Woody Ornamental Disease Management Research Reports 2017

Apple, Crabapple, Crapemyrtle, Flowering Dogwood, Hydrangea,
Lupine, Viburnum and Annual Vinca

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McMinnville, Tennessee

January 2018

TENNESSEE STATE UNIVERSITY

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Acknowledgments

This work was funded by Tennessee State University- Otis L. Floyd Nursery Research Center, and cooperating agro-chemical and biofungicide companies. Plants used in these studies were provided by USDA-ARS researchers and nursery growers. Those supports are greatly appreciated.

The support staff of the Otis L. Floyd Research Station provided excellent technical assistance. Their cooperation and input is greatly appreciated.

Fungicides and biologicals evaluated in these studies were provided by:

BASF Corp.

BioSafe Systems LLC.

BioWorks, Inc.

Italpollina USA, Inc.

Marrone Bio Innovations

OHP, Inc.

Syngenta Crop Protection

APPLE (*Malus domestica* 'Mutsu')
Fireblight; *Erwinia amylovora*

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Evaluation of products for the management of fireblight on container-grown apples, 2017.

Apple (*Malus domestica*) 'Mutsu' plants grown in no. 5 nursery containers in 100% bark substrate were provided by a commercial nursery on 27 Apr. Six single-plant replications per treatment were arranged in a randomized complete block design on a gravel pad at the Otis L. Floyd Nursery Research Center in McMinnville, TN. Cyclic irrigation was applied in each container three times for 3 minutes daily using micro-spray emitter (160° Spot-Spitter fan emitter (Roberts Irrigation Company, Inc., San Marcos, CA)). Treatments except TerraGrow were applied to run-off using a backpack CO_2-pressurized sprayer at 40 psi. TerraGrow was applied four times every three week as a drench application. Blossom blight and shoot blight symptoms were assessed on blossom clusters and terminal shoots by counting all cluster and shoot strikes on 7 Jun and 12 Jul, respectively. Height and trunk diameter (6 in above the substrate surface) were measured on 15 May and 12 Jul. Average maximum temperatures for 27-30 Apr, 1-31 May, 1-30 Jun, and 1-12 Jul were 82.5, 81.5, 84.4 and 87.5ºF; average minimum temperatures were 60.6, 56.5, 62.9 and 67.1ºF; and total rainfall was 0.66, 4.38, 4.41, and 3.26 in., respectively. Analysis of variance was performed using the general linear models procedure with SAS statistical software and means were separated using Fisher's LSD test.

Fireblight infection occurred naturally in this trial. Fireblight disease pressure was high, and mean blossom blight incidence reached 77.2% on 7 Jun in the non-treated control apple plants. Mean shoot blight incidence reached 18.3% on 12 Jul in the non-treated control plants. All fungicide treatments significantly reduced incidence of blossom blight and shoot blight compared to non-treated control plants. Apple plant trunk diameter and height were not significantly different among treated and non-treated control plants. Phytotoxicity was not observed in any of the treated plants.

Treatment and rate	Application method	Application dates*	Incidence of blossom blight (%)	Incidence of shoot blight (%)	Plant trunk diameter (in) (12 Jul)	Plant height (in) (12 Jul)
Areca™ 2.5 lb/100 gal	Foliar	1,2	42.6 b**	10.0 b	1.12 a	83.3 a
Cueva 8.1 fl oz/1 gal	Foliar	1,2	34.4 b	5.8 b	1.08 a	81.6 a
Kocide 3000 46.1DF 14 g/1 gal	Foliar	1,2	42.8 b	10.0 b	1.05 a	82.3 a
Triathlon BA 3 qt/100 gal	Foliar	1,2	43.3 b	9.2 b	1.07 a	83.6 a
ZeroTol 2.0 1.28 fl oz/gal + OxiPhos 0.42 fl oz/gal + TerraGrow 0.4 oz/10 gal	Foliar + Foliar + Drench	1,2,3,4 1,2,3,4 1,4,5,6	47.2 b	11.7 b	1.03 a	80.4 a
Non-treated control			77.2 a	18.3 a	1.07 a	82.9 a
P-value			0.0114	0.0112	0.8504	0.8818

*Application dates for treatments were: 1= 3 May; 2= 10 May; 3= 17 May; 4= 24 May; 5= 14 Jun; 6= 5 Jul.
**Values are the means of six replications; treatments followed by the same letter within a column are not significantly different ($P \leq 0.05$).

FLOWERING CRABAPPLE (*Malus* sp. 'Sugar Tyme®')
Fireblight; *Erwinia amylovora*

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Evaluation of products for the management of fireblight on container-grown flowering crabapples, 2017.

Crabapple 'Sugar Tyme®' plants grown in no. 5 nursery containers in 100% bark substrate were provided by a commercial nursery on 27 Apr. Six single-plant replications per treatment were arranged in a randomized complete block design on a gravel pad at the Otis L. Floyd Nursery Research Center in McMinnville, TN. Cyclic irrigation was applied in each container three times for 3 minutes daily using micro-spray emitter (160° Spot-Spitter fan emitter (Roberts Irrigation Company, Inc., San Marcos, CA)). Treatments except TerraGrow were applied to run-off using a backpack CO_2-pressurized sprayer at 40 psi. TerraGrow was applied four times as a drench application on three-wk intervals. Control plants were sprayed or drenched with water. Blossom blight and shoot blight symptoms were assessed on blossom clusters and terminal shoots by counting all cluster and shoot strikes on 7 Jun and 12 Jul, respectively. Height and trunk diameter (6 in above the substrate surface) were measured on 15 May and 12 Jul. Average maximum temperatures for 27-30 Apr, 1-31 May, 1-30 Jun, and 1-12 Jul were 82.5, 81.5, 84.4 and 87.5ºF; average minimum temperatures were 60.6, 56.5, 62.9 and 67.1ºF; and total rainfall was 0.66, 4.38, 4.41, and 3.26 in., respectively. Analysis of variance was performed using the general linear models procedure with SAS statistical software and means were separated using Fisher's LSD test.

