro® All Purpose Plant Food and 0.5 oz of 18-6-8 Nutricote controlled release fertilizer on 5 May. Six single-plant replications per treatment were arranged in a completely randomized design in a shade house under 56% shade at the Otis L. Floyd Nursery Research Center in McMinnville, TN. Plants were irrigated by an overhead irrigation system for 10 minutes once a day in May, Jun and Jul. Treatments were applied to run-off using a backpack CO_2-pressurized sprayer with TeeJet XR8002VS nozzle at 30 psi on a 14-day interval beginning on 26 May and ending on 23 Jun. The plants showing no powdery mildew symptoms were used for preventative application of Seido, and Heritage. The plants showing 1% disease severity were used for curative application of Seido and KleenGrow. Severity of powdery mildew and phytotoxicity was determined on 26 May, 2, 9, 16, 23 and 30 Jun, and 7 Jul using a scale of 0-100% foliage area affected. The area under the disease progress curve (AUDPC) was calculated according to the formula: $\sum([(x_i + x_{i+1})/2](t_i - t_{i+1}))$ where x_i is the rating at each evaluation time and $(t_i - t_{i+1})$ is the number of days between evaluations. Plant heights were measured on 19 May and 7 Jul. Average maximum temperatures for 26-31 May, Jun and 1-7 Jul were 86.4ºF, 92.8ºF and 91.0ºF; minimum temperatures were 44.7ºF, 53.5ºF and 57.5ºF; and total rainfall was 0.66 in., 4.12 in. and 0.61 in., respectively. One-way analysis of variance was performed using the general linear model procedure with SAS v. 9.4 statistical software and means were separated using Fisher's LSD test.

Powdery mildew infection occurred naturally during this trial. Disease pressure was low to moderate by the end of the trial with non-treated control plants showing 25.0% disease severity by 7 Jul. All treated plants had significantly less mean disease severity percentage and progress compared to the non-treated control plants. Plants preventatively treated with the low rate of Seido (OHP 1902) + Capsil (4 fl oz + 4 fl oz) and preventatively treated with the high and low rates of Seido (OHP 1902) + Capsil had significantly lower disease progress compared to plants curatively treated with Seido (OHP 1902) + Capsil and KleenGrow. There were no significant differences in plant height increase among any of the treated and non-treated control crapemyrtle plants. Phytotoxicity was not observed in any of the treated crapemyrtle plants.

Treatment and rate/100 gal[z]	Application type	Powdery mildew		Height increase (in)
		% Mean severity (7 Jul)	AUDPC	
Seido (OHP 1902) 4 fl oz + Capsil 4 fl oz	Preventative	6.6 b[zz]	87.2 c	2.2 b
Seido (OHP 1902) 5 fl oz + Capsil 4 fl oz	Preventative	4.1 b	86.0 c	1.8 b
Seido (OHP 1902) 5 fl oz + Capsil 4 fl oz	Curative	10.8 b	219.9 b	1.3 b
Heritage 50 WG 4 oz	Preventative	8.3 b	192.5 bc	2.2 b
KleenGrow 0.0025 fl oz	Curative	10.4 b	207.4 b	3.9 a
Non-treated control	-	25.0 a	516.3 a	2.5 ab
P-value	-	<0.0001	<0.0001	0.02

[z]Treatments were applied on 26 May, 9 Jun, and 23 Jun.
[zz]Values are the means of six replications; treatments followed by the same letter within a column are not significantly different at $P \leq 0.05$.

DAYLILY (*Hemerocallis lilioasphodelus* 'Stella d'Oro')
Southern blight; *Athelia rolfsii*

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Evaluation of fungicides for the control of Southern blight on daylily, 2021.

Daylily (*Hemerocallis lilioasphodelus*) 'Stella d'Oro' plants were potted in 1-gallon containers filled with Morton's Nursery mix (processed pine bark [55-65%], Canadian sphagnum peat, and sand). Each plant was fertilized with 3.4 fl oz of 24-8-16 Miracle-Gro® All Purpose Plant Food and 0.2 oz of 18-6-8 Nutricote controlled release fertilizer on 24 Aug. Five single-plant replications per treatment were arranged in a completely randomized design in full sun at the Otis L. Floyd Nursery Research Center in McMinnville, TN. Plants were irrigated using overhead irrigation for 15 minutes twice a day in Aug, Sep and Oct. Treatments were applied as a sprench using a backpack CO_2-pressurized sprayer with TeeJet XR8002VS nozzle at 30 psi except for Orkestra Intrinsic which was applied as a 6.8 fl oz drench on a 14-day interval beginning on 27 Aug and ending on 10 Sep. A strain of *Athelia rolfsii* was used for inoculation on 25 Aug. Inoculum was grown on PDA (potato dextrose agar) for 15 days. After the 15-day period, four sclerotia per daylily were buried around the crown of the plant. On 15 Oct, daylily plants were weighed for their root and total plant weight as well as evaluated at the crown and root for disease. The root system and crown were then incubated for 5 days in a moist chamber at room temperature and re-evaluated for disease severity on the crown and root area. Plant heights were measured on 18 Aug and 14 Oct. Average maximum temperatures for 18-31 Aug, Sep and 1-20 Oct were 88.4ºF, 81.7ºF and 78.1ºF, respectively; average minimum temperatures were 72.5ºF, 63.9ºF and 61.3ºF, respectively. Total rainfall was 3.7 in., 7.9 in. and 3.2 in., respectively. One-way analysis of variance was performed using the general linear model procedure with SAS v. 9.4 statistical software and means were separated using Fisher's LSD test.

Southern blight disease pressure was low in the non-treated, inoculated control plants showing 20.0% and 21.0% crown and root rot severity by 20 Oct, respectively. All treated plants had lower disease severity in both the crown and root areas compared to the non-treated, inoculated control plants. Terraguard + Astun was the least effective among the treatments in crown rot severity control, with all other treatments being similar to one another and the non-treated, non-inoculated control. The Terraguard treatment provided the best control of Southern blight for root rot severity, which was similar to the non-treated, non-inoculated control. Terraguard + Astun, Orkestra Intrinsic, and KleenGrow were similar to Terraguard and the non-treated, non-inoculated control plants for root rot severity. Plants treated with Orkestra Intrinsic, Astun, Terraguard, KleenGrow and the non-treated, non-inoculated control plants were similar in both total and root fresh weight. There were no significant differences in plant height increase among any of the treated and non-treated daylily plants. Phytotoxicity was not observed in any of the treated daylily plants.

	Southern blight				
Treatment and rate/ 100 gal[z]	Crown rot severity (%) (20 Oct)	Root rot severity (%) (20 Oct)	Total fresh weight (oz)	Root fresh weight (oz)	Height increase (in)
Astun 17 fl oz	3.0 c[zz]	9.0 b	15.7 ab	14.9 ab	3.1 a
Terraguard 8 fl oz	3.0 c	2.0 c	17.8 a	17.2 a	3.5 a
Terraguard 4 fl oz + Astun 13.5 fl oz	10.0 b	6.0 bc	9.2 c	8.0 c	3.3 a
Orkestra Intrinsic 10 fl oz	3.0 c	5.0 bc	19.1 a	18.0 a	3.1 a
KleenGrow 25 fl oz	2.0 c	5.0 bc	16.7 a	15.9 a	3.9 a
Non-treated, inoculated control	20.0 a	21.0 a	10.0 bc	9.5 bc	4.1 a
Non-treated, non-inoculated control	0.0 c	0.0 c	14.9 abc	13.9 abc	3.5 a
P-value	<0.0001	<0.0001	0.019	0.02	0.34

[z]All treatments were applied on 27 Aug and 10 Sep.
[zz]Values are the means of five replications; treatments followed by the same letter within a column are not significantly different at $P \leq 0.05$.

