



[Environment Horticulture Program Research Summaries](#)

**IR-4 Environmental Horticulture Program
Rhizoctonia Efficacy: Summary & Literature Review**

Rhizoctonia solani

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Abstract

From 1999 to 2019, numerous products representing 48 active ingredients were evaluated in several greenhouse experiments as soil drench, soil incorporation, foliar or soak application, and in 2 field trials as soil drench, against *Rhizoctonia solani*. Trials were conducted on begonia, chrysanthemum, garden impatiens, petunia, poinsettia, snapdragon, viburnum and zinnia. The relatively new registered products Affirm/Endorse/Veranda O (polyoxin D), Empress Intrinsic (pyraclostrobin), Heritage (azoxystrobin), Medallion (fludioxonil), Mural (azoxystrobin + benzovindiflupyr) and Pageant Intrinsic (pyraclostrobin + boscalid) showed excellent efficacy. Although there were insufficient data for definitive conclusions, BAS 703/Orkestra, BAS 750, Broadform, Compass, Disarm, Hurricane, Picatina, Promax, Prostar, Tourney and Trinity generally provided good to excellent efficacy, while Astun, SP2700, and ZeroTol generally provided poor to mediocre efficacy. The biological products Actinovate, Howler, IT-5103, MBI-110/Stargus, MBI-601, Pvent, RootShield PLUS and SoilGard also provided mediocre to excellent efficacy in limited number of tests. Of the established standards, Terraclor generally provided good efficacy, while 3336 generally provided inconsistent efficacy.

Introduction

In 2018, IR-4 initiated a high priority project to determine efficacy of several fungicides on non-Oomycete root rot pathogens, including *Rhizoctonia* species, and obtain data supporting current and future registrations on ornamentals. We reviewed available ornamental trials published in Biological & Cultural Tests, Fungicide & Nematicide Tests and Plant Disease Management Reports to check efficacy of experimental and registered fungicides on *Rhizoctonia* species. This report is a brief summary of available data from 20 environmental horticulture reports presented in individual tables. The source of report is included under each data table. One trial from 8 reports submitted to the IR-4 project before 2018 is included as one of the individual tables in this report. Efficacy data from the 7 other trials from 1973 to 1999 are included in the 'Summary of product efficacy by pathogen and crop table. Additional data will be added when received from researchers.

Materials and Methods

From 1999 to 2019, numerous products representing 48 active ingredients were evaluated in greenhouse and field trials as soil drench, soil incorporation, foliar, soak application against *Rhizoctonia solani*. Trials were conducted on chrysanthemum, garden impatiens, petunia, poinsettia, snapdragon, viburnum and zinnia. Treatments were generally applied as soil drench either a few days before *Rhizoctonia* inoculation or immediately after inoculation and reapplied biweekly. Researchers used a minimum of four replications. Disease severity and incidence were recorded at various intervals after initial application. Phytotoxicity or lack of it was generally noted in the reports. Nine researchers were involved in the testing (Appendix 1).

Products were supplied by their respective manufacturers.

For IR-4 testing, the following protocols were used: 18-005 and 19-004. Please visit <https://www.ir4project.org/ehc/ehc-registration-support-research/env-hort-researcher-resources/#Protocols> to view and download this protocol.

Table 1. List of Products and Rates Tested on Environmental Horticulture Plants from 1999 to 2019.