Fireblight infection occurred naturally in this trial. Fireblight disease pressure was high, and mean blossom blight incidence reached 70.6% on 7 Jun in the non-treated control flowering crabapple plants. Mean shoot blight incidence reached 8.2% on 12 Jul in the non-treated control plants. All fungicide treatments significantly reduced incidence of blossom blight and shoot blight compared to non-treated control crabapple plants. Flowering crabapple plant trunk diameter and height were not significantly different among the treated and non-treated control plants. Phytotoxicity was not observed in any of the treated plants.

Treatment and rate	Application method	Application dates*	Incidence of blossom blight (%)	Incidence of shoot blight (%)	Plant trunk diameter (in) (12 Jul)	Plant height (in) (12 Jul)
Areca™ 2.5 lbs/100 gal	Foliar	1,2	27.6 b**	3.0 b	0.93	84.7
Cueva 8.1 fl oz/1 gal	Foliar	1,2	17.1 b	2.5 b	0.85	78.7
Kocide 3000 46.1DF 14 g/1 gal	Foliar	1,2	23.3 b	2.5 b	0.91	85.9
Triathlon BA 3 qt/100 gal	Foliar	1,2	27.3 b	1.5 b	0.99	81.7
ZeroTol 2.0 1.28 fl oz/gal + OxiPhos 0.42 fl oz/gal + TerraGrow 0.4 oz/10 gal	Foliar + Foliar + Drench	1,2,3,4 1,2,3,4 1,4,5,6	27.9 b	2.5 b	0.96	83.0
Non-treated control			70.6 a	8.2 a	0.96	85.3
P-value			<.0001	0.0074	0.1553	0.4790

*Application dates for treatments were: 1=3 May; 2=10 May; 3=17 May; 4=24 May; 5=14 Jun; 6=5 Jul.
**Values are the means of six replications; treatments followed by the same letter within a column are not significantly different ($P \leq 0.05$).

CRAPEMYRTLE (*Lagerstroemia indica* 'Whit I')
Cercospora leaf spot; *Cercospora lythracearum*

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Evaluation of fungicides for the control of Cercospora leaf spot of crapemyrtle, 2017.

Crapemyrtle 'Whit I' (*Lagerstroemia indica* Raspberry Sundae™) plants were potted in no. 3 nursery containers in Morton's no. 2 Grow Mix on 22 May and each pot was top-dressed with 1.23 oz of 18-6-12 Osmocote Classic controlled release fertilizer. Five single-plant replications per treatment were arranged in a randomized complete block design outdoor under 56% shade at the Otis L. Floyd Nursery Research Center in McMinnville, TN. Plants were irrigated for 3 minutes twice a day using light green coded SPOT-SPITTER® (Primerus Products, LLC). The initial fungicide application was made when disease was first observed on leaves (0.5-1% disease severity). Fungicide treatments were applied to run-off using a backpack CO_2-pressurized sprayer at 40 psi on 13 and 27 Jun. Control plants were sprayed with water. The severity of Cercospora leaf spot was evaluated weekly from 20 Jun to 26 Jul using a scale of 0-100% foliage area affected, and the area under the disease progress curve (AUDPC) was calculated. Plant quality was evaluated on 26 Jul using a scale of 1-9 where 1 is dead, 6 is commercially acceptable and 9 is a perfect plant. Plant height and width were measured on 12 Jun and 26 Jul. Average maximum temperatures for 12-30 Jun and 1-27 Jul were 85.6 and 89.9ºF; average minimum temperatures were 65.0 and 69.1ºF; and total rainfall was 2.60 and 4.82 in., respectively. Analysis of variance was performed using the general linear models procedure using SAS statistical software and means were separated using Fisher's LSD test.

Cercospora leaf spot infections occurred naturally and disease pressure was high. The final disease severity mean value was 61% in the non-treated control plants. All fungicide treatments significantly reduced Cercospora leaf spot severity and disease progress compared to non-treated control, but there were no differences among treatments. Plant height and width were not significantly different among treated and non-treated control plants on 26 Jul. Phytotoxicity was not observed in any of the treated crape myrtle plants. Non-treated control plants were not commercially acceptable due to the level of disease at the end of the experiment; however, all treated plants were commercially acceptable or better (data not shown).

Treatment and rate	Cercospora leaf spot*		Plant width (in) (26 Jul)	Plant height (in) (26 Jul)
	Disease severity (%) (26 Jul)	AUDPC		
ManKocide DF 0.56 oz/1 gal	3.4 b**	79.5 b	13.9	25.9
ManKocide DF 1.13 oz/1 gal	2.3 b	51.1 b	15.0	25.5
Astun™ SC 15.00 fl oz/100 gal	2.1 b	41.9 b	15.8	26.1
Astun™ SC 17.50 fl oz/100 gal	1.4 b	30.8 b	16.0	25.9
Mural 45WG 7.00 oz/100 gal	3.5 b	58.6 b	12.9	24.9
Non-treated control	61.0 a	1018.2 a	14.9	28.3
P-value	0.0001	0.0001	0.5647	0.6639

*Disease ratings and AUDPC were based on percentage of foliage area affected.
**Values are the means of five replications; treatments followed by the same letter within a column are not significantly different ($P \leq 0.05$).

CRAPEMYRTLE (*Lagerstroemia* spp. 'Muskogee' and 'Whit I')
Powdery mildew; *Erysiphe lagerstroemia*

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Evaluation of fungicide rotations at different application intervals for the control of powdery mildew of crapemyrtle, 2017.