FLOWERING DOGWOOD (*Cornus florida* 'Cherokee Princess')
Powdery mildew; *Erysiphe pulchra*
Spot anthracnose; *Elsinoe corni*

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Evaluation of fungicides for the control of powdery mildew and spot anthracnose of dogwood, 2021.

Dogwood plants were potted in 1-gallon containers filled with Morton's Nursery mix (processed pine bark (55-65%), Canadian sphagnum peat, and sand). Each plant was fertilized with 3.4 fl oz of 24-8-16 Miracle-Gro® All Purpose Plant Food and 0.2 oz of 18-6-8 Nutricote controlled release fertilizer on 21 May. Six single-plant replications per treatment were arranged in a completely randomized design in a shade house under 56% shade at the Otis L. Floyd Nursery Research Center in McMinnville, TN. Plants were irrigated by hand as needed. Treatments were applied to run-off using a backpack CO_2-pressurized sprayer with a TeeJet XR8002VS nozzle at 30 psi on a 14-day interval beginning on 30 Jun and ending on 28 Jul. Severity of powdery mildew, spot anthracnose and phytotoxicity was determined on 1, 8, 15, 22 and 29 Jul, and 4 and 11 Aug using a scale of 0-100% foliage area affected. The area under the disease progress curve (AUDPC) was calculated according to the formula: $\sum([(x_i + x_{i-1})/2](t_i - t_{i-1}))$, where x_i is the rating at each evaluation time and $(t_i - t_{i-1})$ is the number of days between evaluations. Plant height was measured on 22 Jun and 11 Aug. Maximum temperatures for Jun, Jul and 1-11 Aug were 92.8ºF, 94.8ºF, and 92.4ºF, respectively; minimum temperatures were 53.5ºF, 57.5ºF, and 60.2ºF, respectively; and total rainfall for Jun, Jul, and 1-11 Aug was 4.12 in., 0.61 in., and 1.0 in., respectively. Analysis of variance was performed using the general linear model's procedure with SAS statistical software and means were separated using Fisher's LSD test.

Powdery mildew and spot anthracnose developed from natural inoculum. Powdery mildew disease pressure was low (< 30%) in this trial, with mean disease severity of the non-treated control plants being 27.5%. Spot anthracnose disease pressure was low (< 45%) to moderate by the end of the trial with non-treated control plants showing 43.3% disease severity. There were no significant height increases among the treated and non-treated control plants. All treatments significantly lowered powdery mildew and spot anthracnose disease severity and progress compared to the non-treated control. However, there were no significant differences in mean disease severity and disease progress among treatments for both powdery mildew and spot anthracnose. Phytotoxicity was not observed in any of the treated dogwood plants.

		Spot anthracnose		Powdery mildew		
Treatment and rate	Application dates[z]	% Mean severity (11 Aug)	AUDPC	% Mean severity (11 Aug)	AUDPC	Height increase (in.)
Eagle 20 EW 8 fl oz/100 gal	1, 2, 3	8.8 b[y]	128.6 b	1.8 b	30.3 b	1.1 a
Pageant Intrinsic 10 oz/100 gal	1, 2, 3	4.6 b	106.5 b	2.7 b	50.2 b	1.8 a
Mural 7 oz/100 gal	1, 2, 3	5.2 b	87.5 b	1.3 b	26.3 b	2.0 a
KleenGrow 0.25 fl oz/gal	1, 2, 3	9.2 b	202.4 b	3.7 b	62.4 b	1.7 a
Non-treated control	-	43.3 a	681.9 a	27.5 a	478.6 a	1.5 a
P-value	-	<0.0001	<0.0001	<0.0001	<0.0001	0.9

[z]Application dates: 1 = 30 Jun; 2 = 14 Jul; 3 = 28 Jul.
[y]Values are the means of six replications; treatments followed by the same letter within a column are not significantly different at $P \leq 0.05$.

HYDRANGEA (*Hydrangea macrophylla* 'Nikko Blue')
Powdery mildew; *Erysiphe polygoni*
Cercospora leaf spot*; Cercospora hydrangea*

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Evaluation of fungicides for the control of powdery mildew and Cercospora leaf spot of hydrangea, 2021.

Hydrangea 'Nikko Blue' plants were potted in 5-gallon containers filled with Morton's Nursery mix (processed pine bark (55-65%), Canadian sphagnum peat, and sand). Each plant was fertilized with 13.5 fl oz of 24-8-16 Miracle-Gro® All Purpose Plant Food and 1.0 oz of 18-6-8 Nutricote controlled release fertilizer on 7 May. Six single-plant replications per treatment were arranged in a completely randomized design in a shade house under 56% shade at the Otis L. Floyd Nursery Research Center in McMinnville, TN. Plants were irrigated using overhead irrigation for 15 minutes twice a day in May, Jun and Jul. Treatments were applied to run-off using a backpack CO_2-pressurized sprayer with TeeJet XR8002VS nozzle at 30 psi on a 14-day interval beginning on 25 May and ending on 22 Jun; except for Cease, which had a 7-day interval starting 25 May and ending 22 Jun. Severity of powdery mildew, Cercospora leaf spot and phytotoxicity was determined on 25 May, 1, 8, 15, 22, and 29 Jun, and 6 Jul using a scale of 0-100% foliage area affected. The area under the disease progress curve (AUDPC) was calculated according to the formula: $\sum([(x_i + x_{i-1})/2](t_i - t_{i-1}))$, where x_i is the rating at each evaluation time and $(t_i - t_{i-1})$ is the number of days between evaluations. Plant heights were measured on 19 May and 7 Jul. Average maximum temperatures for 25-31 May, Jun and 1-6 Jul were 90.6ºF, 92.8ºF, and 91.0ºF; average minimum temperatures were 44.7ºF, 53.5ºF, and 57.5ºF; and total rainfall was 0.66 in., 4.12 in., and 0.53 in., respectively. One-way analysis of variance was performed using the general linear model's procedure with SAS v. 9.4 statistical software and means were separated using Fisher's LSD test.

Powdery mildew and Cercospora leaf spot developed from natural inoculum. Powdery mildew and Cercospora leaf spot disease pressures were low to moderate with non-treated control plants showing 33.3% and 16.7% disease severity by 6 Jul, respectively. All treated plants had significantly less powdery mildew and Cercospora leaf spot mean disease severity percentage and progress compared to the non-treated control plants. Plants treated with Mural had the lowest mean disease severity and progress in both powdery mildew and Cercospora leaf spot. Plants treated with Mural provided the best control of mean disease severity percentage and disease progress for powdery mildew. Plants treated with Mural and KleenGrow provided the best control of mean disease severity percentage for Cercospora leaf spot. Defoliation was low (< 20%) in this trial, with treated plants having significantly less defoliation compared to the non-treated control plants, except for plants treated with KleenGrow, which exhibited similar percentage of defoliation to the non-treated control. There were no significant differences in plant height increases among any of the treated and non-treated control plants. Phytotoxicity was not observed in any of the treated hydrangea plants.

