Woody Ornamental Disease Management Research Reports 2019

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Apple, Flowering Crabapple, Boxwood, Flowering Dogwood, Hydrangea, Rose and Viburnum

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

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Evaluation of products for the management of fireblight on container-grown apples, 2018.

Apple (*Malus domestica*) 'Mutsu' plants grown in no. 5 nursery containers in 100% bark substrate were provided by a commercial nursery. 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 were applied to run-off using a backpack CO_2-pressurized sprayer at 40 psi. Control plants were sprayed with only water. Blossom blight and shoot blight symptoms were assessed on blossom clusters and terminal shoots by counting all blossom clusters and shoots on 15 May. Height and trunk diameter (6 in above the substrate surface) of apple plants were measured on 10 Apr and 15 May. Average maximum temperatures for 10-30 Apr and 1-15 May were 67.9 and 83.7ºF; average minimum temperatures were 45.3 and 58.7ºF; and total rainfall was 3.84 and 1.04 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 68.5% on 15 May in the non-treated control apple plants. All fungicide treatments significantly reduced incidence of blossom blight and shoot blight compared to non-treated control apple plants. Cueva, Kalmor (14 g/1 gal) alone and the high rate of Kalmor (14 g/1 gal) + Triathlon program were more effective in reducing incidence of blossom blight than the low rate of Kalmor (7 g/1 gal) + Triathlon program and Triathlon BA alone. Incidence of shoot blight reached 18.8% on 15 May in the non-treated control plants. Apple plant trunk diameter and height were not significantly different among the treated and non-treated control plants at the end of the trial. Phytotoxicity was not observed in any of the treated apple plants.

Treatment and rate	Application method	Application dates[*]	Incidence of blossom blight (%)	Incidence of shoot blight (%)	Plant trunk diameter (mm) (15 May)	Plant height (cm) (15 May)
Cueva 8.1 fl oz/1 gal	Foliar	1,2,3	23.7 d	4.6 b	35.9 a	205.5 a
Kalmor 14 g/1 gal	Foliar	1,2,3	26.1 d[**]	4.6 b	36.8 a	211.8 a
Kalmor 14 g/1 gal + Triathlon BA 3 qt/100 gal	Foliar	1,2,3	31.1 cd	3.7 b	32.4 a	215.2 a
Kalmor 7 g/1 gal + Triathlon BA 3 qt/100 gal	Foliar	1,2,3	40.7 b	4.1 b	32.6 a	204.7 a
Triathlon BA 3 qt/100 gal	Foliar	1,2,3	36.1 bc	4.1 b	35.7 a	201.7 a
Non-treated control			68.5 a	18.8 a	33.8 a	211.7 a
P-value			<.0001	<.0001	0.2658	0.2681

[*]Application dates for treatments were: 1=3 Apr; 2=10 Apr; 3=17 Apr.
[**]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, 2018.

Crabapple 'Sugar Tyme®' plants grown in no. 5 nursery containers in 100% bark substrate were provided by a commercial nursery. 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 were applied to run-off using a backpack CO_2-pressurized sprayer at 40 psi. Control plants were sprayed with water only. Blossom blight and shoot blight symptoms were assessed on blossom clusters and terminal shoots by counting all flower cluster and shoots on 15 May. Average maximum temperatures for 10-30 Apr and 1-15 May were 67.9 and 83.7ºF; average minimum temperatures were 45.3 and 58.7ºF; and total rainfall was 3.84 and 1.04 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 and disease pressure was high. Mean blossom blight incidence reached 80.3% and mean shoot blight incidence reached 13.3% on 15 May in the non-treated control flowering crabapple plants. All fungicide treatments significantly reduced incidence of blossom blight and shoot blight compared to non-treated control crabapple plants. Cueva and the high rate of Kalmor (14 g/1 gal) + Triathlon program were more effective in reducing incidence of blossom blight than the low rate of Kalmor (7 g/1 gal) + Triathlon program, but statistically similar in efficacy to the Kalmor (14 g/1 gal) alone and Triathlon BA alone. Incidence of shoot blight was statistically similar among all product treatments. Phytotoxicity was not observed in any of the treated plants.

Treatment and rate	Application dates*	Incidence of blossom blight (%)	Incidence of shoot blight (%)
Cueva 8.1 fl oz/1 gal	1,2,3	26.8 c**	2.5 b
Kalmor 14 g/1 gal + Triathlon BA 3 qt/100 gal	1,2,3	29.3 c	2.8 b
Triathlon BA 3 qt/100 gal	1,2,3	32.5 bc	4.0 b
Kalmor 14 g/1 gal	1,2,3	33.4 bc	4.0 b
Kalmor 7 g/1 gal + Triathlon BA 3 qt/100 gal	1,2,3	40.1 b	4.5 b
Non-treated control		80.3 a	13.3 a
P-value		<0.0001	<0.0001

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

BOXWOOD (*Buxus sinica* var. *insularis* × *B. sempervirens* 'Green Velvet')
Phytophthora root rot; *Phytophthora nicotianae*

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Evaluation of fungicides alone and in rotation programs for the control of Phytophthora root rot of boxwood, 2018.

Bare root boxwood 'Green Velvet' plants were potted in no. 1 nursery containers in Morton's Nursery Mix on 3 Oct. Eight 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. Each pot was top dressed with 5 g of 18-6-8 Nutricote controlled release fertilizer on 5 Oct. Plants were watered with an overhead irrigation system two times per day for 2 minutes. On 26 Oct, plants were inoculated with *P. nicotianae* grown on rice grains for 10 days. Inoculum consisted of four rice grains placed 5 cm below the potting substrate surface on the four opposite sides of the plant. Non-treated, non-inoculated and inoculated containers served as controls. Orkestra Intrinsic was applied as a spray to run-off using a backpack CO_2-pressurized sprayer at 40 psi, while all other fungicides were applied as a drench (4.1 fl oz/plant). Treatments were applied alone or as part of a rotation on a 14-day schedule as indicated in the table below. Defoliation due to disease was assessed by using a scale of 0-100% on 16 and 30 Nov and on 14 Dec. On 14 Dec, total fresh weight, root weight and root length were recorded, and severity of Phytophthora root rot was assessed using a scale of 0-100% roots affected. Average maximum temperatures in the greenhouse for 5-31 Oct, 1-30 Nov, and 1-14 Dec were 81.2, 82.6 and 80.2ºF, respectively; average minimum temperatures were 51.7, 54.1, and 54.5ºF, 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.

All fungicide treatments significantly reduced root rot severity and plant defoliation compared to non-treated, inoculated control boxwood plants, but there were no differences among treatments in the defoliation percentage. All fungicide rotation programs as well as Empress Intrinsic alone most effectively reduced Phytophthora root rot disease severity. Plants treated with Orvego alone had lower fresh weight compared to all other treatments, and were no different than the non-treated, inoculated control. Plants treated with the Empress Intrinsic and Orvego rotation program and those treated with the Orvego and Orkestra Intrinsic program had the highest and statistically similar root weight values. All fungicide-treated boxwood plants had significantly higher root length compared to the inoculated control. Phytotoxicity was not observed in any of the treated boxwood plants.