Active Ingredient(s)	Trade Name(s)	Manufacturer	Rate(s) Tested		# Trials
A14912A	A14912A	Syngenta	Pot substrate incorporation	0.6 oz/ cu ft 1.2 oz/ cu ft 1.8 oz/ cu ft	1
A14912F	A14912F	Syngenta	Pot substrate incorporation	0.6 oz/ cu ft 1.2 oz/ cu ft 1.8 oz/ cu ft	1
Azoxystrobin	Heritage 50WG	Syngenta	Drench	0.23 oz per 100 gal	2
				0.45 oz per 100 gal	2
				0.90 oz per 100 gal	6
				1.80 oz per 100 gal	1
				4 oz per 100 gal	2
			Soak	1 oz per 100 gal	1
				2 oz per 100 gal	
			Spray	2 oz per 100 gal	1
4 oz per 100 gal					
Sprenc	4 oz per 100 gal	1			
Azoxystrobin + Benzovindiflupyr	Mural 45WG	Syngenta	Drench	3 oz per 100 gal	3
<i>Bacillus amyloliquifaciens</i> strain F727	Stargus/MBI 110	Marrone	Drench	1 gal per 100 gal	4
				2 gal per 100 gal	2
CGA173506	CGA173506	Syngenta	Sprenc	1.5 oz per 100 gal	1
Cyazofamid	Segway	OHP	Drench	1.5 oz per 100 gal	1
				3.0 oz per 100 gal	1
Dipotassium phosphate and phosphonate	BioPhos	Agrisel	Drench	1 gal per 100 gal	1
				2 gal per 100 gal	1
Etridiazole + Thiophanate methyl	Banrot 40WP	Scotts	Drench	8 oz per 100 gal	2
Fenamidone	Fenstop	OHP	Drench	7 oz per 100 gal	1
				14 oz per 100 gal	1
Fludioxonil	Medallion	Syngenta	Drench	1 oz per 100 gal	1
				2 oz per 100 gal	4
Fludioxonil + Mefenoxam	Hurricane	Syngenta	Sprenc	4 oz per 100 gal	1
Fluopyram + Trifloxystrobin	Broadform	Bayer	Sprenc	4 fl oz per 100 gal	2
				6 fl oz per 100 gal	2
Fluopicolide	Adorn	Valent	Drench	30 ml per 100 gal	1
				60 ml per 100 gal	1
Fluoxastrobin	Disarm O	OHP	Drench	3 oz per 100 gal	1
Flutolanil	Prostar	Bayer	Sprenc	6 oz per 100 gal	1
Fluxapyroxad + Pyraclostrobin	Orchestra/BAS 703 01F	BASF	Drench	7 fl oz per 100 gal	1
				10 fl oz per 100 gal	2
				14 fl oz per 100 gal	1
Furfural	Multiguard	Agriguard	Drench	250 ppm	1
				500 ppm	1
<i>Gliocladium catenulatum</i> strain J1446	Pvent	BioSafe	Drench	0.1% w/v	1
<i>Gliocladium virens</i> strain GL-21	SoilGard	Certis	Drench	2 lb per 100 gal	3

Active Ingredient(s)	Trade Name(s)	Manufacturer	Rate(s) Tested		# Trials
Hydrogen dioxide + Peroxyacetic acid	ZeroTol	BioSafe	Drench	1 gal per 100 gal	1
Hymexazole	Hymexazole	Sumitomo	Drench	6 oz per 100 gal	1
				12 oz per 100 gal	1
Isofetamid	Astun	OHP	Sprench	13.5 fl oz per 100 gal	4
				17 fl oz per 100 gal	2
Mandipropamid	Micora	Syngenta	Drench	2 oz per 100 gal	1
				8 oz per 100 gal	1
Mefentrifluconazole	BAS 750	BASF	Sprench	3 fl oz per 100 gal	1
Metconazole	Tourney	Valent	Drench	4 oz per 100 gal	1
<i>Muscodor albus</i> strain SA-13	MBI-601	Marrone	Pot substrate incorporation	5 g/cu ft soil	2
				10 g/cu ft soil	2
OHPF-1904	OHPF-1904	OHP	Sprench	4.7 fl oz per 100 gal	1
Pentachloronitro-benzene	Terraclor 75WP	Chemtura	Drench	4 oz per 100 gal	2
				8 oz per 100 gal	1
Polyoxin D	Affirm	Nufarm	Drench	8 oz per 100 gal	1
	Endorse	Arysta	Drench	1.1 lb per 100 gal	1
				2.2 lb per 100 gal	1
Veranda O	OHP	Drench	8 oz per 100 gal	2	
Potassium phosphite	Vital	Luxembourg	Drench	2 pt per 100 gal	1
				4 pt per 100 gal	1
<i>Pseudomonas chlororaphis</i> strain AFS009	Howler	AgBiome	Drench	67 oz per 100 gal	1
	Zio	SePRO	Drench	67 oz per 100 gal	1
100 oz per 100 gal				1	
Pydiflumetofen	Picatina	Syngen	Drench	13.7 fl oz per 100 gal	1
Pyraclostrobin	Empress Intrinsic	BASF	Drench	3 fl oz per 100 gal	3
Pyraclostrobin + Boscalid	Pageant Intrinsic	BASF	Drench	18 oz per 100 gal	4
				SP2700	SePro
<i>Streptomyces lydicus</i>	Actinovate	Novozymes	Drench	10 oz per 100 gal	1
Thiophanate methyl	3336 50W	Cleary	Drench	4 oz per 100 gal	2
				16 oz per 100 gal	2
			Spray	16 oz per 100 gal	1
	3336 F	Cleary	Drench	8 fl oz per 100 gal	1
				20 fl oz per 100 gal	1
OHP 6672 4.5L	OHP	Drench	20 fl oz per 100 gal	1	
Topsin	UPI	Sprench	10.9 oz per 100 gal	1	
Thyme oil	Promax	HumaGro	Drench	2 gal per 100 gal	1
<i>Trichoderma harzianum</i>	RootShield	BioWorks	Drench	5 oz per 100 gal	1
<i>Trichoderma harzianum</i> + <i>T. virens</i>	RootShield Plus	BioWorks	Drench	8 oz per 100 gal	3
<i>Trichoderma</i> spp.	IT-5103 WP	Italpollina	Drench	2 g per plant	3
Trifloxystrobin	Compass 50WG	Bayer	Drench	0.5 oz per 100 gal	1
Triflumizole	Terraguard	UPI NA	Drench	4 fl oz per 100 gal	3
Triticonazole	Trinity	BASF	Drench	6 fl oz per 100 gal	1
				8 fl oz per 100 gal	
				12 fl oz per 100 gal	
				24 fl oz per 100 gal	
V-10190	V-10190 2.5SC	Valent	Drench	8 fl oz per 100 gal	1
				16 fl oz per 100 gal	1