Treatment and rate	Application dates*	Powdery mildew		Cercospora leaf spot		Defoliation (%)	Height increase (in.)
		Mean severity (%) (7 Jul)	AUDPC	Mean severity (%) (7 Jul)	AUDPC		
Mural 45WG 6 oz/100 gal	1, 3, 5	3.8 c	73.2 c	7.5 c	99.8 c	0.7 c	7.6 a
Cease 8 qt/100 gal	1, 2, 3, 4, 5	12.9 b	202.1 b	12.1 b	159.5 b	6.0 bc	5.6 a
KleenGrow 0.25 fl oz/gal	1, 3, 5	10.8 b	135.3 bc	10.0 bc	127.8 bc	10.0 ab	6.4 a
Non-treated control	-	33.3 a	613.7 a	16.7 a	300.4 a	16.7 a	8.3 a
P-value	-	<0.0001	<0.0001	0.0008	<0.0001	0.001	0.5

*Application dates: 1 = 25 May; 2 = 1 Jun; 3 = 8 Jun; 4 = 15 Jun; 5 = 22 Jun.
**Values are the means of six replications; treatments followed by the same letter within a column are not significantly different at $P \leq 0.05$.

HYDRANGEA (*Hydrangea macrophylla* 'Nikko Blue')
Powdery mildew; *Erysiphe polygoni*
Cercospora leaf spot*; Cercospora hydrangea*

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Evaluation of fungicides for the control of powdery mildew and Cercospora leaf spot of hydrangea, 2021.

Hydrangea 'Nikko Blue' plants were potted in 1-gallon containers filled with Morton's Nursery mix (processed pine bark [55-65%], Canadian sphagnum peat, and sand). Each plant was fertilized with 3.4 fl oz of 24-8-16 Miracle-Gro® All Purpose Plant Food and 0.2 oz of 18-6-8 Nutricote controlled release fertilizer on 7 and 14 May, respectively. Six single-plant replications per treatment were arranged in a completely randomized design in a greenhouse at the Otis L. Floyd Nursery Research Center in McMinnville, TN. Plants were irrigated using irrigation emitters for 2 min twice a day in May, Jun and Jul. Treatments were applied to run-off using a backpack CO_2-pressurized sprayer with TeeJet XR8002VS nozzle at 30 psi on a 14-day interval beginning on 26 May and ending on 23 Jun. The plants showing no powdery mildew symptoms were used for a preventative application of Seido and Heritage. The plants showing 1% disease severity were used for a curative application of Seido and KleenGrow. Severity of powdery mildew, Cercospora leaf spot and phytotoxicity was determined on 26 May, 2, 9, 16, 23 and 30 Jun, and 7 Jul using a scale of 0-100% foliage area affected. The area under the disease progress curve (AUDPC) was calculated according to the formula: $\sum([(x_i + x_{i-1})/2](t_i - t_{i-1}))$ where x_i is the rating at each evaluation time and $(t_i - t_{i-1})$ is the number of days between evaluations. Plant heights were measured on 19 May and 7 Jul. Average maximum temperatures for 26-31 May, Jun and 1-7 Jul were 86.4ºF, 92.8ºF and 91.0ºF, respectively; average minimum temperatures were 44.7ºF, 53.5ºF and 57.5ºF, respectively. One-way analysis of variance was performed using the general linear model procedure with SAS v. 9.4 statistical software and means were separated using Fisher's LSD test.

Powdery mildew and Cercospora leaf spot occurred naturally in this trial. Powdery mildew disease pressure was low to moderate and Cercospora leaf spot disease pressure was low with non-treated control plants showing 26.7% and 12.5% mean disease severity by 7 Jul, respectively. All treated plants had significantly less powdery mildew and Cercospora leaf spot mean disease severity percentage and progress compared to the non-treated control hydrangea plants. Plants preventatively treated with the high rate of Seido (OHP 1902) + Capsil (5 fl oz + 4 fl oz) had the lowest mean disease severity of powdery mildew (2.0%) and Cercospora leaf spot (4.2%), and the lowest disease progress in powdery mildew and Cercospora leaf spot by the end of the trial. Preventative treatment of the low rate of Seido (OHP 1902) + Capsil (4 fl oz + 4 fl oz) was similar to preventative treatment of the high rate of Seido (OHP 1902) + Capsil (5 fl oz + 4 fl oz) in both powdery mildew and Cercospora leaf spot mean disease severity and progress. Heritage and KleenGrow were similar to curative treatment of Seido (OHP 1902) + Capsil (5 fl oz + 4 fl oz) in both powdery mildew and Cercospora leaf spot mean disease severity and disease progress. Defoliation was low in this trial, with treated plants having significantly less defoliation compared to the non-treated control plants at 5.4% defoliation. There were no significant differences in plant height increase among any of the treated and non-treated control hydrangea plants. Phytotoxicity was not observed in any of the treated hydrangea plants.

		Powdery mildew		Cercospora leaf spot			
Treatment and rate/100 gal[z]	Application type	Mean severity (%) (7 Jul)	AUDPC	Mean severity (%) (7 Jul)	AUDPC	Defoliation (%)	Height increase (in)
Seido (OHP 1902) 4 fl oz + Capsil 4 fl oz	Preventative	3.1 cd[zz]	48.7 c	5.8 bc	79.0 bc	1.3 b	1.9 a
Seido (OHP 1902) 5 fl oz + Capsil 4 fl oz	Preventative	2.0 d	35.6 c	4.2 c	60.1 c	2.2 b	0.9 a
Seido (OHP 1902) 5 fl oz + Capsil 4 fl oz	Curative	7.5 b	137.1 b	8.3 b	112.0 b	1.7 b	1.2 a
Heritage 50 WG 4 oz	Preventative	6.7 bc	102.7 bc	5.8 bc	85.2 bc	2.8 b	1.7 a
KleenGrow 0.0025 fl oz	Curative	7.9 b	156.0 b	8.3 b	105.6 b	3.0 b	0.4 a
Non-treated control	-	26.7 a	477.8 a	12.5 a	183.8 a	5.4 a	1.8 a
P-value	-	<0.0001	<0.0001	0.002	<0.0001	0.02	0.4

[z]Treatments were applied on 26 May, 9 Jun, and 23 Jun.
[zz]Values are the means of six replications; treatments followed by the same letter within a column are not significantly different at $P \leq 0.05$.

HYDRANGEA (*Hydrangea macrophylla* 'Nikko Blue')
Powdery mildew; *Erysiphe polygoni*
Cercospora leaf spot*; Cercospora hydrangea*

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Evaluation of fungicides and application intervals for the control of powdery mildew and Cercospora leaf spot of hydrangea, 2021.