Treatment and rate (application dates[z])	Phytophthora root rot severity (%)[y]	Defoliation (%)	Total fresh weight (g)	Root weight (g)	Root length (cm)
Non-treated, non-inoculated control	0.0 d[x]	0.0 c	17.9 a	9.6 b	15.5 a
Non-treated, inoculated control	75.6 a	4.3 a	7.3 b	3.3 d	7.6 c
Empress Intrinsic 23.8SC 3 fl oz/100 gal (1,2)	11.3 c	1.0 b	15.9 a	9.4 b	14.0 a
Orkestra Intrinsic SC 10 fl oz/100 gal (1,2)	23.1 b	0.9 bc	16.8 a	9.1 bc	13.0 ab
Orvego SC 14 fl oz/100 gal (1,2)	21.9 b	1.4 b	10.1 b	6.4 c	10.9 b
Empress Intrinsic 23.8SC 3 fl oz/100 gal (1) *alt* Orvego SC 14 fl oz/100 gal (2)	5.6 cd	1.0 b	17.6 a	10.2 ab	12.5 ab
Orvego SC 14 fl oz/100 gal (1) *alt* Orkestra Intrinsic SC 10 fl oz/100 gal (2)	5.0 cd	0.6 bc	19.0 a	12.9 a	15.1 a
Segovis 1.67SC 3 fl oz/100 gal (1) *alt* Subdue Maxx 22ME 2 fl oz/100 gal (2)	5.6 cd	0.6 bc	17.4 a	9.8 b	14.6 a
P-value	≤0.0001	≤0.0001	≤0.0001	≤0.0001	≤0.0001

[z] Application dates: 1=2 Nov; 2=16 Nov.
[y] Disease severity was based on percentage of roots affected.
[x] Values are the means of eight replicates; treatments followed by the same letter within a column are not significantly different at $P \leq 0.05$

BOXWOOD (*Buxus sinica* var. *insularis* × *B. sempervirens* 'Green Velvet')
Phytophthora root rot; *Phytophthora nicotianae*

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Evaluation of fungicides alone and in rotation programs for the control of Phytophthora root rot of boxwood rooted cuttings, 2019.

Boxwood 'Green Velvet' cuttings were taken from mother plants at a commercial nursery in Smithville, TN. Cuttings were 4-in. in height with three leaves remaining. Cuttings were dipped in 1% 3- *Indole Butyric Acid* (IBA; Harmodin® 3, OHP Inc, Mainland, PA) and stacked with wet clothes until transplant. Cuttings were planted in 2-in. nursery containers filled with Morton's Nursery Mix on 7 Nov 2018 and inoculated with *P. nicotianae* grown on rice grains for 10 days. Inoculum consisted of two rice grains placed 1-in. below the potting mix surface on the opposite sides of each plant. Non-treated, non-inoculated and inoculated containers served as controls. Twenty single-boxwood cuttings per treatment were arranged in a completely randomized design in a greenhouse at the Otis L. Floyd Nursery Research Center in McMinnville, TN. Cuttings were watered with an overhead irrigation system once a day for 1 minute. Cuttings were re-potted from 2- to 4-in. nursery containers in Morton's Nursery Mix on 28 Nov 2018, and from 4-in. to 1 gal nursery containers on 9 Jan 2019. A standard treatment including Subdue Maxx only (drench) at a 10-week interval, was compared to a rotation program including Pageant (spray), Chipco 26019 (spray) and Empress Intrinsic (drench) as indicated in the table below. Spray applications of fungicides were made to run-off using a backpack CO_2-pressurized sprayer at 40 psi. Drench application volumes for 2-in., 4-in., and 1 gal nursery containers were 0.7, 1.4 and 4.1 fl oz per plant, respectively. Five plants were pulled and cleaned on 28 Nov 2018, 9 Jan, 6 Feb and 6 Mar 2019 for assessment of root development using a 1-5 scale (1 = unrooted cutting not callused, no roots developed; 2 = callus with root bumps; callus with first true root; 3 = at least 3-5 roots ¼ -½ in. in length; 4 = 5-7 or more roots at least 1 in. in length; 5 = fully rooted liner) and for assessment of Phytophthora root rot severity using a scale of 0-100% roots affected. Plant height, total fresh weight, root weight and plant marketability were also recorded on 6 Mar. Plant marketability was evaluated using a scale of 1-5 where 1 is dead, 3 is commercially acceptable and 5 is a perfect plant. Average maximum temperatures in the greenhouse for 15-31 Oct, 1-30 Nov, 1-31 Dec 2018, 1-31 Jan, 1-28 Feb, and 1-6 Mar 2019 were 80.5, 82.6, 80.4, 81.8, 81.2 and 81.0ºF, respectively; average minimum temperatures were 51.7, 54.1, 54.6, 54.2, 54.6 and 56.3ºF, 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.

Phytophthora root rot disease pressure was high in this trial with non-treated, inoculated control rooted boxwood cuttings showing 53.0% disease severity by 6 Mar. Both the fungicide rotation program (Pageant Intrinsic, Chipco 26019 and Empress Intrinsic) and Subdue Maxx alone significantly reduced Phytophthora root rot severity compared to the non-treated, inoculated control. All fungicide-treated plants had increased plant height, total fresh weight and root weight compared to non-treated, inoculated control plants. Boxwood plants in the rotation program had a higher increase in height compared to both controls. Phytotoxicity and defoliation were not observed in any of the rooted boxwood cuttings. Non-treated, inoculated control plants were not commercially acceptable due to the level of Phytophthora root rot at the end of the experiment (data not shown).

Treatment and rate (application dates[z])	Phytophthora root rot severity (%)[y] (6 Mar)	Plant height (in.)	Plant height increase (%)[x]	Total fresh weight (oz)	Root weight (oz)
Non-treated, non-inoculated control	0.0 b[w]	7.6 a	46.9 b	0.5 a	0.3 a
Non-treated, inoculated control	53.0 a	5.4 b	21.8 c	0.3 b	0.1 b
Subdue Maxx 22ME 2 fl oz/100 gal (1,5)	8.0 b	7.4 a	62.4 ab	0.6 a	0.4 a
Pageant Instrinsic 6 oz/100 gal (1, 2) *alt* Chipco 26019 2fl oz/ 100 gal (3) *alt* Empress Intrinsic 23.8SC 3 fl oz/100 gal (4)	1.2 b	7.9 a	70.3 a	0.6 a	0.4 a
P-value	≤0.0001	≤0.0001	0.0006	0.0042	0.0005

[z]Application dates: 1=7 Nov; 2=21 Nov, 3=12 Dec, 4=2 Jan, 5=9 Jan.
[y]Disease severity was based on percentage of roots affected.
[x]Percent plant height increase was calculated according to the formula: [(final plant height - initial plant height)/initial plant height x100].
[w]Values are the means of five replicates; 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 fungicides at different application intervals for the control of powdery mildew of dogwood, 2018.