Crapemyrtle 'Muskogee' (*Lagerstroemia indica* x *L. fauriei*) and 'Whit I' (*L. indica* Raspberry Sundae™) plants were potted in no. 1 nursery containers in Morton's no. 2 Grow Mix. Each plant was fertilized with 0.5 oz of 18-6-12 Osmocote Classic controlled release fertilizer on 16 May and 0.5 oz of 24-8-16 Miracle-Gro® All Purpose Plant Food on 19 May. Twelve single-plant replications per treatment were arranged in a randomized complete block design in a greenhouse at the Otis L. Floyd Nursery Research Center in McMinnville, TN. Plants were watered with a drip irrigation system two times per day for 5 minutes. The initial fungicide application was made after observing the first symptoms of powdery mildew. Treatments were applied in a 14 or 21-day rotation program to run-off using a backpack CO_2-pressurized sprayer at 40 psi beginning on 8 Jun and ending on 10 Aug. Control plants were sprayed with water. The severity of powdery mildew was evaluated on 15, 22 and 29 Jun; 6, 13, 20 and 27 Jul; 3, 10 and 17 Aug using a scale of 0-100% foliage area affected, and the area under the disease progress curve (AUDPC) was calculated. Plant quality was evaluated on 17 Aug using a scale of 1-9 where 1 is dead, 6 is commercially acceptable and 9 is a perfect plant. Plant height and width were measured on 8 Jun and 17 Aug. Average maximum temperatures for 8-30 Jun, 1-31 Jul and 1-17 Aug were 80.2, 83.6 and 83.2ºF; average minimum temperatures were 61.0, 65.7 and 64.5ºF, respectively. Analysis of variance was performed for each cultivar using the general linear models procedure with SAS statistical software and means were separated using Fisher's least significant difference test.

Powdery mildew infections occurred naturally in the greenhouse and disease pressure was moderate to high. The final disease severity means were 37.1% and 53.5% in the non-treated control Muskogee and Whit I plants, respectively. Both fungicide rotation programs significantly reduced powdery mildew severity and disease progress compared to the non-treated control in both cultivars. The 14-day rotation program significantly reduced powdery mildew severity and disease progress compared to the 21-day rotation program in both cultivars. Plant height and width was not significantly different among treated plants on a 14-day schedule or 21-day schedule and non-treated control plants on 17 Aug in both cultivars. Phytotoxicity was not observed in any of the treated crapemyrtle cultivars. Non-treated control crapemyrtle plants for both cultivars were not commercially acceptable due to disease at the end of the experiment; however, all treated plants were commercially acceptable or better (data not shown).

Treatment and rate	Cultivar	Application dates[z]	Spray interval (days)	Powdery mildew		Plant height (in)	Plant width (in)
				Disease severity (%)[y] (17 Aug)	AUDPC[y]		
Mural 45WG 7 oz/100 gal	Muskogee	1	14	2.8 c[x]	69.3 c	8.6	21.7
alt Palladium WDG 6 oz/100 gal		2					
alt Concert II 4.3SE 35 fl oz/100 gal		4					
alt Palladium WDG 6 oz/100 gal		5					
Mural 45WG 7 oz/100 gal	Muskogee	1	21	7.9 b	177.5 b	7.9	24.5
alt Palladium WDG 6 oz/100 gal		3					
alt Concert II 4.3SE 35 fl oz/100 gal		6					
alt Palladium WDG 6 oz/100 gal		7					
Non-treated control	Muskogee			37.1 a	1123.4 a	7.8	23.6
P-value	Muskogee			≤0.0001	≤0.0001	0.4659	0.5118
Mural 45WG 7 oz/100 gal	Whit I	1	14	4.7 c[x]	122.2 c	8.9	18.0
alt Palladium WDG 6 oz/100 gal		2					
alt Concert II 4.3SE 35 fl oz/100 gal		4					
alt Palladium WDG 6 oz/100 gal		5					
Mural 45WG 7 oz/100 gal	Whit I	1	21	10.8 b	308.0 b	9.6	20.7
alt Palladium WDG 6 oz/100 gal		3					
alt Concert II 4.3SE 35 fl oz/100 gal		6					
alt Palladium WDG 6 oz/100 gal		7					
Non-treated control	Whit I			53.5 a	1382.1 a	8.6	20.4
P-value	Whit I			≤0.0001	≤0.0001	0.4350	0.3196

[z]Application dates: 1=8 Jun; 2=22 Jun; 3=29 Jun; 4=6 Jul; 5=20 Jul; 6=21 Jul; 7=10 Aug.
[y]Disease severity ratings and AUDPC were based on percentage foliage affected.
[x]Values are the means of twelve 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*

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Evaluation of experimental fungicides for the control of powdery mildew of dogwood, 2017.

Flowering dogwood (*Cornus florida*) cultivar 'Cherokee Princess' seedlings were potted in no. 1 nursery containers in Morton's no. 2 Grow Mix on 16 May. Each plant was top-dressed with 0.5 oz of 18-6-12 Osmocote Classic controlled release fertilizer. Four single-plant replications per treatment were arranged in a randomized complete block design in a greenhouse at the Otis L. Floyd Nursery Research Center in McMinnville, TN. Flowering dogwood plants were hand watered two times per day. Treatments were applied to run-off using a backpack CO_2-pressurized sprayer at 40 psi on 3 and 17 Jul. Control plants were sprayed with water. The severity of powdery mildew was evaluated on 10, 17, 24 and 31 Jul; 7 and 17 Aug using a scale of 0-100% foliage area affected, and the area under the disease progress curve (AUDPC) was calculated. Plant quality was evaluated on 17 Aug using a scale of 1-9 where 1 is dead, 6 is commercially acceptable and 9 is a perfect plant. Plant height and width were measured on 27 Jun and 17 Aug. Average maximum temperatures for 3-31 Jul and 1-17 Aug were 86.2 and 86.0ºF; average minimum temperatures were 54.5 and 59.9ºF, respectively. Analysis of variance was performed using the general linear models procedure with SAS statistical software and means were separated using Fisher's least significant difference test.

Powdery mildew infection occurred naturally in the greenhouse and disease pressure was high; the final (17 Aug) mean disease severity rating was 80% in the non-treated control plants. All treatments significantly reduced powdery mildew severity and disease progress compared to the non-treated control, but there were no differences among treatments. Plant height and width were not significantly different among treated and non-treated control plants on 17 Aug. Phytotoxicity was not observed in any of the treated dogwood seedlings. Non-treated control plants were not commercially acceptable due to disease at the end of the experiment; however, all treated plants were commercially acceptable or better (data not shown).