Hydrangea 'Nikko Blue' plants were potted in 5-gallon containers filled with Morton's Nursery mix (processed pine bark (55-65%), Canadian sphagnum peat, and sand). Each plant was fertilized with 13.5 fl oz of 24-8-16 Miracle-Gro® All Purpose Plant Food and 1.0 oz of 18-6-8 Nutricote controlled release fertilizer on 7 May. Six single-plant replications per treatment were arranged in a completely randomized design in a shade house under 56% shade at the Otis L. Floyd Nursery Research Center in McMinnville, TN. Plants were irrigated using overhead irrigation for 15 minutes twice a day in Jun, Jul, Aug and Sep. Treatments were applied to run-off using a backpack CO_2-pressurized sprayer with TeeJet XR8002VS nozzle at 30 psi on a 2-week, 4-week, and 6-week intervals. Severity of powdery mildew, Cercospora leaf spot, defoliation and phytotoxicity were determined weekly with final evaluation at 21 days after last spray application for different interval (2, 4 or 6-week interval) using a scale of 0-100% foliage area affected. The area under the disease progress curve (AUDPC) was calculated according to the formula: $\sum([(x_i + x_{i+1})/2](t_i - t_{i+1}))$, where x_i is the rating at each evaluation time and $(t_i - t_{i+1})$ is the number of days between evaluations. Plant heights were measured on 7 Jun and 21 Sep. Average maximum temperatures for 8-30 Jun, Jul, Aug and 1-21 Sep were 92.8ºF, 94.8ºF, 96.0ºF, and 82.9ºF; average minimum temperatures were 53.5ºF, 57.5ºF, 67.0ºF, and 67.0ºF; and total rainfall was 2.39 in., 3.72 in., 10.0 in., and 7.4 in., respectively. One-way analysis of variance was performed using the general linear model's procedure with SAS v. 9.4 statistical software and means were separated using Fisher's LSD test.

Powdery mildew and Cercospora leaf spot developed from natural inoculum in this trial. All treated plants had significantly less powdery mildew and Cercospora leaf spot mean disease severity percentage and progress compared to the non-treated control plants for all application intervals. The low and mid-rates of Postiva (14 fl oz and 20 fl oz) applied with the 2-week interval significantly reduced powdery mildew compared to Mural applied with the 2-week interval. All rates of Postiva applied with the 2-week interval significantly reduced powdery mildew disease progress compared to Mural applied with the 2-week interval. The mid-rate of Postiva (20 fl oz) applied with the 2-week interval significantly reduced Cercospora leaf spot compared to Mural applied with the 2-week interval. There were no differences on Cercospora leaf spot disease progress between the treatments applied with the 2-week interval. The low-rate of Postiva (14 fl oz) applied with the 4-week interval significantly reduced powdery mildew compared to Mural applied with the 4-week interval. The low and mid-rates of Postiva (14 fl oz and 20 fl oz) applied with the 4-week interval significantly reduced powdery mildew disease progress compared to Mural applied with the 4-week interval. There were no differences on Cercospora leaf spot disease severity between the treatments applied with the 4-week interval. The low and mid-rates of Postiva (14 fl oz and 20 fl oz) applied with the 4-week interval significantly reduced Cercospora leaf spot disease progress compared to Mural and the high rate off Postiva (28 fl oz) applied with the 4-week interval. There were no differences on powdery mildew or Cercospora leaf spot disease severity, and disease progress between the treatments applied with the 6-week interval. All treated plants showed reduced defoliation compared to the non-treated control plants, except for Mural at the 2-week interval. There were no significant differences in plant height increase among any of the treated and non-treated control plants for all application intervals. Phytotoxicity was not observed in any of the treated hydrangea plants.

Treatment and rate/ 100 gal	Application dates*	Powdery mildew		Cercospora leaf spot		Defoliation (%)	Height increase (in.)
		Mean severity (%)	AUDPC	Mean severity (%)	AUDPC		
Postiva 200 SC + Capsil 14 fl oz + 4 fl oz	1, 2, 3	6.3 c**	202.4 c	8.8 bc	201.5 b	5.0 bc	1.9 ab
Postiva 200 SC + Capsil 20 fl oz + 4 fl oz	1, 2, 3	6.3 c	200.1 c	8.3 c	188.4 b	3.7 c	1.3 b
Postiva 200 SC + Capsil 28 fl oz + 4 fl oz	1, 2, 3	7.9 bc	246.2 c	10.0 bc	199.5 b	5.2 bc	2.6 a
Mural 45WG + Capsil 7 oz + 4 fl oz	1, 2, 3	10.4 b	322.9 b	11.7 b	227.5 b	8.3 ab	2.6 a
Non-treated control	-	29.2 a	805.3 a	15.8 a	322.6 a	11.7 a	2.5 a
P-value	-	<0.0001	<0.0001	0.0004	<0.0001	0.0023	0.1459

*Application dates (2-week interval): 1 = 8 Jun; 2 = 22 Jun; 3 = 6 Jul.
**Values are the means of six replications; treatments followed by the same letter within a column are not significantly different at $P \leq 0.05$.

Treatment and rate/ 100 gal	Application dates*	Powdery mildew		Cercospora leaf spot		Defoliation (%)	Height increase (in.)
		Mean severity (%)	AUDPC	Mean severity (%)	AUDPC		
Postiva 200 SC + Capsil 14 fl oz + 4 fl oz	1, 2, 3	20.0 c**	563.5 c	22.5 b	609.6 c	12.5 b	1.2 a
Postiva 200 SC + Capsil 20 fl oz + 4 fl oz	1, 2, 3	25.8 bc	511.6 c	25.8 b	596.2 c	8.3 b	1.6 a
Postiva 200 SC + Capsil 28 fl oz + 4 fl oz	1, 2, 3	25.8 bc	666.2 bc	26.7 b	738.5 b	8.3 b	1.4 a
Mural 45WG + Capsil 7 oz + 4 fl oz	1, 2, 3	30.8 b	823.4 b	28.3 b	742.0 b	10.8 b	2.2 a
Non-treated control	-	55.0 a	1875.7 a	46.7 a	1165.5 a	21.7 a	2.5 a
P-value	-	<0.0001	<0.0001	<0.0001	<0.0001	0.0001	0.3719

*Application dates (4-week interval): 1 = 8 Jun; 2 = 6 Jul; 3 = 3 Aug.
**Values are the means of six replications; treatments followed by the same letter within a column are not significantly different at $P \leq 0.05$.

		Powdery mildew		Cercospora leaf spot			
Treatment and rate/ 100 gal	Application dates*	Mean severity (%)	AUDPC	Mean severity (%)	AUDPC	Defoliation (%)	Height increase (in.)
Postiva + Capsil 14 fl oz + 4 fl oz	1, 2, 3	54.2 b	1709.8 b	55.0 b	1915.7 b	26.7 b	1.7 a
Postiva + Capsil 20 fl oz + 4 fl oz	1, 2, 3	49.2 b	1836.9 b	57.5 b	1949.5 b	27.5 b	1.3 a
Postiva + Capsil 28 fl oz + 4 fl oz	1, 2, 3	55.0 b	1787.9 b	53.3 b	1915.7 b	25.0 b	2.2 a
Mural + Capsil 7 oz + 4 fl oz	1, 2, 3	51.7 b	1809.5 b	55.8 b	1963.5 b	30.8 b	2.0 a
Non-treated control	-	85.0 a	3829.9 a	70.0 a	2845.5 a	37.5 a	2.5 a
P-value	-	<0.0001	<0.0001	0.0018	<0.0001	0.004	0.7

*Application dates (6-week interval): 1 = 8 Jun; 2 = 20 Jul; 3 = 31 Aug.

**Values are the means of six replications; treatments followed by the same letter within a column are not significantly different at $P \leq 0.05$.

HYDRANGEA (*Hydrangea quercifolia* 'Queen of Hearts')
Fusarium root and crown rot; *Fusarium oxysporum*

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Evaluation of fungicides for the management of Fusarium root and crown rot of hydrangea, 2021.