Flowering dogwood (*Cornus florida*) cultivar Cherokee Princess seedlings were potted in no. 1 nursery containers in Morton's no. 2 Grow Mix on 15 May. Each plant was top-dressed with 0.5 oz of 18-6-12 Osmocote Classic controlled release fertilizer on 1 Jun. 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 twice per day using an overhead irrigation system. Treatments were applied to run-off using a backpack CO_2-pressurized sprayer at 40 psi on a 14- or 21-day interval. Control plants were sprayed with water. The severity of powdery mildew was evaluated on 14, 21 and 28 Jun, and on 5, 12 and 19 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 the same dates using a scale of 1-9 where 1 is dead, 7 is commercially acceptable, and 9 is a perfect plant. Plant height and width were measured on 19 Jul. Average maximum temperatures for 14-30 Jun and 1-19 Jul were 81.2 and 83.0ºF, respectively; average minimum temperatures were 59.5 and 58.9ºF, 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 (19 Jul) 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. However, there were no significant differences in disease progress among treatments. Plants treated with the low and high rates of Mural on a 14-day application interval, with the high rate of Mural on a 21-day application interval, and with Concert II on a 14-day application interval, had significantly less powdery mildew than those treated with the low rate of Mural or Concert II on a 21-day application interval. Plant height and width were not significantly different among treatments on 19 Jul. 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 (data not shown).

Treatment and rate	Application dates*	Final disease severity (%)**	AUDPC*	Plant width (in) (Jul 19)	Plant height (in) (Jul 19)
Mural 45WG 5.0 oz/100 gal	1,2,4	2.1 cd***	41.6 b	11.6	12.1
Mural 45WG 7 oz/100 gal	1,2,4	0.8 d	18.4 b	13.6	13.9
Concert II 4.3SE 35.0 fl oz/100 gal	1,2,4	3.8 bcd	46.4 b	13.9	14.9
Mural 45WG 5.0 oz/100 gal	1,3	4.5 bc	62.1 b	12.4	14.9
Mural 45WG 7 oz/100 gal	1,3	2.4 bcd	44.2 b	13.8	13.1
Concert II 4.3SE 35.0 fl oz/100 gal	1,3	5.6 b	77.4 b	13.8	15.9
Non-treated control		80.0 a	1210.1 a	10.8	10.4
P-value		≤0.0001	≤0.0001	0.2754	0.1592

*Fungicide application dates were: 1=14 Jun; 2=28 Jun; 3=5 Jul; 4=12 Jul.
**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 $P \le 0.05$.

HYDRANGEA (*Hydrangea macrophylla* 'Nikko Blue')
Powdery mildew; *Erysiphe polygoni*

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Evaluation of fungicides for the control of powdery mildew of Hydrangea, 2018.

Uniform big leaf hydrangea plants (*Hydrangea macrophylla*) cv. 'Nikko Blue' were potted in no. 1 nursery containers in Morton's no. 2 Grow Mix on 1 Mar. Ten 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. Each plant was top dressed with 0.35 oz of 18-6-8 Nutricote controlled-release fertilizer on 14 Mar. Hydrangea plants were watered with overhead irrigation system twice per day for 2 minutes. The initial fungicide application occurred after observing the first symptoms of powdery mildew. Treatments were applied to run-off using a backpack CO_2-pressurized sprayer on a 14-day interval beginning on 31 Aug and ending on 28 Sep. Severity of powdery mildew resulting from natural infections and phytotoxicity were determined on 7, 14, 21, and 28 Sep; 5 and 12 Oct and were expressed as the percentage of foliage area affected. Area under disease progress curve (AUDPC) was calculated. Plant height and width were recorded on 31 Aug and 12 Oct. Average maximum temperatures for 31 Aug, 1-30 Sep and 1-12 Oct were 87.7, 88.8 and 78.9ºF; average minimum temperatures were 66.6, 62.9 and 61.7ºF, 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.

Powdery mildew infection occurred naturally and disease pressure was moderate to high, with severity reaching 51% in the non-treated control hydrangea plants. All of the treatments significantly reduced powdery mildew severity and AUDPC throughout the experiment compared to the non-treated control. The treatments that most effectively reduced powdery mildew disease severity and progression (AUDPC) were Mural and the high and medium rates of Gatten. No phytotoxicity was observed on the plants (including flowers) treated with three different rates of Gatten or Mural fungicides. There were no significant differences between plants treated with the different rates of Gatten, Mural and non-treated control plants in the plant height or average plant width at the end of the experiment (data not shown).

Treatment and rate	Application dates*	Powdery mildew	
		Mean severity (%) (12 Oct)	AUDPC
Gatten EC 6.4 fl oz/100 gal	1, 2, 3	9 b**	200 b
Gatten EC 12.8 fl oz/100 gal	1, 2, 3	5 bc	129 bc
Gatten EC 25.4 fl oz/100 gal	1, 2, 3	5 bc	143 bc
Mural 45WG 7.0 oz/100 gal	1, 2, 3	2 c	41 c
Non-treated control		51 a	956 a
P-value		<.0001	<.0001

*Application dates: 1=31 Aug; 2=14 Sep; 3=28 Sep.
**Values are the means of ten replications; treatments followed by the same letter within a column are not significantly different at $P \leq 0.05$.

HYDRANGEA (*Hydrangea macrophylla* 'Nikko Blue')
Cercospora leaf spot; *Cercospora hydrangea*

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Evaluation of fungicides for control of Cercospora leaf spot on Hydrangea, 2018.

Hydrangea (*Hydrangea macrophylla*) 'Nikko Blue' plants were potted in no. 5 nursery containers filled with 100% pine bark substrate, which was amended with 0.48 lbof 19-5-9 Osmocote® Pro controlled release fertilizer, 0.06 lb of Micromax® micronutrient fertilizer, 0.04 lbiron sulfate and 0.01 lb Epsom salt per cubic feet of mix. Plants received additional 2.5 oz of 19-5-9 Osmocote® Pro in Apr and Jul. Six single-plant replications per treatment were arranged in a randomized complete block design outdoors 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 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 14 Aug and ending on 25 Sep. Severity of Cercospora leaf spot resulting from natural infections and phytotoxicity were determined on 14, 21, and 28 Aug; 4, 11, 18, and 25 Sep; 2 Oct 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 14, 21, and 28 Aug; 4, 11, 18, and 25 Sep; 2 Oct using a scale of 1-9 where 1 is dead, 6 is commercially acceptable and 9 is a perfect plant. Plant height was measured on 13 Aug and 3 Oct. Average maximum temperatures for 14-31 Aug; 1-30 Sep and 1-2 Oct were 87.5, 86.7 and 73ºF; average minimum temperatures were 68.7, 66.7 and 67.3ºF; and total rainfall was 3.05, 6.44 and 0.62 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 to high in this trial with non-treated control plants showing 50.8% disease severity by 2 Oct. All of the treatments significantly reduced Cercospora leaf spot severity and AUDPC throughout the experiment compared to the non-treated control. The treatments that most effectively reduced Cercospora leaf spot severity and the progression of disease were Orkestra Intrinsic and the high rate of A20259E (18.5 fl oz/100 gal). Phytotoxicity and defoliation were not observed in any of the treated hydrangea plants. Plant height was greater in plants treated with the mid and high rates of A20259E (13.3 fl oz/100 gal and18.5 fl oz/100 gal, respectively) and Orkestra Intrinsic compared to the low rate of A20259E (8.0 fl oz/100 gal) or non-treated control hydrangea plants (data not shown). All non-treated control plants (6 of 6 plants) and 3 of 6 of plants treated with the low rate of A20259E (8.0 fl oz/100 gal) were not commercially acceptable due to Cercospora disease severity at the end of the experiment (data not shown).