Results

Comparative Efficacy on *Rhizoctonia solani*

Begonia

In 2018, Norman conducted a greenhouse trial to determine efficacy of several fungicides applied as drench, sprench or soil incorporation for the control of *Rhizoctonia* root and crown rot, *Rhizoctonia solani*, on wax begonia (*Begonia semperflorens*). Treatments were applied at various dates shown in Table 2. All fungicide treatments gave some control of *Rhizoctonia* root and crown rot of begonia, with Broadform and Prostar providing 100% control that was similar to Uninoculated control. However, by day 42 only 5 products were still significantly better than the inoculated control. These treatments were BAS 750, Broadform, MBI-601, ProStar and Stargus/MBI-110. No evidence of phytotoxicity was observed for any treatment.

Table 2. Efficacy for *Rhizoctonia* Stem Rot, *Rhizoctonia solani*, on Wax Begonia (*Begonia semperflorens*) ‘Bada Bing Scarlet’, Norman, FL, 2018.

Treatment	Rate Per 100 Gal	Application Method	Application Dates	% Leaf Damage ^x at 42 DAT
Astun (isofetamid)	13.5 fl oz	Sprenc	4/26, 5/3	43.5 e
BAS750 (mefentrifluconazole)	3 fl oz	Sprenc	4/23, 5/10, 5/24	4.5 ab
Broadform (fluopyram + trifloxystrobin)	4 fl oz	Sprenc	4/26, 5/10	0 a
	6 fl oz	Sprenc	4/26, 5/10	0 a
MBI-601 (<i>Muscodor albus</i> strain SA-13)	5g/cu ft soil	Pot substrate incorp.	4/12, Potted 4/18	4.5 bc
	10g/cu ft soil	Pot substrate incorp.	4/12, Potted 4/18	39.5 de
ProStar (flutalonil)	6 oz	Sprenc	4/26, 5/10	0 a
SP2700 (SP2700)	11 fl oz	Drench	4/23, 5/10, 5/24	32 cde
Stargus/MBI-110 (<i>Bacillus amyloliquefaciens</i> strain F727)	1%	Drench	4/26, 5/10, 5/24	27.5 cd
	2%	Drench	4/26, 5/10, 5/24	27 cd
Untreated uninoculated	-	-	-	0 a
Untreated inoculated	-	-	-	45 e

^x Means followed by same letter do not differ significantly based on LSD test, (P=0.05).