Oak leaf hydrangea 'Queen of Hearts' were potted in 1-gallon containers filled with Morton's Nursery mix (processed pine bark [55-65%], Canadian sphagnum peat, and sand). Each plant was fertilized with 0.2 oz of 18-16-8 Nutricote controlled released fertilizer on 3 Jan. Six single-plants per treatment were arranged in a completely randomized design in a greenhouse at the Otis L. Floyd Nursery Research Center in McMinnville, TN. Plants were irrigated using irrigation emitters for 2 minutes per day in Jan and Feb. Plants were inoculated with 150 ml of *Fusarium oxysporum* conidial suspension (1.0×10^{6} conidia/ml) on 18 Jan. Treatments were applied as a soil drench or sprench starting from 15 Jan and ending on 3 Feb. Plant height was recorded on 14 Jan and 17 Feb. Total fresh weight and root weight were recorded for all plants on 18 Feb, and the roots and crown were assessed for Fusarium root and crown rot disease severity using scale of 0-100% of parts affected. Average maximum temperatures for 1-30 Jan and 1-18 Feb were 82.5 and 82.9ºF; average minimum temperatures were 56.4 and 55.9ºF. Analysis of variance was performed using the general linear model procedure with SAS statistical software and means were separated using Fisher's least significant difference test.

Fusarium root and crown rot disease pressure was moderate to high in this trial. All of the treatments significantly reduced Fusarium root rot and crown rot severity compared to the non-treated, inoculated control. BAS75002F, the low rate of Postiva, the high rate of SP2700, Terraguard, and KleenGrow were more effective in reducing root rot disease severity in hydrangea plants than other treatments. The treatments that effectively reduced Fusarium crown rot disease severity were Empress Intrinsic, the high rate of BW161N, KleenGrow, the high rate of SP2700 and TXC2020 applied 6 days after inoculation. Phytotoxicity was not observed in any treated hydrangea plants.

Treatment and rate/100 gal	Application date[z]	Height increase (in)	Total fresh weight (oz)	Root weight (oz)	Fusarium root rot severity (%)[y]	Fusarium crown rot severity (%)[w]
Non-treated, non-inoculated control		0.65	0.99	0.66	10.83 h[x]	3.67 j
Non-treated, inoculated control		0.46	0.62	0.43	53.33 a	31.67 a
Astun 17 fl oz	3,6	0.55	0.64	0.45	29.33 b-e	18.33 d-g
Astun 13.5 fl oz	3,6	0.49	0.67	0.47	31.5 c-f	22.50 b-e
BAS750 3 fl 0z	1,5	0.88	0.67	0.46	21.67 e-g	19.17 b-f
BW161N 5 oz	1,5	0.59	0.60	0.44	29.17 c-f	16.67 f-i
BW161N 3 oz	1,5	0.55	0.71	0.51	26.67 c-f	20.83 b-f
Empress Intrinsic 3 fl oz	3,6	0.62	0.73	0.55	29.17 c-f	11.67 i
KleenGrow 25 fl oz	3,6	0.59	0.64	0.48	24.33 e-g	16.67 f-i
MBI121 128 fl oz	1,4,5	0.59	0.66	0.47	26.67 c-f	17.50 e-h
MBI121 96 fl oz	1,4,5	0.62	0.67	0.42	29.00 c-f	23.33 b-d
Postiva 14 fl oz	1	0.65	0.60	0.40	23.67 e-g	19.17 b-f
Postiva 21 fl oz	1	0.68	0.65	0.48	32.50 bc	23.33 b-d
SP2480 15 fl oz	2,4,5	0.68	0.82	0.55	30.00 b-d	24.17 bc
SP2480 25 fl oz	2,4,5	0.55	0.71	0.46	27.50 c-f	25.83 b
SP 2700 WP 11 oz	2,4,5	0.71	0.59	0.42	30.83 bc	17.50 e-h
SP2700 WP 22 oz	2,4,5	0.68	0.59	0.40	21.67 e-g	14.17 g-i
TXC 2020 64 fl oz	1,3,5	0.62	0.65	0.43	35.83 b	22.50 b-e
TXC2020 64 fl oz	1,4,5	0.52	0.63	0.45	25.83 c-f	12.50 f-i
Terraguard 8 fl oz	3,6	0.55	0.79	0.53	23.50 e-g	20.83 b-f
Terraguard 8 fl oz + Astun13.5 fl oz	3,6	0.52	0.67	0.50	27.83 c-f	17.50 e-h
P-value		0.6833	0.5157	0.7542	<0.0001	<0.0001

[z]Application dates: 1=15 Jan, 2=19 Jan, 3=21 Jan, 4=24 Jan, 5=31 Jan and 6= 3rd Feb

[y]Disease severity was based on percentage of roots affected.

[w]Disease severity was based on percentage of crown affected.

[x]Values are the means of six replicates; treatments followed by the same letter within a column are not significantly different at $P \leq 0.05$

LILAC (*Syringa reticulata* 'Ivory Silk')
Bacterial blight; *Pseudomonas syringae* pv. *syringae*

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Evaluation of treatments for control of bacterial blight on lilac, 2021.

Lilac (*Syringa reticulata*) 'Ivory Silk' plants were potted in 5-gallon containers filled with Morton's Nursery mix (processed pine bark [55-65%], Canadian sphagnum peat, and sand). Plants were fertilized with Miracle-Gro® All Purpose Plant Food 24-8-16 (13.5 fl oz/gal) on 7 May and with Nutricote Total (18-6-8) (1.0 oz/plant) on 14 May. Five single-plant replications per treatment were arranged in a completely randomized design in a shade house under 56% shade at the Otis L. Floyd Nursery Research Center in McMinnville, TN. Plants were irrigated using emitters for 2 minutes twice a day in Jun and Jul with irrigation stakes. All plants except for the non-treated, non-inoculated control plants were inoculated with *Pseudomonas syringae* pv. *syringae* (approximately 10^{7} CFU/ml) with a handheld sprayer to uniformly cover foliage with inoculum once on May 17 and again on 7 Jun. Treatments were applied to run-off using a backpack CO_2-pressurized sprayer with a TeeJet XR8002VS nozzle at 30 psi beginning on 4 Jun and ending on 21 Jun. Severity of bacterial blight, defoliation and phytotoxicity were evaluated on 3, 10, 17 and 24 Jun and, and 1 and 8 Jul and were expressed as the percentage of foliage area affected. The area under the disease progress curve (AUDPC) was calculated according to the formula: $\sum([(x_i + x_{i+1})/2](t_i - t_{i1}))$ where x_i is the rating at each evaluation time and $(t_i - t_{i1})$ is the number of days between evaluations. Plant heights were measured on 5 May and 28 Jun. The average maximum temperatures for 3-30 Jun and 1-8 Jul were 92.8ºF and 91.0ºF; average minimum temperatures were 53.5ºF and 57.5ºF; and total rainfall was 3.51 in. and 0.61 in., respectively. One-way analysis of variance was performed using the general linear model procedure with SAS v. 9.4 statistical software and means were separated using Fisher's LSD test.

Bacterial blight disease pressure was low to moderate with non-treated, inoculated plants showing 22.0% disease severity by 8 Jul. Plants treated with Postiva, Proud 3, Stargus, TDA-NC-1 (three application dates), Tril-21 (two application dates) and Triathlon had the most reduction in disease severity and were similar to the non-treated, non-inoculated control plants. Plants treated with Postiva, Proud 3, Tril-21 (two application dates) and Triathlon also had the lowest disease progress, which were similar to the non-treated, non-inoculated control. Defoliation occurred in all plants with the highest percentage being the non-treated, inoculated plants at 4.5%. Plant height increase was not significantly different among treated or control plants. Phytotoxicity was not observed in any of the treated lilac plants.