Treatment and rate	Application dates*	Cercospora leaf spot	
		Mean severity (%) (2 Oct)	AUDPC
A20259E 8.0 fl oz/100 gal	1, 2, 3, 4	16 b**	433 b
A20259E 13.3 fl oz/100 gal	1, 2, 3, 4	13 c	373 b
A20259E 18.5 fl oz/100 gal	1, 2, 3, 4	11 cd	257 c
Orkestra Intrinsic SC 6 fl oz/100 gal	1, 2, 3, 4	10 d	212 c
Non-treated control		51 a	1269 a
P-value		≤0.0001	≤0.0001

*Application dates: 1=14 Aug; 2=28 Aug; 3=11 Sep ; 4=25 Sep.
**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*)
Phytophthora root rot; *Phytophthora nicotianae*

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Evaluation of biorational products and fungicides for the control of Phytophthora root rot of Hydrangea in field condition, 2017.

The experiment was conducted at the Otis L. Floyd Nursery Research Center in McMinnville, TN in a field plot with Waynesboro loam soil. The field was cultivated on 9 May and leveled on 15 May. Plots were measured and marked in a randomized complete block design with four replications on 15 Jun. Plots were inoculated with *Phytophthora nicotianae* grown on rice grains for 10 days. Four rice grains were placed 2 inches below the surface soil every 1 ft on 19 Jun. Non-treated, non-inoculated and inoculated plots served as controls. Oak leaf hydrangea (cvs. Alice, Munchkin and Ruby Slippers) rooted cuttings were transplanted on 8 Aug. Each plot consisted of 2 plants of each cultivar spaced 2 ft apart with 7 ft between rows. Plants were fertilized with 0.4 oz of 18-6-8 Nutricote controlled-release fertilizer on 18 Aug. Plants were watered as needed using drip irrigation system. The herbicide Finale (4 fl oz/gal) was applied as spot treatment into the test field on 26 Mar, 29 Aug, and 11 Oct. On 7 Aug, TerraClean 5.0 was drenched into the soil 24 hr prior to transplanting in dedicated plots (70 gal of mixed solution/1000 ft^2). On 8 Aug, TerraGrow at 1.0 oz/10 gal rate was prepared and dedicated rooted cuttings for this treatment were dipped into mixed solution prior to planting; one day after transplanting, these plants received TerraGrow at 0.4 oz/10 gal as a soil drench. The other treatments were applied as soil drenches starting after transplanting on 8 Aug and ending on 31 Oct. Plant height and width were recorded on 20 Nov. Plants were dug on 21 Nov for root infection analysis. On 21 Nov, fresh weight was recorded and severity of Phytophthora root rot was assessed using a scale of 0-100% roots affected. Average maximum temperatures for 19-30 Jun, Jul, Aug, Sep, Oct and 1-20 Nov were 83.95, 91.58, 85.76, 82.97, 73.74 and 63.54ºF; average minimum temperatures were 64.16, 68.50, 65.13, 58.13, 49.23 and 43.76ºF; and total rainfall amounts were 1.34, 5.21, 4.45, 4.96, 4.82 and 3.97 in., respectively. Analysis of variance was performed using the general linear models procedure with SAS statistical software and means were separated using Tukey test.

Phytophthora root rot disease pressure in hydrangea cvs. Alice, Munchkin and Ruby Slippers were 65.9%, 58.0%, and 47.5% respectively. All of the treatments significantly reduced Phytophthora root rot severity in all three hydrangea cultivars compared to non-treated inoculated control. The treatments most effective in reducing Phytophthora root rot severity in all three cultivars were Segovis, Empress Intrinsic, Subdue Maxx, and MBI110, but TerraClean 5.0 + TerraGrow program was also effective in cvs Alice and Ruby Slipper, and RootShield *PLUS*[+] WP was effective in cvs. Munchkin and Ruby Slipper. There were no significant differences among the treatments in plant weight, root weight, plant height and plant width for all three cultivars. Phytotoxicity and defoliation were not observed in any of the hydrangea plants.

Treatment and rate for cv. Alice	Application dates[z]	Phytophthora root rot severity (%)[y]	Plant fresh weight (oz)	Root weight (oz)	Plant height (in)	Plant width (in)
RootShield *PLUS*[+] WP 8 oz/100 gal	2,10	26.0 c[x]	4.27 a	2.17 a	28.30 a	13.09 a
MBI110 1%	2-14	19.6 cd	3.15 a	1.33 a	25.69 a	12.18 a
IT-5103 WP 2 g/plant	2,5,8,11,14	36.6 b	3.97 a	2.00 a	27.56 a	13.59 a
OxiPhos 0.2% (v/v)	2,4,6,8,10, 12,14	39.4 b	4.37 a	2.29 a	27.95 a	13.98 a
TerraClean 5.0 0.2% (v/v) TerraGrow 1.0 oz/10 gal TerraGrow 0.4 oz/10 gal	1 2 5,8,11,14	20.1 cd	3.97 a	1.98 a	26.97 a	15.01 a
Empress Intrinsic 23.8SC 3 fl oz/100 gal	2,5,8,11,14	18.4 cd	3.68 a	1.69 a	23.87 a	13.44 a
Segovis 1.67SC 3 fl oz/100 gal	2,5,8,11,14	14.3 de	3.59 a	1.70 a	26.18 a	14.10 a
Subdue Maxx 22ME 2 fl oz/100 gal	2,12	17.1 cd	3.72 a	1.89 a	22.74 a	14.49 a
Non-treated, inoculated control		65.9 a	3.33 a	1.44 a	27.12 a	13.66 a
Non-treated, non-inoculated control		7.1 e	4.56 a	2.06 a	24.46 a	12.99 a
P-value		<.0001	0.8862	0.9314	0.0979	0.7108

[z] Application dates: 1=7 Aug; 2=8 Aug; 3=15 Aug; 4=22 Aug; 5=29 Aug; 6=5 Sep; 7=12 Sep; 8=19 Sep; 9=26 Sep; 10=3 Oct; 11=10 Oct; 12=17 Oct; 13=24 Oct; 14=31 Oct.

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

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

Treatment and rate for cv. Munchkin	Application dates[z]	Phytophthora root rot severity (%)[y]	Plant fresh weight (oz)	Root weight (oz)	Plant height (in)	Plant width (in)
RootShield *PLUS*[+] WP 8 oz/100 gal	2,10	23.5 bc[x]	2.24 a	1.20 a	11.22 a	8.66 a
MBI110 1%	2-14	22.3 bc	2.70 a	1.51 a	10.43 a	9.25 a
IT-5103 WP 2 g/plant	2,5,8,11,14	33.0 b	1.82 a	0.90 a	9.84 a	8.17 a
OxiPhos 0.2% (v/v)	2,4,6,8,10, 12,14	29.3 b	2.61 a	0.97 a	9.15 a	10.29 a
TerraClean 5.0 0.2% (v/v) TerraGrow 1.0 oz/10 gal TerraGrow 0.4 oz/10 gal	1 2 5,8,11,14	26.0 b	1.99 a	1.07 a	10.04 a	9.25 a
Empress Intrinsic 23.8SC 3 fl oz/100 gal	2,5,8,11,14	21.5 bc	2.24 a	1.06 a	8.46 a	9.99 a
Segovis 1.67SC 3 fl oz/100 gal	2,5,8,11,14	17.3 bc	1.91 a	0.92 a	10.83 a	8.89 a
Subdue Maxx 22ME 2 fl oz/100 gal	2,12	16.8 bc	2.20 a	1.35 a	9.35 a	9.55 a
Non-treated, inoculated control		58.0 a	1.75 a	0.79 a	8.27 a	9.06 a
Non-treated, non-inoculated control		7.8 c	3.17 a	1.60 a	9.45 a	9.30 a
P-value		<.0001	0.4635	0.7784	0.8024	0.9527

[z]Application dates: 1=7 Aug; 2=8 Aug; 3=15 Aug; 4=22 Aug; 5=29 Aug; 6=5 Sep; 7=12 Sep; 8=19 Sep; 9=26 sep; 10=3 Oct; 11=10 Oct; 12=17 Oct; 13=24 Oct; 14=31 Oct.