Chrysanthemum

In 2011, Beckerman conducted a greenhouse trial to determine efficacy of several fungicides applied as sprench for the control of *Rhizoctonia* stem rot, *Rhizoctonia solani*, on chrysanthemum (*Chrysanthemum morifolium*). Hurricane and CGA173506 were applied on May 27, and plants inoculated 14 days later. Topsin M was applied on Jun 24 when the first symptoms of stem discoloration were observed and was re-applied on Jul 4. All treatments provided excellent control of a moderate disease pressure (Table 3). No evidence of phytotoxicity was observed for any treatment.

Table 3. * Efficacy for Rhizoctonia Stem Rot, *Rhizoctonia solani*, on Chrysanthemum (*Chrysanthemum morifolium*) ‘Goldcrest Yellow’, Beckerman, IN, 2011.

Treatment	Rate Per 100 Gal	Disease Severity Rating ^x		
		Oct 28	Nov 4	Nov 11
CGA173506 32WG	1.5 oz	1.0 a	1.0 a	1.2 b
Hurricane 48WP (fludioxonil + mefenoxam)	1.5oz	1.0 a	1.0 a	1.0 b
Topsin M 70WP (thiophanate methyl)	10.9 oz	1.0 a	1.0 a	1.0 b
Untreated uninoculated	-	1.0 a	1.0 a	1.0 b
Untreated inoculated	-	1.3 a	2.2 a	4.0 a

* Not an IR-4 Experiment: Plant Disease Management Reports 7:OT013.

^x Disease severity was on a 1 - 10 scale where 1=0-10%, 2=11-20%, 3=21-30%, 4=31-40%, 5=41-50%, 6=51-60%, 7=61- 70%, 8=71-80%, 9=81-90%, 10=91-100% of leaves wilted and discolored on a stem, or stems, with basal stem rot. Means followed by same letter do not differ significantly based on Waller-Duncan *k*-ratio, *t*-test, *k*=100, (P=0.05).

Garden Impatiens

In 1999, Benson conducted a greenhouse trial to determine efficacy of several fungicides, applied as drench at 2 pt per sq ft, for the control of *Rhizoctonia* crown rot, *Rhizoctonia solani*, on garden impatiens (*Impatiens balsamina*). A single application of Heritage at the lowest rate gave complete control of a high *Rhizoctonia* crown rot pressure for up to 41 days after inoculation (Table 4). Because control was so effective with Heritage, the effect of including a wetting agent could not be assessed. Compass and Cleary's 3336 also gave very good control of crown rot, but the low rate of Compass began to lose effectiveness after 27 days.

In 2013, Hand conducted a greenhouse trial to determine efficacy of several fungicides for the control of *Rhizoctonia* crown rot, *Rhizoctonia solani*, on garden impatiens (*Impatiens balsamina*). Treatments were applied as a drench at transplanting on Sep 13. All treatments, except 3336 WP, provided excellent protection against a severe disease pressure (Table 5). No statistically significant differences were observed between Medallion and the low rate of Heritage. Treatments receiving the high rate of Heritage had significantly greater biomass compared to all other treatments with the exception of the low rate of Heritage. No evidence of phytotoxicity was observed for any treatment.

In 2018, Hand conducted a greenhouse trial to determine efficacy of several fungicides for the control of *Rhizoctonia* crown rot, *Rhizoctonia solani*, on impatiens (*Impatiens walleriana*). Treatments were applied preventatively as a spray to the plant stems and foliage on May 22 and Jun 5. On May 23, plants were transplanted into a growing medium in which *Rhizoctonia solani*-infested millet had been previously incorporated. Astun at 17 fl oz/100 gal provided very good control of a severe disease pressure, almost comparable to the untreated uninoculated check, and better than Terraguard (Table 6). No evidence of phytotoxicity was observed for any treatment.

In 2019, Norman conducted a greenhouse trial to determine efficacy of several fungicides applied as drench, sprench or soil incorporation for the control of *Rhizoctonia* root and crown rot, *Rhizoctonia solani*, on buzzy lizzy impatiens (*Impatiens walleriana*). Treatments were applied at various dates shown in Table 7. Efficacy for *Rhizoctonia* Stem Rot, *Rhizoctonia solani*, on Impatiens (*Impatiens walleriana*) ‘Super Elfin Red’, Norman, FL, 2019. Products that were effective include BAS750, Broadform, MBI-601, Orkestra Int., Postiva, Pvent, and Cleary’s 3336. There was some leaf burn with Orkestra Int. on impatiens. The final evaluation of plant height did not reflect disease control.