Treatment and rate /100 gal	Final disease severity (%)*	AUDPC*	Plant width (in) (Aug 17)	Plant height (in) (Aug 17)
A20259 8.0 fl oz	0.9 b**	22.1 b	11.3	11.0
A20259 14.0 fl oz	0.8 b	14.1 b	9.1	11.3
A21573 10.0 fl oz	0.5 b	17.3 b	8.9	8.3
A21573 15.5 fl oz	0.9 b	10.4 b	8.3	7.7
Alibi Flora SC 8.0 fl oz	1.0 b	25.8 b	9.5	9.1
Banner MAXX II EC 8.0 fl oz	3.1 b	41.3 b	9.1	9.8
Non-treated control	80.0 a	1744.9 a	9.0	9.8
P-value	≤0.0001	≤0.0001	0.1889	0.2642

*Disease severity and AUDPC were based on percentage of the foliage affected.
**Values are the means of four 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*

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Evaluation of fungicide rotations at different application intervals for the control of powdery mildew of dogwood, 2017.

Flowering dogwood (*Cornus florida*) cultivar 'Cherokee Princess' seedlings were potted in no. 1 nursery containers in Morton's no. 2 Grow Mix on 16 May. Each plant was top-dressed with 0.5 oz of 18-6-12 Osmocote Classic controlled release fertilizer. Ten single-plant replications per treatment were arranged in a randomized complete block design in a greenhouse at the Otis L. Floyd Nursery Research Center in McMinnville, TN. Flowering dogwood plants were watered with a drip irrigation system two times per day for 5 minutes. The initial fungicide application was made after observing the first symptoms of powdery mildew disease. Treatments were applied in a 14 or 21-day rotation program to run-off using a backpack CO_2-pressurized sprayer at 40 psi beginning on 8 Jun and ending on 10 Aug. Control plants were sprayed with water. The severity of powdery mildew was evaluated on 15, 22 and 29 Jun; 6, 13, 20 and 27 Jul; 3, 10 and 17 Aug using a scale of 0-100% foliage area affected, and the area under the disease progress curve (AUDPC) was calculated. Plant quality was evaluated on 17 Aug using a scale of 1-9 where 1 is dead, 6 is commercially acceptable and 9 is a perfect plant. Plant height and width were measured on 8 Jun and 17 Aug. Average maximum temperatures for 8-30 Jun, 1-31 Jul and 1-17 Aug were 80.2, 83.6 and 83.2ºF; average minimum temperatures were 61.0, 65.7 and 64.5ºF, respectively. Analysis of variance was performed using the general linear models procedure with SAS statistical software and means were separated using Fisher's least significant difference test.

Powdery mildew infection occurred naturally in the greenhouse and disease pressure was moderate; the final (17 Aug) mean disease severity rating was 32.3% in the non-treated control plants. Both fungicide rotation programs significantly reduced powdery mildew severity and disease progress compared to the non-treated control. The 14-day rotation program significantly reduced powdery mildew severity and disease progress compared to the 21-day rotation program. Plant width was not significantly different among treated plants on a 14-day schedule or 21-day schedule and non-treated control plants on 17 Aug. The 14-day rotation program resulted in a significantly greater plant height compared to the non-treated control. Phytotoxicity was not observed in any of the treated dogwood seedlings. Non-treated control plants were not commercially acceptable due to disease at the end of the experiment; however, all treated plants were commercially acceptable or better (data not shown).

Treatment and rate/100 gal	Application dates[z]	Spray interval (days)	Powdery mildew		Plant height (in)	Plant width (in)
			Disease severity (%)[y] (17 Aug)	AUDPC[y]		
Mural 45WG 7 oz	1	14	1.9 c[x]	49.8 c	24.7 a	20.9
alt Palladium WDG 6 oz	2					
alt Concert II 4.3SE 35 fl oz	4					
alt Palladium WDG 6 oz	5					
Mural 45WG 7 oz	1	21	6.3 b	134.8 b	24.1 ab	20.2
alt Palladium WDG 6 oz	3					
alt Concert II 4.3SE 35 fl oz	6					
alt Palladium WDG 6 oz	7					
Non-treated control			32.3 a	710.3 a	21.2 b	19.0
P-value			≤0.0001	≤0.0001	0.0590	0.0846

[z]Application dates: 1=8 Jun; 2=22 Jun; 3=29 Jun; 4=6 Jul; 5=20 Jul; 6=21 Jul; 7=10 Aug.
[y]Disease severity ratings and AUDPC were based on percentage foliage affected.
[x]Values are the means of ten replications; treatments followed by the same letter within a column are not significantly different at $P \leq 0.0590$.

FLOWERING DOGWOOD (*Cornus florida* 'Cherokee Princess')
Phytophthora root rot; *Phytophthora cinnamomi*

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Evaluation of fungicides for the control of Phytophthora root rot of dogwood, 2017.

Flowering dogwood (*Cornus florida*) cultivar 'Cherokee Princess' seedlings were potted in no. 1 nursery containers in Morton's no. 2 Grow Mix. Each plant was top-dressed with 0.5 oz of 18-6-12 Osmocote Classic controlled release fertilizer. Four single-plant replications per treatment were arranged in a randomized complete block design in a greenhouse at the Otis L. Floyd Nursery Research Center in McMinnville, TN. Flowering dogwood plants were watered two times per day using overhead irrigation system. One drench application was made for each treatment at 200 ml per plant 5 days before inoculation on 13 Oct. Control plants were drenched with only water. Plants were inoculated by placing a single rice grain that had been colonized for 10 days by *Phytophthora cinnamomi* at four opposite sides of the root zone of each plant on 18 Oct. Non-treated, inoculated and non-treated, non-inoculated plants served as controls. Plant root system was assessed on 28 Nov for root rot severity using a 1 to 5 scale based on percentage of the root with visible rot symptoms: 1=0% (healthy), 2=1-25%, 3=26-50%, 4=51-75%, and 5=76-100%. The median value of each range was used for data analysis. Root fresh weight was determined on 28 Nov. Average maximum temperatures for 13-31 Oct and 1-28 Nov were 80.1 and 78.4ºF; average minimum temperatures were 55.4 and 52.3ºF, respectively. Analysis of variance was performed using the general linear models procedure with SAS statistical software and means were separated using Fisher's least significant difference test.