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

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

Treatment and rate for cv. Ruby Slipper	Application dates[z]	Phytophthora root rot severity (%)[y]	Plant fresh weight (oz)	Root weight (oz)	Plant height (in)	Plant width (in)
RootShield *PLUS*[+] WP 8 oz/100 gal	2,10	24.5 bc[x]	1.97 a	0.96 a	14.47 a	9.94 a
MBI110 1%	2-14	18.8 bcd	3.09 a	1.67 a	14.57 a	12.40 a
IT-5103 WP 2 g/plant	2,5,8,11,14	30.0 b	1.27 a	0.73 a	13.58 a	6.84 a
OxiPhos 0.2% (v/v)	2,4,6,8,10, 12,14	29.0 b	2.77 a	1.90 a	16.04 a	8.66 a
TerraClean 5.0 0.2% (v/v) TerraGrow 1.0 oz/10 gal TerraGrow 0.4 oz/10 gal	1 2 5,8,11,14	22.0 bcd	2.87 a	1.85 a	13.34 a	8.32 a
Empress Intrinsic 23.8SC 3 fl oz/100 gal	2,5,8,11,14	15.8 cd	2.15 a	1.14 a	12.94 a	9.11 a
Segovis 1.67SC 3 fl oz/100 gal	2,5,8,11,14	11.5 de	2.82 a	1.99 a	14.07 a	9.25 a
Subdue Maxx 22ME 2 fl oz/100 gal	2,12	15.3 cde	3.19 a	2.18 a	14.57 a	9.30 a
Non-treated, inoculated control		47.5 a	2.36 a	1.53 a	15.75 a	8.66 a
Non-treated, non-inoculated control		3.0 e	3.25 a	2.57 a	16.34 a	8.07 a
P-value		<.0001	0.1181	0.1354	0.8083	0.1079

[z]Application dates: 1=7 Aug; 2=8 Aug; 3=15 Aug; 4=22 Aug; 5=29 Aug; 6=5 Sep; 7=12 Sep; 8=19 Sep; 9=26 sep; 10=3 Oct; 11=10 Oct; 12=17 Oct; 13=24 Oct; 14=31 Oct.

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

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

HYDRANGEA (*Hydrangea* spp.)
Phytophthora root rot; *Phytophthora nicotianae*

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Evaluation of biorational products and fungicides for the control of Phytophthora root rot of hydrangea in greenhouse condition, 2017.

The experiment was conducted at the Otis L. Floyd Nursery Research Center in McMinnville, TN. Uniform big leaf hydrangea (*H. macrophylla*) cv. 'Princess Juliana' and oak leaf hydrangea (*H. quercifolia*) cv.'Picnic Hill' were potted in no. 2 nursery containers in Morton's no. 2 Grow Mix on 4 Sep. Four 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. Each plant was top dressed with 10 g of 18-6-8 Nutricote controlled-release fertilizer on 18 Sep. Hydrangea plants were watered with overhead irrigation system two times per day for 4 minutes. Plants were inoculated with *P. nicotianae* grown on rice grains for 10 days. Four rice grains were placed 2 in below the surface potting soil on 17 Jan. Non-treated, non-inoculated and inoculated pots served as controls. Treatments were applied as drench application beginning on 9 Jan and ending on 11 Apr. Plant height and width were recorded on 20 Apr. Plants were dug and cleaned on 21 Apr for root infection analysis. On 21 Apr, fresh weight was recorded and severity of Phytophthora root rot was assessed using a scale of 0-100% roots affected. Average maximum temperatures for 11-31 Jan, 1-28 Feb, 1-31 Mar, and 1-21 Apr were 83.5, 81.7, 81.4 and 82.4ºF; average minimum temperatures were 54.7, 54.6, 54.6 and 56.3ºF, respectively. Analysis of variance was performed using the general linear models procedure with SAS statistical software and means were separated using Tukey test.

Phytophthora root rot disease pressure was low to moderate in big leaf hydrangea cv. 'Princess Juliana' reaching 27.6% in the non-treated, inoculated control and was high in oak leaf hydrangea cv. 'Picnic Hill' reaching 60.9% in the non-treated, inoculated control. All of the treatments except RootShield *PLUS*® and Grotab significantly reduced Phytophthora root rot severity compared to non-treated, inoculated control in big leaf hydrangea cv. 'Princess Juliana', but there were no significant differences among treatments. All of the treatments except Grotab significantly reduced Phytophthora root rot severity compared to non-treated, inoculated control in oak leaf hydrangea cv. 'Picnic Hill'. There were no significant differences in plant weight, root weight, plant height and width between treated and non-treated big leaf hydrangea (cv. Princess Juliana) plants. On the other hand in cv. Picnic Hill Subdue Maxx significantly increased the root weight compared to biocontrol treatments and numerically increased compared to the non-treated controls and other treatments. There were no significant differences in plant fresh weight, plant height and width between treated and non-treated controls in both cultivars. Phytotoxicity and defoliation were not observed in any of the hydrangea plant.

Treatment and rate (application dates[z]) *H. macrophylla* cv. 'Princess Juliana'	Phytophthora root rot severity (%)[y]	Plant fresh weight (oz)	Root weight (oz)	Plant height (in)	Plant width (in)
RootShield *PLUS*® WP 8 oz/100 gal (2,10)	12.8 ab[x]	2.28 a	1.69 a	5.25 a	5.05 a
MBI110 1% (2-15)	6.8 b	3.19 a	2.59 a	4.00 a	5.12 a
Grotab 2 tablets/pot (2)	10.9 ab	1.98 a	1.38 a	4.59 a	4.72 a
Pageant Intrinsic 38WG 18 oz/100 gal (2,5,8,11,14)	4.5 b	4.12 a	2.86 a	3.94 a	6.10 a
TerraClean 5.0 0.2% (1) TerraGrow 1.0 oz/10 gal (2) TerraGrow 0.4 oz/10 gal (5,8,11,14)	6.8 b	2.62 a	1.89 a	3.67 a	6.56 a
Empress Intrinsic 23.8SC 3 fl oz/100 gal (2,5,8,11,14)	4.5 b	3.84 a	3.20 a	5.51 a	5.12 a
Segovis 1.67SC 3 fl oz/100 gal (2,5,8,11,14)	4.5 b	2.70 a	2.00 a	4.59 a	6.37 a
Subdue Maxx 22ME 2 fl oz/100 gal (2,10)	4.5 b	2.50 a	1.60 a	5.25 a	6.04 a
Non-treated, inoculated control	27.6 a	2.37 a	1.80 a	3.02 a	5.25 a
Non-treated, non-inoculated control	2.3 b	3.05 a	2.18 a	3.81 a	5.78 a
P-value	0.0010	0.3122	0.4583	0.3380	0.8074

[z]Application dates: 1=9 Jan; 2=10 Jan; 3=17 Jan; 4=24 Jan; 5=31 Jan; 6=7 Feb; 7=14 Feb; 8=21 Feb; 9=28 Feb; 10=7 Mar; 11=14 Mar; 12=21 Mar; 13=28 Mar; 14=3 Apr; 15=11 Apr.
[y]Disease severity was based on percentage of roots affected.
[x]Values are the means of four replicates; treatments followed by the same letter within a column are not significantly different at $P \leq 0.05$.