Treatment and rate/100 gal	Application dates*	Bacterial blight			Height increase (in)
		Mean severity (%) (8 Jul)	AUDPC	Defoliation (%)	
BW 165N 4 lb + Capsil 2 fl oz	1, 4, 6	8.0 cde**	108.5 bc	1.4 cd	12.4 a
MBI-121 128 fl oz	1, 4, 6	10.0 cd	128.8 bc	2.1 bcd	17.6 a
Postiva 10 fl oz	2, 6	2.5 fg	62.0 cd	1.2 d	7.0 a
Proud 3 4 qt	1, 3, 5	4.0 efg	91.0 bcd	2.1 bcd	10.4 a
Stargus 128 fl oz	1, 4, 6	4.5 efg	113.8 bc	0.9 d	11.2 a
TDA-NC-1 570 g + Silwet	1, 2, 3, 4, 5, 6	7.0 c-f	129.5 bc	1.6 bcd	18.7 a
TDA-NC-1 570 g + Silwet	1, 3, 5	5.0 d-g	125.3 bc	1.6 bcd	17.8 a
Tril-21 64 oz	1, 3, 6	7.5 c-f	113.8 bc	2.2 bcd	11.1 a
Tril-21 64 oz	4, 6	4.0 efg	88.9 bcd	0.7 d	21.4 a
Camelot O 128 fl oz	2, 4, 6	10.5 c	145.3 b	1.1 d	17.4 a
KleenGrow 0.0025 fl oz	4, 6	8.0 cde	165.9 b	1.3 cd	14.8 a
Grotto 1.5 gal	1, 2, 4, 6	28.0 a	402.5 a	3.4 ab	19.6 a
Triathlon 3 qt	1, 2, 4, 6	6.0 c-g	108.5 bc	0.9 d	19.3 a
Grotto 1 gal + Triathlon 2 qt	1, 2, 4, 6	29.0 a	410.9 a	3.2 abc	14.0 a
Non-treated, inoculated control		22.0 b	357.0 a	4.5 a	19.1 a
Non-treated, non-inoculated control		1.0 g	17.5 d	0.8 d	13.0 a
P-value	-	<0.0001	<0.0001	0.006	1.0

*Application dates: 1=4 Jun; 2=7 Jun; 3=10 Jun ; 4=14 Jun ; 5=17 Jun ; 6=21 Jun.

**Values are the means of five replications; treatments followed by the same letter within a column are not significantly different at $P \leq 0.05$.

RED MAPLE (*Acer rubrum* 'Brandywine')
Phytophthora root rot; *Phytophthora nicotianae*

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Efficacy of fungicides and biofungicides for the control of Phytophthora root rot of red maple, 2021.

Bare rooted red maple plants were transplanted in no. 1 size black nursery containers filled with soilless potting mix (Morton's Nursery Mix: Canadian sphagnum peat [55–65%]) on 10 Feb. Treatment were arranged in a completely randomized design with six single-plant replications in a greenhouse at the Otis L. Floyd Nursery Research Center in McMinnville, TN. On 7 Mar, 0.2 oz of 18-6-8 Nutricote controlled-release granular fertilizer was top dressed in each container. Plants were watered twice per day for 3 minutes using an overhead irrigation system. Plants in black plastic containers were artificially inoculated with *P. nicotianae* colonized on rice grains for 10 days. Four rice grains were buried 2 inches below the surface potting mix on four opposite sides of the red maple plant on 3 Jun. Non-treated, non-inoculated and non-treated, inoculated plants served as controls. On 9 Jun, TerraClean 5.0 was drenched into the potting mix 24 hr prior to transplanting in dedicated containers. On 10 Jun, TerraGrow at 1.0 oz/10 gal rate was prepared and dedicated rooted plants for this treatment were dipped into mixed solution prior to planting; 1 Jul, these plants received TerraGrow at 0.4 oz/10 gal as a drench and the application continued in 3 weeks interval. The rest of the treatments were applied as drench starting on 10 Jun and ending on 2 Sep following a particular application interval indicated in the table below. Plant height was measured on 2 Jun and 14 Sep and the height increase was calculated by subtracting initial height from final height. Plant fresh weight and root fresh weight were recorded for all plants on 14 Sep, and roots were assessed for Phytophthora root rot disease severity using a scale of 0-100% of roots damaged. Average maximum temperatures for Jun, Jul, Aug, and Sep were 86.4, 85.6, 84.0, and 83.4ºF; average minimum temperatures were 65.6, 68.7, 67.8 and 59.2ºF, respectively. One-way analysis of variance (ANOVA) was performed using the general linear models (GLM) procedure in SAS software v. 9.4 and when the effects were significant, the *post hoc* Fisher's LSD test was used for means comparisons.

Phytophthora root rot disease pressure was high in this trial with mean root rot severity in the non-treated, inoculated control exceeding 50%. All fungicide and biofungicide treatments significantly reduced Phytophthora root rot severity compared to the non-treated, inoculated controls. The treatments most effective in reducing Phytophthora root rot severity were Subdue MAXX, Segovis, Pageant Intrinsic. There were no significant differences in plant height, plant fresh weight and root fresh weight among the treatments at the end of the trial. Phytotoxicity was not observed in any of the treated red maple plants.

Treatment and rate	Application dates[z]	Plant height increase (in)	Plant fresh weight (oz)	Root fresh weight (oz)	Phytophthora root rot severity (%)[y]
Empress Intrinsic 23.8SC 6 fl oz/100 gal	2, 5, 8, 11, 14	29.6 a[x]	6.0 a	1.8 a	20.0 def
Grotto 1 gal/100 gal	2, 5, 8, 11, 14	23.3 a	5.1 a	1.7 a	39.2 b
Mural 45WG 3 oz/100gal	2, 5, 8, 11, 14	26.7 a	5.8 a	2.0 a	23.3 cde
Orkestra Intrinsic 21.26SC 10 fl oz/100 gal	2, 5, 8, 11, 14	31.3 a	6.6 a	2.0 a	20.8 def
Pageant Intrinsic 38WG 18 oz/100 gal	2, 5, 8, 11, 14	26.9 a	6.5 a	2.3 a	16.7 efg
RootShield Plus® WP 8 oz/100 gal	2, 8, 14	28.6 a	5.5 a	2.0 a	28.3 c
Segovis 1.67SC 3.2 fl oz/100 gal	2, 5, 8, 11, 14	32.0 a	5.9 a	1.9 a	15.8 fg
Stargus L 128 fl oz/100 gal	2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14	28.1 a	6.1 a	2.1 a	20.8 def
Subdue MAXX 22ME 2 fl oz/100 gal	2,11	30.4 a	6.5 a	2.0 a	11.7 g
TerraClean 5.0 0.2% (v/v)	1	26.9 a	6.2 a	2.4 a	26.7 cd
TerraGrow 1.0 oz/10 gal	2				
TerraGrow 0.4 oz/10 gal	5, 8, 11, 14				
Non-treated, inoculated		23.7 a	5.5 a	1.8 a	53.3 a
Non-treated, non-inoculated		31.2 a	6.5 a	2.4 a	0.0 h
P-value		0.6934	0.9600	0.8795	<0.0001

[z]Application dates: 1=9 Jun; 2=10 Jun; 3=17 Jun; 4=24 Jun; 5=1 Jul; 6=8 Jul; 7=15 Jul; 8=22 Jul; 9=29 Jul; 10=5 Aug; 11=12 Aug; 12=19 Aug; 13=26 Aug; 14=2 Sep.