In 2019, Hand conducted a greenhouse trial to determine efficacy of several fungicides for the control of *Rhizoctonia* crown rot on impatiens (*Impatiens walleriana*). Treatments were applied preventatively as a spray to the plant stems on Jul 31 and Aug 14. On Aug 2, plants were transplanted into a growing medium in which *Rhizoctonia solani*-infested millet had been previously incorporated. OHPF-1904 and Heritage provided 100% control of a severe disease pressure, comparable to the Untreated uninoculated treatment (Table 8) Astun at 17 fl oz/100 gal provided 90% control, and was statistically similar to that of Heritage and OHPF-1904. No evidence of phytotoxicity was observed for any treatment.

Table 4. * Efficacy for *Rhizoctonia* Crown Rot, *Rhizoctonia solani*, on Garden Impatiens (*Impatiens balsamina*) ‘Super Elfin Mix’, Benson, NC, 1999.

Treatment	Rate Per 100 Gal	Infected Transplants (%) ^x at Days After Treatment				
		14	22	27	34	41
3336 50W (thiophanate methyl)	16 oz	0 b	0 b	0 b	0 c	0 c
Compass 50W (trifloxystrobin)	0.5 oz	3.3 b	3.3 b	0 b	13.3 b	56.7 b
Heritage 50WG (azoxystrobin)	0.23 oz	0 b	0 b	0 b	0 c	0 c
Heritage 50WG	0.45 oz	0 b	0 b	0 b	0 c	0 c
Heritage 50WG	0.9 oz	0 b	0 b	0 b	0 c	0 c
Heritage 50WG	0.23 oz	0 b	0 b	0 b	0 c	0 c
Heritage 50WG	0.45 oz	0 b	0 b	0 b	0 c	0 c
Heritage 50WG	0.9 oz	0 b	0 b	0 b	0 c	0 c
Heritage 50WG +Lesco	0.23 oz + 8 fl oz	0 b	0 b	0 b	3.3 c	0 c
Heritage 50WG +Lesco	0.45 oz + 8 fl oz	0 b	0 b	0 b	3.3 c	0 c
Heritage 50WG +Lesco	0.9 oz + 8 fl oz	0 b	0 b	0 b	0 c	0 c
Untreated inoculated	-	53.3	63.3 a	76.7 a	86.7 a	93.3 a

* Not an IR-4 Experiment: F&N Tests 55:547. Not all treatments included in table.

^x Means followed by same letter do not differ significantly based on Waller-Duncan k-ratio, t-test (P=0.05).

Table 5. Efficacy for *Rhizoctonia* Crown Rot, *Rhizoctonia solani*, on Garden Impatiens (*Impatiens balsamina*) ‘Super Elfin Salmon XP’, Hand, OH, 2013.

Treatment	Rate Per 100 Gal	Sep 17	Sep 20	Sep 23	Sep 26	Sep 29	Oct 2	Dry Wt (oz) ^y Oct 2
<i>Plant Death (%)^x</i>								
Cleary's 3336 50W (thiophanate methyl)	16 oz	0.0 a	0.0 a	0.0 a	30.0 ab	100.0 b	100.0 b	0.000 c
Heritage 50WG (azoxystrobin)	0.9 oz	0.0 a	0.0 a	10.0 a	10.0 a	10.0 a	10.0 a	0.022 ab
Heritage 50WG (azoxystrobin)	1.8 oz	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.025 a
Medallion 50WP (fludioxonil)	1 oz	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.016 b
Untreated inoculated	-	10.0 a*	20.0 a	20.0 a	60.0 b	90.0 b	100.0 b	0.000 c
<i>Leaf Wilt (%)</i>								
Cleary's 3336 50W (thiophanate methyl)	16 oz	0.0 a	53.2 b	64.0 b	88.0 b	100.0 b	100.0 b	
Heritage 50WG (azoxystrobin)	0.9 oz	0.0 a	10.0 a	10.0 a	10.0 a	10.0 a	10.0 a	
Heritage 50WG (azoxystrobin)	1.8 oz	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	
Medallion 50WP (fludioxonil)	1 oz	0.0 a	0.0 a	0.0 a	5.0 a	7.5 a	12.5 a	
Untreated inoculated	-	10.0 a*	26.0 a	26.0 a	60.0 b	90.0 b	100.0 b	

* Not an IR-4 Experiment: Plant Disease Management Reports 8:OT007.