Treatment and rate (application dates[z]) *H. quercifolia* cv. 'Picnic Hill'	Phytophthora root rot severity (%)[y]	Plant fresh weight (oz)	Root weight (oz)	Plant height (in)	Plant width (in)
RootShield *PLUS*[+] WP 8 oz/100 gal (2,10)	19.3 bc[x]	5.26 a	2.26 b	19.03 a	16.37 a
MBI110 1% (2-15)	10.9 c	5.18 a	3.03 b	9.45 a	12.14 a
Grotab 2 tablets/pot (2)	48.4 ab	4.84 a	3.27 b	12.99 a	11.25 a
Pageant Intrinsic 38WG 18 oz/100 gal (2,5,8,11,14)	19.3 bc	5.49 a	3.57 ab	10.24 a	14.07 a
TerraClean 5.0 0.2% (1) TerraGrow 1.0 oz/10 gal (2) TerraGrow 0.4 oz/10 gal (5,8,11,14)	19.3 bc	6.92 a	3.54 ab	14.24 a	13.75 a
Empress Intrinsic 23.8SC 3 fl oz/100 gal (2,5,8,11,14)	19.3 bc	7.64 a	5.01 ab	13.26 a	12.5 a
Segovis 1.67SC 3 fl oz/100 gal (2,5,8,11,14)	27.6 bc	5.49 a	3.33 ab	12.99 a	14.5 a
Subdue Maxx 22ME 2 fl oz/100 gal (2,10)	15.1 bc	7.21 a	6.28 a	14.96 a	15.55 a
Non-treated, inoculated control	60.9 a	4.32 a	3.43 ab	12.99 a	10.73 a
Non-treated, non-inoculated control	4.5 c	7.01 a	5.24 ab	7.81 a	12.37 a
P-value	0.0002	0.2286	0.0037	0.4552	0.1863

[z]Application dates: 1=9 Jan; 2=10 Jan; 3=17 Jan; 4=24 Jan; 5=31 Jan; 6=7 Feb; 7=14 Feb; 8=21 Feb; 9=28 Feb; 10=7 Mar; 11=14 Mar; 12=21 Mar; 13=28 Mar; 14=3 Apr; 15=11 Apr.

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

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

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

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Evaluation of fungicides for the control of black spot of rose, 2018.

Rose 'Queen Elizabeth' and 'Louis Philippe' 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. Plants received additional 2.5 oz of 19-5-9 Osmocote® Pro and 0.5 oz/gal 24-8-16 Miracle-Gro® water-soluble fertilizer (10 fl oz/plant) on 15 Mar. Six single-plant replications per treatment were arranged under 45% shade in a randomized complete block design as a separate trial for each cultivar at the Otis L. Floyd Nursery Research Center in McMinnville, TN. Rose plants were watered twice a day for 5 min using an overhead irrigation system. Fungicides were applied as a foliar spray to run-off using a backpack CO_2-pressurized sprayer at 40 psi on 15 and 29 May, and 12 Jun for a total of 3 applications. The severity of black spot was evaluated on 15, 22 and 29 May, 5,12, 19 and 26 Jun, and 3 Jul using a scale of 0-100% foliage affected. Area under the disease progress curve (AUDPC) values were also calculated. Phytotoxicity (scores ranging between 0 = no phytotoxicity and 10 = complete kill), chlorosis, defoliation, discoloration and stunting (scores ranging between 0 = no effect and 10 = complete plant affected) were also evaluated on the same dates disease was assessed. Plant quality/acceptability was evaluated on the same dates diseased was assessed using a scale of 1-9 where 1 is dead, 6 is commercially acceptable and 9 is a perfect plant. Plant height was measured on 3 Jul. Average maximum temperatures for 15-31 May, 1-30 Jun and 1-3 Jul were 85.2, 90.3 and 90.0°F; average minimum temperatures were 65.9, 66.8 and 71.5°F; and total rainfall amounts were 3.3, 4.7 and 0.4 in., 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.

Black spot infection occurred naturally in both trials and disease pressure was moderate to high in 'Queen Elizabeth' trial with non-treated control plants showing 37.5% foliar disease severity; and low in 'Louise Philippe' trial with non-treated control plants showing 12.9% foliar disease severity by 3 Jul. All fungicide treatments significantly reduced final severity (3 Jul) and the area under the disease progress curve (AUDPC) compared to the non-treated control in both trials. The treatments that most effectively reduced black spot severity were A19649B, Eagle 20EW and the high rate of Mural for both cultivars. There were no significant differences in disease progress (AUDPC) among fungicide treatments for 'Queen Elizabeth' trial. Treatment with the high rate of Mural, Eagle 20EW and A19649B were more effective in reducing AUDPC in 'Louis Philippe' trial than Orkestra Intrinsic and the low rate of Mural. There were no significant differences in plant height between treated and non-treated plants at the end of both trials. Non-treated control 'Queen Elizabeth' plants were not commercially acceptable due to the level of disease at the end of the trial (data not shown). Phytotoxicity, chlorosis, defoliation, discoloration and stunting were not observed in any of the treated plants.

Treatment and rate/100 gal	Cultivar	Disease severity (%)* (3 Jul)	AUDPC*	Plant height (cm) (3 Jul)
Non-treated control	Queen Elizabeth	37.5 a**	886.1 a	87.8 a
Orkestra Intrinsic SC 8 fl oz	Queen Elizabeth	9.6 b	188.7 b	91.5 a
Mural 45WG 7 oz	Queen Elizabeth	6.3 bc	163.6 b	90.3 a
Mural 45WG 5 oz	Queen Elizabeth	9.6 b	233.6 b	94.8 a
Eagle 20EW 8 fl oz	Queen Elizabeth	3.2 c	108.5 b	83.5 a
A19649B 10 fl oz	Queen Elizabeth	5.0 bc	137.1 b	89.5 a
P-value		≤0.0001	≤0.0001	0.8929

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

Treatment and rate/100 gal	Cultivar	Disease severity (%)[z] (3 Jul)	AUDPC[z]	Plant height (cm) (3 Jul)
Non-treated control	Louis Philippe	12.9 a[y]	203.3 a	38.8 a
Orkestra Intrinsic SC 8 fl oz	Louis Philippe	5.8 b	106.2 b	38.7 a
Mural 45WG 7 oz	Louis Philippe	1.6 c	32.9 c	39.8 a
Mural 45WG 5 oz	Louis Philippe	5.4 b	107.6 b	41.0 a
Eagle 20EW 8 fl oz	Louis Philippe	1.8 c	20.7 c	41.2 a
A19649B 10 fl oz	Louis Philippe	3.1 c	62.1 bc	47.0 a
P-value		≤0.0001	≤0.0001	0.5235

[z]Disease severity ratings and area under the disease progress curve (AUDPC) were based on percentage foliage affected.
[y]Treatments followed by the same letter within a column are not significantly different at $P \leq 0.05$.