Phytophthora root rot severity was moderate to high; the final (28 Nov) mean root rot severity was 69.3% in the non-treated, inoculated control dogwood plants. All treatments significantly reduced Phytophthora root rot severity and resulted in greater root fresh weight compared to the non-treated, inoculated control. Segovis, Empress Intrinsic, Subdue Maxx and MBI-110 were significantly more effective than RootShield *PLUS*$^{+}$ and Pageant Intrinsic at preventing root rot severity. Segovis, Empress Intrinsic, and Mural treatments had numerically greater root fresh weight compared to the non-treated, non-inoculated control and statistically greater root fresh weight compared to the non-treated, inoculated control. Phytotoxicity was not observed in any of the treated dogwood seedlings.

Treatment and rate/100 gal	Root rot severity (%)	Root fresh weight (oz)
Segovis 1.67SC 3 fl oz	3.3 d[*]	54.0 a
Empress Intrinsic 23.8SC 3 fl oz	6.5 d	52.9 ab
Subdue Maxx 22ME 2 fl oz	9.8 d	46.3 bc
MBI-110 2%	13.0 cd	43.9 cd
Mural 45WG 3 oz	25.5 bc	49.8 abc
Pageant Intrinsic 38WG 18 oz	31.8 b	39.3 d
RootShield *PLUS*$^{+}$ WP 8 oz	31.8 b	38.3 d
Non-treated, non-inoculated control	3.3 d	49.0 abc
Non-treated, inoculated control	69.3 a	21.3 e
P-value	≤0.0001	≤0.0001

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

HYDRANGEA (*Hydrangea macrophylla*)
Botrytis blight; *Botrytis cinerea*

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Evaluation of fungicides for control of Botrytis blight on hydrangea, 2016.

Hydrangea (*Hydrangea macrophylla*) 'Zaunkoenig' x 'Princess Juliana' plants were potted in no. 5 nursery containers filled with 100% pine bark substrate, which was amended with 0.48 lb of 19-5-9 Osmocote® Pro controlled release fertilizer, 0.06 lb of Micromax® micronutrient fertilizer, 0.04 lb iron sulfate and 0.01 lb Epsom salt per cubic feet of mix. Each plant was top-dressed with 1.1 oz of 18-6-8 Florkian® controlled release fertilizer on 20 Sep. Plants were fertilized with 0.5 oz/gal 24-8-16 Miracle-Gro® water-soluble fertilizer (10 fl oz/plant) on 20 Sep and 3 Oct, and with 0.4 oz/5 gal Scott's® Peters Professional Water Soluble Fertilizer (17 fl oz/plant) on 30 Sep. Four single-plant replications per treatment were arranged in a randomized complete block design in a greenhouse at the Otis L. Floyd Nursery Research Center in McMinnville, TN. Plants were irrigated for 3 minutes twice a day using irrigation system with green spot-spitter spray stick (160° spray pattern). Treatments were applied to run-off using a backpack CO_2-pressurized sprayer at 40 psi on a 10-day interval on 4, 14 and 24 Oct. Hydrangea plants were inoculated by uniformly spraying foliage with conidia of *Botrytis cinerea* (FBG2015-02) (approximately $3x10^4$ conidia/ml) using a hand-held sprayer on 5 Oct. Non-inoculated control plants were sprayed with sterilized water. After inoculation, each plant was enclosed in a clear plastic box to increase the relative humidity for 48 hours. Severity of Botrytis blight and phytotoxicity were evaluated on 11, 18 and 25 Oct; 1 and 8 Nov using a scale of 0-100% foliage area affected. Area under the disease progress curve (AUDPC) values were calculated. Average maximum temperatures for 4-31 Oct and 1-8 Nov were 83.7 and 82.2ºF; average minimum temperatures were 57.5 and 57.3ºF, respectively. Analysis of variance was performed using the general linear models procedure with SAS statistical software and means were separated using Fisher's least significant difference test.

Botrytis blight disease pressure was moderate in this trial with non-treated, inoculated control plants showing 43.8% disease severity by 8 Nov. All of the treatments significantly reduced Botrytis blight severity and AUDPC throughout the experiment compared to the non-treated, inoculated control. Final disease severity rating in plants treated with Astun™, regardless of rate, was significantly less than plants treated with Decree 50WDG. The high and mid rate of Astun™ numerically reduced progression (AUDPC) of Botrytis blight compared to the low rate of Astun™. Phytotoxicity was not observed in any of the treated hydrangea plants.

Treatment and rate	Botrytis blight	
	Final disease severity (%)* (8 Nov)	AUDPC*
Non-treated, non-inoculated control	0.0 c**	0.0 c
Non-treated, inoculated control	43.8 a	612.5 a
Decree 50WDG 1.5 lb/100 gal	6.9 b	85.3 b
Astun™ SC 10 fl oz/100 gal	2.1 c	35.4 bc
Astun™ SC 13.5 fl oz/100 gal	1.6 c	9.2 c
Astun™ SC 17 fl oz/100 gal	0.3 c	0.9 c
P-value	≤0.0001	≤0.0001

* Disease severity and area under the disease progress curve (AUDPC) were based on percentage of the foliage area affected.
** Values are the means of four replications; treatments followed by the same letter within a column are not significantly different at $P \leq 0.05$.

HYDRANGEA (*Hydrangea macrophylla*)
Botrytis blight; *Botrytis cinerea*

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Evaluation of fungicides for control of Botrytis blight on detached hydrangea leaves, 2017.