[y]Disease severity was based on percentage of roots damaged.

[x]Values are the means of six plants; treatments followed by the same letter within a column are not significantly different at $P \leq 0.05$.

RED MAPLE (*Acer rubrum* 'Brandywine')
Rhizoctonia root rot; *Rhizoctonia solani*

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Efficacy of fungicides and biofungicides for the control of Rhizoctonia root rot of red maple, 2021.

A greenhouse experiment was carried out at the Otis L. Floyd Nursery Research Center in McMinnville, TN. Soilless potting mix (Morton's Nursery Mix: Canadian sphagnum peat [55–65%]) was filled in no. 1 size black nursery containers and bare-rooted red maple plants (*A. rubrum)* were transplanted on 10 Feb. Treatments were arranged in a completely randomized design with six single-plant replications. On 7 Mar, 0.2 oz of 18-6-8 Nutricote controlled-release granular fertilizer was top dressed in each container. Plants were watered using an overhead irrigation system twice per day for 3 minutes. Plants in each container were drench-inoculated with a *Rhizoctonia solani* slurry at the rate of 10 fl oz/container on 3 Jun. Seven-day old cultures of *R. solani* grown on PDA medium were homogenized in the sterile distilled water and slurry was prepared at the rate of 1 petri plate/L. Non-treated, non-inoculated and non-treated, inoculated plants served as controls. On 9 Jun, TerraClean 5.0 was drenched into the potting mix 24 hr prior to transplanting in dedicated containers. On 10 Jun, TerraGrow at 1.0 oz/10 gal rate was prepared and dedicated rooted plants for this treatment were dipped into mixed solution prior to planting; 1 Jul, these plants received TerraGrow at 0.4 oz/10 gal as a drench and the application continued in 3 weeks interval. The rest of the treatments were applied as drench starting on 10 Jun and ending on 2 Sep following a particular application interval indicated in the table below. Plant height was measured on 2 Jun and 14 Sep and the height increase was calculated by subtracting initial height from final height. Plant fresh weight and root fresh weight were recorded for all plants on 14 Sep, and roots were assessed for Rhizoctonia root rot disease severity using a scale of 0-100% of roots damaged. Average maximum temperatures for Jun, Jul, Aug, and Sep were 86.4, 85.6, 84.0, and 83.4ºF; average minimum temperatures were 65.6, 68.7, 67.8, and 59.2ºF, respectively. One-way analysis of variance (ANOVA) was performed using the general linear models (GLM) procedure in SAS software v. 9.4 and when the effects were significant, the *post hoc* Fisher's LSD test was used for means comparisons.

Rhizoctonia root rot disease pressure was high in this trial with mean root rot severity in the non-treated, inoculated control exceeding 50%. All fungicide and biofungicide treatments significantly reduced Rhizoctonia root rot severity compared to the non-treated, inoculated controls. The treatments most effective in reducing Rhizoctonia root rot severity were Pageant Intrinsic, Empress Intrinsic, RootShield Plus and the combination of TerraClean 5.0 + TerraGrow program. There were no significant differences in plant height, plant fresh weight and root fresh weight among the treatments at the end of the trial. Phytotoxicity was not observed in any of the treated red maple plants.

Treatment and rate	Application dates[z]	Plant height increase (in)	Plant fresh weight (oz)	Root fresh weight (oz)	Rhizoctonia root rot severity (%)[y]
Empress Intrinsic 23.8SC 6 fl oz/100 gal	2, 5, 8, 11, 14	29.9 a[x]	5.9 a	2.4 a	15.8 cd
Grotto 1 gal/100 gal	2, 5, 8, 11, 14	27.7 a	5.9 a	2.2 a	27.5 b
Mural 45WG 3 oz/100 gal	2, 5, 8, 11, 14	31.8 a	5.7 a	2.5 a	21.7 bc
Pageant Intrinsic 38WG 18 oz/100 gal	2, 5, 8, 11, 14	29.4 a	6.1 a	2.6 a	14.2 d
RootShield Plus® WP 8 oz/100 gal	2, 8, 14	32.7 a	6.3 a	2.7 a	20.8 bcd
Stargus L 128 fl oz/100 gal	2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14	33.1 a	6.4 a	3.1 a	23.3 b
TerraClean 5.0 0.2% (v/v)	1				
TerraGrow 1.0 oz/10 gal	2				
TerraGrow 0.4 oz/10 gal	5, 8, 11, 14	34.9 a	6.6 a	2.6 a	20.8 bcd
Non-treated, inoculated		27.5 a	5.8 a	2.2 a	51.7 a
Non-treated, non-inoculated		37.9 a	6.6 a	3.2 a	0.0 e
P-value		0.633	0.996	0.6392	<0.0001

[z]Application dates: 1=9 Jun; 2=10 Jun; 3=17 Jun; 4=24 Jun; 5=1 Jul; 6=8 Jul; 7=15 Jul; 8=22 Jul; 9=29 Jul; 10=5 Aug; 11=12 Aug; 12=19 Aug; 13=26 Aug; 14=2 Sep.

[y]Disease severity was based on percentage of roots affected.

[x]Values are the means of six plants; treatments followed by the same letter within a column are not significantly different at $P \leq 0.05$.

ROSE (*Rose* sp. 'Miniature')
Black leaf spot; *Diplocarpon rosae*
Cercospora leaf spot; *Cercospora rosicola*

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Evaluation of fungicides for the control of black leaf spot and Cercospora leaf spot of rose, 2021.

Rose 'Miniature' plants were potted in 3-gallon containers filled with Morton's Nursery mix (processed pine bark (55-65%), Canadian sphagnum peat, and sand). Each plant was fertilized with 6.8 fl oz of 24-8-16 Miracle-Gro® All Purpose Plant Food and 0.5 oz of 18-6-8 Nutricote controlled release fertilizer on 7 May. Six single-plant replications per treatment were arranged in a completely randomized design in a shade house under 56% shade at the Otis L. Floyd Nursery Research Center in McMinnville, TN. Plants were irrigated using an overhead irrigation system for 15 minutes twice a day in May, Jun and Jul. Three treatments (Broadform 4 fl oz/100 gal, Mural 6 oz/100 gal and KleenGrow 0.25 fl oz/gal) were applied to run-off using a backpack CO_2-pressurized sprayer with a TeeJet XR8002VS nozzle at 30 psi on a 14-day interval and one treatment (Broadform 3 fl oz/100 gal) was applied via drench (13.5 fl oz/plant) on a 28-day interval, beginning on 25 May and ending on 22 Jun. Severity of black leaf spot, Cercospora leaf spot, defoliation and phytotoxicity were determined on 27 May, 3, 10, 17 and 24 Jun, and 1 and 8 Jul using a scale of 0-100% foliage area affected. The area under the disease progress curve (AUDPC) was calculated according to the formula: $\sum([(x_i + x_{i-1})/2](t_i - t_{i-1}))$, where x_i is the rating at each evaluation time and $(t_i - t_{i-1})$ is the number of days between evaluations. Plant heights were measured on 19 May and 1 Jul. Average maximum temperatures for 25-31 May, Jun and 1-8 Jul were 90.6ºF, 92.8ºF and 91.0ºF; average minimum temperatures were 44.7ºF, 53.5ºF, and 57.5ºF; and total rainfall was 0.66 in., 4.12 in., and 0.61 in., respectively. One-way analysis of variance was performed using the general linear model's procedure with SAS v. 9.4 statistical software and means were separated using Fisher's LSD test.