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

F. Baysal-Gurel, T. Simmons
Tennessee State University,
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Evaluation of fungicides for the control of black spot of rose, 2018.

Rose 'Queen Elizabeth' and 'Louis Philippe' plants were potted in no. 5 nursery containers filled with 100% pine bark substrate amended with 0.48 lb of 19-5-9 Osmocote® Pro controlled release fertilizer, 0.06 lbof Micromax® micronutrient fertilizer, 0.04 lbiron sulfate and 0.01 lb Epsom salt per cubic feet of mix. Plants received an additional 2.5 oz of 19-5-9 Osmocote® Pro and 0.5 oz/gal 24-8-16 Miracle-Gro® water-soluble fertilizer (10 fl oz/plant) on 15 Mar. Six single-plant replications per treatment were arranged in a randomized complete block design as a separate trial for each cultivar under 45% shade at the Otis L. Floyd Nursery Research Center in McMinnville, TN. Rose plants were watered twice a day for 5 minutes using overhead irrigation system. Spray applications of fungicides were applied to run-off using a backpack CO_2-pressurized sprayer at 40 psi beginning on 15 and 29 May, and 12 Jun for a total of 3 applications on a 14-day schedule. The severity of black spot was evaluated on 15, 22 and 29 May, 5,12, 19 and 26 Jun, and 3 Jul using a scale of 0-100% foliage affected. Area under the disease progress curve (AUDPC) values were calculated. Phytotoxicity (scored as 0 = no phytotoxicity and 10 = complete kill), chlorosis, defoliation, discoloration and stunting (scored as 0 = no effect and 10 = complete plant affected) were evaluated on 15, 22 and 29 May, 5,12, 19 and 26 Jun, and 3 Jul. Plant quality was evaluated on 15, 22 and 29 May, 5,12, 19 and 26 Jun, and 3 Jul using a scale of 1-9 where 1 is dead, 6 is commercially acceptable and 9 is a perfect plant. Plant height was measured on 15 May and 3 Jul. Average maximum temperatures for 15-31 May, 1-30 Jun and 1-3 Jul were 85.2, 90.3 and 90.0°F, average minimum temperatures were 65.9, 66.8 and 71.5°F, and total rainfall amounts were 3.3, 4.7 and 0.4 in, 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.

Black spot infection occurred naturally and disease pressure was moderate to high on 'Queen Elizabeth' plants with non-treated control plants showing 38% foliar disease severity; disease pressure was low on 'Louise Philippe' plants with non-treated control plants showing 13% foliar disease severity by 3 Jul. All of the treatments significantly reduced final severity (3 Jul) and AUDPC compared to the non-treated control in both trials. The treatments that most effectively reduced black spot severity were the high and low rates of Broadform, Eagle 20EW and Mural for 'Queen Elizabeth' trial and the treatments that most effectively reduced black spot severity were the high rate of Broadform, Eagle 20EW and Mural for 'Louise Philippe' trial. There were no significant differences in disease progress (AUDPC) between fungicide treatments for 'Queen Elizabeth' trial. Treatment with the high and low rates of Broadform, Mural and Eagle 20EW were more effective in reducing AUDPC in 'Louis Philippe' trial than Orkestra Intrinsic. There were no significant differences in plant height between treated and non-treated plants at the end of both 'Queen Elizabeth' and Louise Philippe' trials. Non-treated control 'Queen Elizabeth' plants were not commercially acceptable due to the level of disease at the end of the trial (data not shown). Phytotoxicity, chlorosis, defoliation, discoloration and stunting were not observed in any of the treated rose plants.

Treatment and rate	Cultivar	Disease severity (%)* (3 Jul)	AUDPC*	Plant height (cm) (3 Jul)
Non-treated control	Queen Elizabeth	38 a**	886 a	87.8
Broadform SC 4 fl oz/100 gal	Queen Elizabeth	7 bc	218 b	89.5
Broadform SC 8 fl oz/100 gal	Queen Elizabeth	3 c	75 b	79.5
Orkestra Intrinsic SC 8 fl oz/100 gal	Queen Elizabeth	10 b	189 b	91.5
Mural 45WG 7 oz/100 gal	Queen Elizabeth	6 bc	164 b	90.3
Eagle 20EW 8 fl oz/100 gal	Queen Elizabeth	3 c	109 b	83.5
P-value		≤0.0001	≤0.0001	0.7625

*Disease severity ratings and area under the disease progress curve (AUDPC) were based on percentage foliage affected.
**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	Cultivar	Disease severity (%)[*] (3 Jul)	AUDPC[*]	Plant height (cm) (3 Jul)
Non-treated control	Louis Philippe	13 a[**]	203 a	38.8
Broadform SC 4 fl oz/100 gal	Louis Philippe	4 c	61 bc	39.2
Broadform SC 8 fl oz/100 gal	Louis Philippe	1 d	28 c	37.3
Orkestra Intrinsic SC 8 fl oz/100 gal	Louis Philippe	6 b	106 b	38.7
Mural 45WG 7 oz/100 gal	Louis Philippe	2 d	33 c	39.8
Eagle 20EW 8 fl oz/100 gal	Louis Philippe	2 d	21 c	41.2
P-value		≤0.0001	≤0.0001	0.9746

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

VIBURNUM (*Viburnum odoratissimum*)
Rhizoctonia root rot; *Rhizoctonia solani*

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Evaluation of biorational products and fungicides for the control of Rhizoctonia root rot of viburnum in field condition, 2017.

The experiment was conducted at the Otis L. Floyd Nursery Research Center in McMinnville, TN in field plot with Waynesboro loam soil. The field was cultivated on 9 May and leveled on 15 May. Plots were measured and marked in a randomized complete block design with four replications on 15 Jun. Plots were drench-inoculated with a slurry of *Rhizoctonia solani* (7-day old cultures on PDA were homogenized) at a rate of 3.4 fl oz/ft^2 on 19 Jun. Non- treated, non-inoculated and inoculated plots served as controls. Viburnum rooted cuttings were transplanted on 8 Aug. Each plot consisted of 5 plants spaced 2 ft apart with 7 ft between rows. Plants were fertilized with 0.4 oz of 18-6-8 Nutricote controlled-release fertilizer on 18 Aug. Plants were watered as needed using a drip irrigation system. The herbicide Finale (3 fl oz/gal) was applied as spot treatments in the test field on on 26 March; 29 Aug, and 11 Oct. On 7 Aug, TerraClean 5.0 was drenched into the soil 24 hr prior to transplanting in dedicated plots (70 gal of mixed solution/1000 ft^2). On 8 Aug, dedicated rooted cuttings were dipped in TerraGrow at 1.0 oz/10 gal rate prior to planting and then received a soil drench of TerraGrow at 0.4 oz/10 gal after planting. The other treatments were applied as soil drenches starting after transplanting on 8 Aug and ending 31 Oct. Plant height and width were recorded on 20 Nov. Plants were dug on 21 Nov for root infection analysis. On 21 Nov, fresh weight was recorded and severity of Rhizoctonia root rot was assessed using a scale of 0-100% of roots affected. Average maximum temperatures for 19-30 Jun, Jul, Aug, Sep, Oct and 1-20 Nov were 83.95, 91.58, 85.76, 82.97, 73.74 and 63.54ºF; average minimum temperatures were 64.16, 68.5, 65.13, 58.13, 49.23 and 43.76ºF; and total rainfall amounts were 1.34, 5.21, 4.45, 4.96,4.82 and 3.97 in., 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.