Hydrangea (*Hydrangea macrophylla*) 'Zaunkoenig' x 'Princess Juliana' plants were potted in no. 5 nursery containers filled with 100% pine bark substrate, which was amended with 0.48 lb of 19-5-9 Osmocote® Pro controlled release fertilizer, 0.06 lb of Micromax® micronutrient fertilizer, 0.04 lb iron sulfate and 0.01 lb Epsom salt per cubic feet of mix. Each plant was top-dressed with 1.1 oz of 18-6-8 Florikan® controlled release fertilizer on 5 Apr. Plants were fertilized with 0.5 oz/gal of 24-8-16 Miracle-Gro® water-soluble fertilizer (10 fl oz/plant) on 10 May. Four single-plant replications per treatment were arranged outside in a randomized complete block design under 56% shade at the Otis L. Floyd Nursery Research Center in McMinnville, TN. Plants were irrigated for 3 minutes twice a day using irrigation system with green spot-spitter spray stick (160° spray pattern). Treatments were applied to run-off using a backpack CO_2-pressurized sprayer for a total of two applications on 7-day, 10-day or 14-day intervals. Three hydrangea leaves were collected from four single-plant replications per treatment on 6, 13, 16, 20 and 27 Jun and a plug of potato-dextrose agar (PDA) colonized with *Botrytis cinerea* (no. 4 cork borer) was applied to the upper surface of detached leaf, and then placed in a moist chamber container. Non-inoculated control leaves received a PDA plug only. Lesion area on the detached leaves was determined 10 days after inoculation by tracing the margins of the leaf lesion on transparent acetate placed over the lesion and counting, on a grid, the number of square centimeters within the traced area. Average temperature was 72ºF in the laboratory. Analysis of variance was performed using the general linear models procedure with SAS statistical software and means were separated using Fisher's least significant difference test.

All of the treatments were highly effective in reducing mean lesion area compared to the non-treated, inoculated control. At the end of the trial, on 20 and 27 Jun, the high rate of Astun™ was the only treatment not significantly different than the non-treated, non-inoculated control. Mean lesion area after the first and second applications of Astun™, regardless of rate or spray intervals, was less than those of plants treated with Decree. The high rate of Astun™ on 14-day application schedule significantly reduced mean lesion area compared to low and mid rate of Astun™ and Decree on 20 and 27 Jun. Phytotoxicity was not observed in any of the treated hydrangea plants.

Treatment and rate	Application dates*	Spray interval (days)	Botrytis blight Mean lesion area (cm^2)				
			6 Jun	13 Jun	16 Jun	20 Jun	27 Jun
Astun™ SC 10.0 fl oz/100 gal	1,2	7	0.4 c**	0.3 de	0.7 cd	0.9 c	1.6 c
Astun™ SC 13.5 fl oz/100 gal	1,3	10	0.3 c	1.1 c	0.6 d	0.8 c	1.1 d
Astun™ SC 17.0 fl oz/100 gal	1,4	14	0.3 c	0.8 cd	1.3 c	0.1 d	0.3 e
Decree 50WDG 1.5 lb/A	1,3	10	1.6 b	2.2 b	2.1 b	1.6 b	2.3 b
Non-treated, non-inoculated control			0.0 c	0.0 e	0.0 d	0.0 d	0.0 e
Non-treated, inoculated control			5.6 a	5.5 a	6.2 a	6.5 a	6.3 a
P-value			≤0.0001	≤0.0001	≤0.0001	≤0.0001	≤0.0001

*Application dates for treatments were: 1=5 Jun; 2=12 Jun; 3=15 Jun; 4=19 Jun.
**Treatments followed by the same letter within a column are not significantly different at $P \leq 0.05$.

HYDRANGEA (*Hydrangea macrophylla* 'Endless Summer®')
Cercospora leaf spot; *Cercospora hydrangea*

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Evaluation of fungicides for control of Cercospora leaf spot on hydrangea, 2017.

Hydrangea 'Endless Summer®' plants were potted in no. 3 nursery containers filled with 100% pine bark substrate, which was amended with 0.48 lb of 19-5-9 Osmocote® Pro controlled release fertilizer, 0.06 lb of Micromax® micronutrient fertilizer, 0.04 lb iron sulfate and 0.01 lb Epsom salt per cubic feet of mix on 6 Mar. Plants received additional 1.1 oz of 18-6-8 Nutricote controlled-release fertilizer on 10 Apr, 0.5 oz of 24-8-16 Miracle-Gro® All Purpose Plant Food on 26 Apr and 1 Jun, 0.4 oz/5 gal Scott's® Peters Professional Water Soluble Fertilizer (17 fl oz/plant) on 25 May. Four single-plant replications per treatment were arranged outside in a randomized complete block design under 56% shade at the Otis L. Floyd Nursery Research Center in McMinnville, TN. Plants were irrigated for 3 minutes twice a day in Jun and for 4 minutes twice a day in Jul using micro bubbler emitters installed on short stakes. Treatments were applied to run-off using a backpack CO_2-pressurized sprayer on a 14-day interval beginning on 8 Jun and ending on 6 Jul. Control plants were sprayed with only water. Severity of Cercospora leaf spot resulting from natural infections and phytotoxicity were determined on 15, 22 and 29 Jun; 6,13 and 20 Jul and were expressed as the percentage of foliage area affected. The area under the disease progress curve (AUDPC) was calculated. Plant quality was evaluated on 20 Jul using a scale of 1-9 where 1 is dead, 6 is commercially acceptable and 9 is a perfect plant. Average maximum temperatures for 8-30 Jun and 1-20 Jul were 84.3 and 90.3ºF; average minimum temperatures were 63.6 and 68.6ºF; and total rainfall was 2.60 and 2.23 in., respectively. Analysis of variance was performed using the general linear models procedure with SAS statistical software and means were separated using Fisher's LSD test.

Cercospora leaf spot disease pressure was moderate in this trial with non-treated control plants showing 38.8% disease severity by 20 Jul. All of the treatments significantly reduced Cercospora leaf spot severity and AUDPC throughout the experiment compared to the non-treated control. Picatina was more effective in reducing mean severity and AUDPC in hydrangea plants than Regalia and Concert II; but statistically similar in efficacy to Mural and Palladium. Phytotoxicity and defoliation were not observed in any of the hydrangea plants. Non-treated control plants were not commercially acceptable due to disease severity at the end of the experiment; however, all treated plants were commercially acceptable or better (data not shown).