^x Column means followed by the same letter are not significantly different based on Tukey's HSD test ($P=0.05$).

^y Column means followed by the same letter are not significantly different based on the Wilcoxon test ($P=0.05$).

Table 6. * Efficacy for Rhizoctonia Crown Rot, *Rhizoctonia solani*, on Impatiens (*Impatiens walleriana*) 'Super Elfin Lipstick, Hand, OH, 2018.

Treatment	Rate Per 100 Gal	Observation Dates			
		May 29	Jun 4	Jun 11	Jun 18
Disease Incidence (%) ^x					
Astun™ SC (isofetamid)	13.5 fl oz	60.0 ab	90.0 a	90.0 a	90.0 a
	17.0 fl oz	20.0 bc	20.0 b	20.0 b	50.0 b
Terraguard SC (triflumizole)	6.0 fl oz	0.0 c	90.0 a	100.0 a	100.0 a
Untreated uninoculated	-	0.0 c	0.0 b	0.0 b	0.0 c
Untreated inoculated	-	70.0 a	80.0 a	80.0 a	90.0 a
Disease Severity (%) ^x					
Astun™ SC (isofetamid)	fl oz	22.5 ab	86.0 a	87.0 a	87.5 a
	fl oz	6.5 ab	7.5 b	16.5 b	33.0 b
Terraguard SC (triflumizole)	fl oz	0.0 b	74.0 a	86.0 a	95.5 a
Untreated uninoculated	-	0.0 b	0.0 b	0.0 b	0.0 b
Untreated inoculated	-	35.0 a	80.0 a	80.0 a	82.0 a

* Not an IR-4 Experiment: Plant Disease Management Reports 13:OT009.

^x Means followed by same letter do not differ significantly based on Tukey HSD test ($P=0.05$).

Table 7. Efficacy for Rhizoctonia Stem Rot, *Rhizoctonia solani*, on Impatiens (*Impatiens walleriana*) 'Super Elfin Red', Norman, FL, 2019.

Treatment	Rate Per 100 Gal	Application Method	Application Dates	% Leaf Damage ^x at 42 DAT
Astun (isofetamid)	13.5 fl oz	Drench	10/10, 10/24	46.0 b-e
BAS750 (mefentrifluconazole)	3 fl oz	Drench	10/7, 10/24	18.5 ab
Broadform (fluopyram + trifloxystrobin)	4 fl oz	Sprenc	10/10, 10/24	0.0 a
	6 fl oz	Sprenc	10/10, 10/24	0.0 a
Cleary's 3336 50W (thiophanate methyl)	8 fl oz	Drench	10/7	17.5 ab
MBI-601 (<i>Muscodor albus</i> strain SA-13)	5g/cu ft soil	Pot substrate incorp.	09/26	23.5 abc
	10g/cu ft soil		09/26	19.0 ab
Orkestra Int. (fluxapyroxad + pyraclostrobin)	10 fl oz	Drench	10/7, 10/24	1.0 a
Picatina (pydiflumetofen)	13.7 fl oz	Drench	10/7	28.5 a-d
Pvent (<i>Gliocladium catenulatum</i> strain J1446)	0.1% w/v	Drench	10/7/, 10/10,10/24	21.0 ab
SP2700 (SP2700)	11 fl oz	Drench	10/7, 10/24	58.0 e
Stargus/MBI-110 (<i>Bacillus amyloliquefaciens</i> strain F727)	2%	Drench	10/10, 10/24	56.0 de
ZeroTol 2.0 (hydrogen dioxide + peroxyacetic acid)	1 gal	Drench	10/10, 10/24	90.5 ef
Zio (<i>Pseudomonas chlororaphis</i> strain AFS009)	67 oz	Drench	10/7, 10/24	52.5 cde
	100 oz	Drench	10/7, 10/24	62.0 ef
Untreated uninoculated	-		-	0.0 a
Untreated inoculated	-		-	67.0 ef

^x Means followed by same letter do not differ significantly based on LSD test, ($P=0.05$).