Black leaf spot and Cercospora leaf spot both developed from natural inoculum. Black leaf spot disease pressure was low for non-treated control plants, which had 19.0% mean disease severity by 8 Jul. There were no significant differences in the mean disease severity and progress of black leaf spot in any of the treated versus non-treated control plants. Cercospora leaf spot disease pressure was low, with the mean disease severity of the non-treated controls being 5.0%. There were no significant differences in the mean disease severity and progress of Cercospora leaf spot in any of the treated versus non-treated control plants. Defoliation was low (<15%), with plants treated with the drench application of Broadform (3 fl oz) and the non-treated control plants experiencing the highest degree of defoliation at 12.0% and 9.0%, respectively. Treated and non-treated control plants were similar in plant height increase. Phytotoxicity was not observed in any of the treated rose plants.

		Black leaf spot		Cercospora leaf spot			
Treatment and rate	Application dates[z]	% Mean severity (8 Jul)	AUDPC	% Mean severity (8 Jul)	AUDPC	Defoliation (%)	Height increase (in.)
Broadform 3 fl oz/100 gal	1, 3	20.0 a[zz]	282.8 a	4.9 a	101.9 a	12.0 a	0.6 a
Broadform 4 fl oz/100 gal	1, 2, 3	12.0 a	247.1 a	2.9 a	50.8 a	3.4 c	0.8 a
Mural 45WG 6 oz/100 gal	1, 2, 3	10.0 a	152.6 a	3.7 a	32.6 a	3.2 c	1.7 a
KleenGrow 0.25 fl oz/gal	1, 2, 3	12.0 a	225.8 a	1.9 a	21.4 a	6.2 bc	1.3 a
Non-treated control	-	19.0 a	331.1 a	5.0 a	92.1 a	9.0 ab	0.4 a
P-value	-	0.1	0.08	0.4	0.2	0.01	0.4

[z]Application dates: 1 = 25 May; 2 = 8 Jun; 3 = 22 Jun.
[zz]Values are the means of six replications; treatments followed by the same letter within a column are not significantly different at $P \leq 0.05$.

ROSE (*Rosa* sp. 'Queen Elizabeth')
Black spot; *Diplocarpon rosae*

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Evaluation of fungicides for the control of black spot of rose, 2021.

Rose 'Queen Elizabeth' plants were potted in 5-gallon containers filled with Morton's Nursery mix (processed pine bark [55-65%], Canadian sphagnum peat, and sand). Each plant was fertilized with 13.5 fl oz of 24-8-16 Miracle-Gro® All Purpose Plant Food and 1.0 oz of 18-6-8 Nutricote controlled release fertilizer on 7 May. Six single-plant replications per treatment were arranged in a completely randomized design in a shade house under 56% shade at the Otis L. Floyd Nursery Research Center in McMinnville, TN. Plants were irrigated using overhead irrigation for 15 minutes twice a day in Jun, Jul, Aug and Sep. Treatments were applied to run-off using a backpack CO_2-pressurized sprayer with TeeJet XR8002VS nozzle at 30 psi on a 2-week or 4-week interval as separate trial. Severity of black spot, defoliation and phytotoxicity were determined weekly with final evaluation at 21 days after last spray application for different interval (2 or 4-week interval) using a scale of 0-100% foliage area affected. The area under the disease progress curve (AUDPC) was calculated according to the formula: $\sum([(x_i + x_{i-1})/2](t_i - t_{i-1}))$ where x_i is the rating at each evaluation time and $(t_i - t_{i-1})$ is the number of days between evaluations. Plant heights were measured on 29 Jun and 15 Sep. Average maximum temperatures for 30 Jun, Jul, Aug and 1-15 Sep were 91.1ºF, 94.8ºF, 96.0ºF, and 84.5ºF; average minimum temperatures were 69.5ºF, 57.5ºF, 67ºF and 65.9ºF; and total rainfall was 0.0 in, 3.72 in. 10.0 in. and 2.5 in., respectively. One-way analysis of variance was performed using the general linear model procedure with SAS v. 9.4 statistical software and means were separated using Fisher's LSD test.

Black spot infection occurred naturally in this trial. Black spot disease pressure was moderate to high with non-treated control plants showing 42.5 % and 84.2% disease severity at the 2- and 4-week interval, respectively. All treated plants had significantly less black spot mean disease pressure and progression compared to the non-treated control rose plants at both the 2- and 4-week intervals. At the 2-week interval, all treated plants were similar in mean disease severity and progression. At the 4-week interval, all rates of Postiva were similar to each other on black spot disease severity and progress; they were more effective on reducing black leaf spot disease severity and progress compared to Mural. All treated rose plants had reduced defoliation compared to the non-treated control except for plants treated with Mural at the 4-week interval. There were no significant differences in plant height increase among any of the treated and non-treated control rose plants. Phytotoxicity was not observed in any of the treated rose plants.

		Black spot			
Treatment and rate/100 gal	Application dates[z]	Mean severity (%)	AUDPC	Defoliation (%)	Height increase (in)
Postiva 200 SC 14 fl oz + Capsil 4 fl oz	1, 2, 3	5.6 b[zz]	150.2 b	0.0 b	8.1 a
Postiva 200 SC 20 fl oz + Capsil 4 fl oz	1, 2, 3	13.3 b	273.0 b	0.0 b	8.0 a
Postiva 200 SC 28 fl oz + Capsil 4 fl oz	1, 2, 3	13.8 b	299.0 b	0.8 b	6.4 a
Mural 45WG 7 oz + Capsil 4 fl oz	1, 2, 3	20.2 b	403.4 b	2.9 b	5.5 a
Non-treated control	-	42.5 a	797.7 a	20.8 a	8.5 a
P-value	-	0.006	0.002	0.0113	0.7

[z]Application dates (2-week interval): 1 = 30 Jun; 2 = 14 Jul; 3 = 28 Jul.
[zz]Values are the means of six replications; treatments followed by the same letter within a column are not significantly different at $P \leq 0.05$.

Treatment and rate/100 gal	Application dates*	Black spot		Defoliation (%)	Height increase (in)
		Mean severity (%)	AUDPC		
Postiva 200 SC 14 fl oz + Capsil 4 fl oz	1, 2, 3	20.4 c**	649.3 bc	7.5 b	7.0 a
Postiva 200 SC 20 fl oz + Capsil 4 fl oz	1, 2, 3	14.2 c	382.1 c	6.3 b	7.9 a
Postiva 200 SC 28 fl oz + Capsil 4 fl oz	1, 2, 3	20.8 c	646.9 bc	15.0 b	9.5 a
Mural 45WG 7 oz + Capsil 4 fl oz	1, 2, 3	55.0 b	1634.2 ab	46.7 a	7.2 a
Non-treated control	-	84.2 a	2629.4 a	63.3 a	8.5 a
P-value	-	<0.0001	0.0005	0.0009	0.8

*Application dates (4-week interval): 1 = 30 Jun; 2 = 28 Jul; 3 = 25 Aug.

**Values are the means of six replications; treatments followed by the same letter within a column are not significantly different at $P \leq 0.05$.

For more information on this report or to receive copies of this or similar publications, please contact:

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