Treatment and rate	Cercospora leaf spot	
	Mean severity (%) (20 Jul)	AUDPC
Picatina 1.67SC 7 fl oz/100 gal	3.8 d*	78.3 d
Palladium WDG 6 oz/100 gal	7.5 cd	167.1 cd
Mural 45WG 6 oz/100 gal	7.5 cd	146.6 cd
Concert II 4.3SE 35 fl oz/100 gal	8.1 c	201.7 bc
Regalia SC 1% (v/v)	14.4 b	269.5 b
Non-treated control	38.8 a	694.8 a
P-value	≤0.0001	≤0.0001

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

LUPINE (*Lupinus polyphyllus* 'Russell's Extra Choice Mix')
Anthracnose; *Colletotrichum gloeosporioides*

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Evaluation of fungicides for the control of anthracnose of lupine, 2017.

Lupine cultivar 'Russell's Extra Choice Mix' seeds were sown into 50-cell plug trays containing Morton's no. 2 Grow Mix on 22 Feb. Lupine seedlings were transplanted in no. 1 nursery containers on 18 Apr. Each plant was fertilized with 0.5 oz of 24-8-16 Miracle-Gro® All Purpose Plant Food on 26 Apr and 0.5 oz of 18-6-12 Osmocote Classic controlled release fertilizer on 8 May. Ten single-plant replications per treatment were arranged in a randomized complete block design in a greenhouse at the Otis L. Floyd Nursery Research Center in McMinnville, TN. Lupine plants were watered two times per day using overhead irrigation system. Foliar treatments were applied to run-off using a backpack CO_2-pressurized sprayer at 40 psi and drench treatments were applied using measurement cup at 200 ml treatment output per plant. Control plants were sprayed or drenched with water. The severity of anthracnose was evaluated on 19 and 26 Jun, and 3, 10, 17 and 24 Jul using a scale of 0-100% foliage area affected, and the area under the disease progress curve (AUDPC) was calculated. Average maximum temperatures for 12-30 Jun and 1-24 Jul were 83.8 and 85.7 F; average minimum temperatures were 64.4 and 68.3 F, average relative humidity was 82.1 and 86.3, respectively. Analysis of variance was performed using the general linear models procedure with SAS statistical software and means were separated using Fisher's least significant difference test.

Anthracnose infection occurred naturally in the greenhouse and disease pressure was low; the final (24 Jul) mean disease severity rating was 23.5% in the non-treated control lupine plants. All treatments significantly reduced anthracnose severity and disease progress compared to the non-treated control. The foliar application of 16 and 32 fl oz/100 gal Orkestra Intrinsic and the foliar application of 55.6 and 111.2/100 gal A20808C reduced anthracnose disease severity compared to 8 fl oz/100 gal Orkestra Intrinsic, the foliar application of 27.8/100 gal A20808C and drench application of 27.8, 55.6 and 111.2/100 gal A20808C. The foliar application of 16 and 32 fl oz/100 gal Orkestra Intrinsic, the foliar application of 55.6 and 111.2/100 gal A20808C and the drench application of 55.6 and 111.2/100 gal A20808C reduced disease progress compared to the drench and foliar application of 27.8/100 gal A20808C and the foliar application of 8 fl oz/100 gal Orkestra Intrinsic. Phytotoxicity, chlorosis, defoliation, discoloration and stunting were not observed in any of the treated lupine plants.

Treatment and rate/ 100 gal	Application method	Application dates[z]	Final disease severity (%)[y]	AUDPC[y]
Orkestra Intrinsic SC 8.0 fl oz	Foliar	1,2,3	9.0 cd[x]	203.4 b
Orkestra Intrinsic SC 16.0 fl oz	Foliar	1,2,3	6.5 de	141.8 b-e
Orkestra Intrinsic SC 32.0 fl oz	Foliar	1,2,3	3.9 e	83.8 e
A20808C 27.8 fl oz	Foliar	1,2,3	12.0 bc	171.2 bc
A20808C 55.6 fl oz	Foliar	1,2,3	8.0 cde	124.9 cde
A20808C 111.2 fl oz	Foliar	1,2,3	5.8 de	89.4 de
A20808C 27.8 fl oz	Drench	1	13.5 b	162.2 bcd
A20808C 55.6 fl oz	Drench	1	11.5 bc	131.3 b-e
A20808C 111.2 fl oz	Drench	1	11.0 bc	130.6 b-e
Non-treated control			23.5 a	317.8 a
P-value			≤0.0001	≤0.0001

[z]Application dates: 1=12 Jun; 2=26 Jun; 3=10 Jul.
[y]Disease severity and AUDPC were based on percentage of the foliage affected.
[x]Values are the means of ten replications; treatments followed by the same letter within a column are not significantly different at $P \leq 0.05$.

ANNUAL VINCA (*Catharanthus roseus* 'Pacifica XP Deep Orchid')
Botrytis blight; *Botrytis cinerea*

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Evaluation of fungicides for the control of Botrytis blight of annual vinca, 2017.

This trial was conducted as part of the IR-4 Ornamental Horticulture Program. Annual vinca 'Pacifica XP Deep Orchid' seeds were sown into 50-cell plug trays containing Morton's no. 2 Grow Mix on 22 Feb. Annual vinca seedlings were transplanted in no. 1 nursery containers on 19 Apr. Each plant was fertilized with 0.5 oz of 24-8-16 Miracle-Gro® All Purpose Plant Food on 26 Apr and 0.5 oz of 18-6-12 Osmocote Classic controlled release fertilizer on 8 May. Ten single-plant replications per treatment were arranged in a randomized complete block design in a greenhouse at the Otis L. Floyd Nursery Research Center in McMinnville, TN. Plants were watered two times per day using overhead irrigation system. Treatments were applied as a soil drench using a measurement cup at 200 ml mixed product per plant on 12 Jun. Control plants were drenched with water. The severity of Botrytis blight was evaluated on 19 and 26 Jun, and 3, 10, 17 and 24 Jul using a scale of 0-100% foliage area affected, and the area under the disease progress curve (AUDPC) was calculated. Phytotoxicity was rated using a scale of 0 to 10 (0=no phytotoxicity; 10=complete kill) and chlorosis, defoliation, discoloration, stunting were rated using a scale of 0 to 10 (0=no effect; 10=complete plant affected); the above abiotic effects were evaluated on 19 and 26 Jun, and 3, 10, 17 and 24 Jul. Mean plant width and height were measured on 24 Jul. Average maximum temperatures for 12-30 Jun and 1-24 Jul were 83.8 and 85.7 F; average minimum temperatures were 64.4 and 68.3 F, average relative humidity was 82.1 and 86.3, respectively. Analysis of variance was performed using the general linear models procedure with SAS statistical software and means were separated using Fisher's least significant difference test.