Rhizoctonia root rot disease pressure was high in this trial. All of the treatments significantly reduced Rhizoctonia root rot severity compared to the non-treated, inoculated control. There were no significant differences on Rhizoctonia root rot severity between plants treated with Mural, Empress Intrinsic, Pageant Intrinsic and non-treated, non-inoculated control. There were no significant differences in plant fresh weight, root weight and plant height between treated and non-treated plants. Biocontrol products IT-5103, SoilGard. RootShield *PLUS*+ WP, and MBI110 significantly increased plant width compared to the non-treated, inoculated control. Phytotoxicity and defoliation were not observed in any of the viburnum plants.

Treatment and rate	Application dates[z]	Rhizoctonia root rot severity (%)[y]	Plant fresh weight (oz)	Root weight (oz)	Plant height (in)	Plant width (in)
RootShield *PLUS*+ WP 8 oz/100 gal	2,10	26.1 bcd[x]	1.08 a	0.45 a	11.89 a	11.21 bc
MBI110 1%	2-14	25.9 bcd	1.00 a	0.38 a	12.80 a	10.73 bcd
SoilGard 2 lb/100 gal	2	28.6 bcd	1.00 a	0.41 a	11.02 a	11.25 bc
IT-5103 WP 2 g/plant	2,5,8,11,14	36.1 b	1.05 a	0.50 a	10.63 a	12.99 b
TerraClean 5.0 0.2% (v/v) TerraGrow 1.0 oz/10 gal TerraGrow 0.4 oz/10 gal	1 2 5,8,11,14	18.6 cde	0.83 a	0.34 a	10.58 a	8.26 de
Mural 45WG 3 oz/100 gal	2,5,8,11,14	9.9 ef	1.05 a	0.44 a	11.34 a	7.83 e
Empress Intrinsic 23.8SC 3 fl oz/100 gal	2,5,8,11,14	11.3 ef	1.20 a	0.42 a	12.01 a	8.91 cde
Pageant Intrinsic 38WG 18 oz/100 gal	2,5,8,11,14	16.4 def	1.02 a	0.46 a	11.30 a	8.94 cde
Non-treated, inoculated control		66.4 a	0.82 a	0.35 a	9.23 a	7.35 e
Non-treated, non-inoculated control		7.6 f	1.05 a	0.43 a	11.72 a	17.67 a
P-value		<.0001	0.5445	0.7071	0.1052	<.0001

[z]Application dates: 1=7 Aug; 2=8 Aug; 3=15 Aug; 4=22 Aug; 5=29 Aug; 6=5 Sep; 7=12 Sep; 8=19 Sep; 9=26 sep; 10=3 Oct; 11=10 Oct; 12=17 Oct; 13=24 Oct; 14=31 Oct.

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

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

VIBURNUM (*Viburnum odoratissimum*)
Rhizoctonia root rot; *Rhizoctonia solani*

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Evaluation of biorational products and fungicides for the control of Rhizoctonia root rot of viburnum in greenhouse condition, 2017.

The experiment was conducted at the Otis L. Floyd Nursery Research Center in McMinnville, TN. Uniform viburnum plants (*V. odoratissimum*) were potted in no. 1 nursery containers in Morton's no. 2 Grow Mix on 4 Sep. Four 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. Each plant was top dressed with 0.35 oz of 18-6-8 Nutricote controlled-release fertilizer on 20 Jan. Viburnum plants were watered with overhead irrigation system two times per day for 2 minutes. Plants were drench-inoculated with a slurry of *Rhizoctonia solani* (7-day old cultures on PDA were homogenized) at a rate of 3.38 fl oz/ft^2 on 7 Mar. Non-treated, non-inoculated and inoculated plants served as controls. Treatments were applied as drench application beginning on 27 Feb and ending on 16May. Plant height and width were recorded on 22 May. Plants were dug and cleaned on 23 May for root infection analysis. On 23 May, fresh weight was recorded and severity of Rhizoctonia root rot was assessed using a scale of 0-100% roots affected. Average maximum temperatures for 7-31 Mar, 1-30 Apr, and 1-23 May were 81.4, 82.4, and 83.1ºF; average minimum temperatures were 54.6, 56.3, and 57.7ºF; respectively. Analysis of variance was performed using the general linear models procedure with SAS statistical software and means were separated using Tukey test.

Rhizoctonia root rot disease pressure was moderate to high in this trial with non-treated control plants showing 59.88% disease severity by 7 Jun. All of the treatments significantly reduced Rhizoctonia root rot severity compared to non-treated inoculated control except RootShield *PLUS*+, MBI110 and SoilGard. The treatments most effective in reducing Rhizoctonia root rot severity were Mural, Empress Intrinsic, Pageant, TerraClean 5.0 + TerraGrow program and IT-5103. There were no significant differences in plant height and width between treated and non-treated plants. Phytotoxicity and defoliation were not observed in any of the viburnum plants.

Treatment and rate (application dates[z])	Rhizoctonia root rot severity (%)[y]	Plant height (in)	Plant width (in)
RootShield *PLUS*+ WP 8 oz/100 gal (2,10)	38.0 ab[x]	3.64 a	3.22 a
MBI110 1% (2-13)	25.5 ab	1.67 a	3.03 a
SoilGard 2 lb/100 gal (2)	31.8 ab	2.31 a	3.89 a
IT-5103 WP 2 g/plant (2,5,8,11)	19.3 b	1.13 a	3.47 a
TerraClean 5.0 0.2% (1) TerraGrow 1.0 oz/10 gal (2) TerraGrow 0.4 oz/10 gal (5,8,11)	19.3 b	1.28 a	3.35 a
Mural 45WG 3 oz/100 gal (2,5,8,11)	9.9 b	2.81 a	3.69 a
Empress Intrinsic 23.8SC 3 fl oz/100 gal (2,5,8,11)	16.1 b	2.12 a	4.82 a
Pageant Intrinsic 38WG 18 oz/100 gal (2,5,8,11)	22.4 b	2.22 a	5.59 a
Non-treated, inoculated control	59.9 a	2.25 a	4.41 a
Non-treated, non-inoculated control	9.9 b	2.07 a	5.71 a
P-value	0.0010	0.2139	0.2373

[z]Application dates: 1=27 Feb; 2=28 Feb; 3=7 Mar; 4=14 Mar; 5=21 Mar; 6=28 Mar; 7=4 Apr; 8=11 Apr; 9=18 Apr; 10=25 Apr; 11=2 May; 12=9 May; 13=16 May.

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

[x]Values are the means of four replicates; 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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