Botrytis blight infection occurred naturally in the greenhouse and disease pressure was low; the final (24 Jul) mean disease severity rating was 14.8% in the non-treated control plants. There were no significant differences in disease severity, AUDPC, plant width and plant height between treated and non-treated plants. Phytotoxicity, chlorosis, defoliation, discoloration and stunting were not observed in any of the treated plants.

Treatment and rate/ 100 gal	Disease severity (%)* (24 Jul)	AUDPC*	Plant width (in) (24 Jul)	Plant height (in) (24 Jul)
Inosco 4.2L (A14658C) 8 pt	13.5	288.4	9.2	8.9
Inosco 4.2L (A14658C) 16 pt	13.8	239.2	9.1	8.9
Inosco 4.2L (A14658C) 32 pt	13.8	287.9	8.9	8.6
Non-treated control	14.8	298.0	9.0	8.7
P-value	0.8595	0.3994	0.8242	0.6625

*Disease severity and AUDPC were based on percentage of the foliage affected.

ANNUAL VINCA (*Catharanthus roseus* 'Pacifica XP Deep Orchid')
Phytophthora aerial blight; *Phytophthora nicotianae*

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Fungicidal control of Phytophthora aerial blight on annual vinca, 2017.

Annual vinca variety 'Pacifica XP Deep Orchid' seeds were sown into 50-cell plug trays containing Morton's no. 2 Grow Mix on 22 Feb. Seedlings were transplanted in no. 1 nursery containers on 19 Apr. Each plant was fertilized with 0.5 oz of 24-8-16 Miracle-Gro® All Purpose Plant Food on 26 Apr and 0.5 oz of 18-6-12 Osmocote Classic controlled release fertilizer on 8 May. Eight single-plant replications per treatment were arranged in a randomized complete block design in a greenhouse at the Otis L. Floyd Nursery Research Center in McMinnville, TN. Plants were watered two times per day using overhead irrigation system. Treatments were applied as a soil drench once using a measurement cup at 200 ml mixed product per plant at 7, 14, and 21 days before inoculation (DBI) on 26, 19 and 12 Jun, respectively. Control plants were drenched with water. Plants were inoculated by placing a single rice grain that had been colonized for 10 days by *Phytophthora nicotianae* at four opposite sides of the root zone of each plant on 3 Jul. Non-treated, inoculated and non-treated, non-inoculated plants served as controls. Plants were assessed four times starting on 17 Jul and ending on 28 Aug for symptom severity using a 1 to 5 scale based on percentage of the foliage with visible symptoms: 1=0% (healthy), 2=1-25%, 3=26-50%, 4=51-75%, and 5=76-100%. The median value of each range was used for data analysis. Plant fresh weight was determined on 28 Aug. Average maximum temperatures for 12-30 Jun, 1-31 Jul and 1-28 Aug were 81.2, 83.4 and 84.6 F; average minimum temperatures were 62.2, 64.6 and 68.7 F, respectively. Analysis of variance was performed using the general linear models procedure with SAS statistical software and means were separated using Fisher's least significant difference test.

Phytophthora aerial blight pressure was moderate to high; the final (28 Aug) mean disease severity was 66.1% in the non-treated, inoculated control plants. Both rates of Segovis significantly reduced Phytophthora aerial blight severity compared to the non-treated inoculated control throughout the evaluation period, regardless of the application timing. There were no significant differences in disease severity between low and high rates of the Segovis drench applications on 17 and 31 Jul. The low rate applied 7 DBI significantly reduced Phytophthora aerial blight severity compared to the low rate of Segovis applied 21 DBI on 14 and 28 Aug, but statistically similar in efficacy to the low rate of Segovis applied 14 DBI. The high rate applied 7 and 14 DBI significantly reduced Phytophthora aerial blight severity compared to the high rate of Segovis applied 21 DBI on 14 Aug. The high rate applied 7 DBI significantly reduced Phytophthora aerial blight severity compared to the high rate of Segovis applied 21 DBI on 28 Aug, but statistically similar in efficacy to the high rate of Segovis applied 14 DBI. Both rates of Segovis applied 7, 14 or 21 DBI except the high rate of Segovis applied 21 DBI resulted increase in plant weight compared to the non-treated, inoculated control. Phytotoxicity was not observed in any of the treated plants.

Treatment and rate/ 100 gal	DBI	Disease severity (%)				Plant weight (oz)
		17 Jul	31 Jul	14 Aug	28 Aug	
Segovis 1.67SC 1 fl oz	7	0.0 b*	1.6 b	4.9 d	9.8 c	1.7 ab
Segovis 1.67SC 1 fl oz	14	0.0 b	1.6 b	6.5 cd	11.4 bc	1.6 ab
Segovis 1.67SC 1 fl oz	21	1.6 b	4.9 b	12.9 bc	19.3 b	1.7 ab
Segovis 1.67SC 2 fl oz	7	0.0 b	1.6 b	1.6 d	8.1 c	1.8 a
Segovis 1.67SC 2 fl oz	14	0.0 b	1.6 b	1.6 d	12.9 bc	1.8 a
Segovis 1.67SC 2 fl oz	21	1.6 b	3.3 b	14.5 b	19.3 b	1.2 bc
Non-treated, inoculated control	-	6.5 a	25.5 a	41.1 a	66.1 a	0.7 c
Non-treated, non-inoculated control	-	0.0 b	1.6 b	3.3 d	4.9 c	2.1 a
P-value		0.0029	≤0.0001	≤0.0001	≤0.0001	0.0008

*Values are the means of eight 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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