Table 8. * Efficacy for Rhizoctonia Crown Rot, *Rhizoctonia solani*, on Impatiens (*Impatiens walleriana*) ‘Super Elfin Lipstick, Hand, OH, 2019.

Treatment	Rate Per 100 Gal	Disease Severity (%) ^x	AUDPC
Astun SC (isofetamid)	13.5 fl oz	60 a	945.0 b
	17.0 fl oz	10 b	105.0 c
Heritage 50 WG (azoxystrobin)	4.0 oz	0 c	0.0 c
OHPF-1904	4.7 fl oz	0 c	0.0 c
Untreated uninoculated	-	0 c	0.0 c
Untreated inoculated	-	90 a	1767.5 a

* Not an IR-4 Experiment: Plant Disease Management Reports 13:OT009.

^x Means followed by same letter do not differ significantly based on Tukey HSD test, (P=0.05).

Petunia

In 1999, Moorman conducted a greenhouse trial to determine efficacy of several fungicides applied as drench for the control of *Rhizoctonia* crown rot, *Rhizoctonia solani*, on petunia (*Petunia x hybrida*). All treated plants were healthier than the untreated checks but Heritage protected plants better than Banrot or 3336 F.). The addition of wetting agent did not significantly improve the performance of Heritage. Slight chlorosis developed in all Heritage treated plants.

In 2006, Reddy conducted a greenhouse trial for IR-4 to determine efficacy of several fungicides applied as drench for the control of *Rhizoctonia* root rot, *Rhizoctonia solani*, on petunia (*Petunia x hybrida*). Treatments were applied at 1 and 2 weeks after transplanting. All treatments provided excellent protection against a severe disease pressure resulting in higher healthy plant stand and vigor (Table 10). No evidence of phytotoxicity was observed for any treatment.

Table 9. * Efficacy for Rhizoctonia Root Rot, *Rhizoctonia solani*, on Petunia (*Petunia x hybrida*) ‘Fantasy Hybrid Crystal Red’, Moorman, PA, 1999.

Treatment	Rate Per 100 Gal	Amount per sq ft	Disease Rating (%) ^x	
			Nov 16	Nov 23
3336 F (thiophanate methyl)	20 fl oz	1 pt	2.0 c	3.1 d
Banrot 40WP (etridiazole + thiophanate methyl)	8 oz	1 pt	2.9 d	3.1 d
Heritage 50WG (azoxystrobin)	0.23 oz	1 pt	1.4 ab	1.5 ab
Heritage 50WG	0.45 oz	1 pt	1.1 a	2.0 b
Heritage 50WG	0.9 oz	1 pt	1.0 a	1.7 ab
Heritage 50WG	0.23 oz	2 pt	1.0 a	1.4 ab
Heritage 50WG	0.45 oz	2 pt	1.0 a	1.1 a
Heritage 50WG	0.9 oz	2 pt	1.0 a	1.0 a
Heritage 50WG +Lesco	0.23 oz + 4 fl oz	1 pt	2.2 c	2.4 bc
Heritage 50WG +Lesco	0.45 oz + 4 fl oz	1 pt	1.0 a	1.0 a
Heritage 50WG +Lesco	0.9 oz + 4 fl oz	1 pt	1.3 ab	2.3 bc
Untreated inoculated	-	-	4.0 e**	4.0 e

* Not an IR-4 Experiment: F&N Tests 56:OT021.

^x 1 = no disease; 2 = slight yellowing or stunting, plants marketable; 3 = moderate yellowing and some wilting, not marketable; 4 = obvious lesion, dying leaves or stems, not marketable; 5 = dead. Means followed by same letter do not differ significantly based on Tukey's Studentized Range (HSD) test (P=0.05).

Table 10. Efficacy for Rhizoctonia Root Rot, *Rhizoctonia solani*, on Petunia (*Petunia x hybrida*), Reddy, AL, 2006.

Treatment	Rate Per 100 Gal	Vigor ^x	% Healthy Stand	% Pre-emergence Damping-off	% Post-emergence Damping-off	Root rot Severity ^y
Actinovate (<i>Streptomyces lydicus</i>)	10 oz	4.5*	65.4*	21.1*	12.8*	4.7*
Adorn (fluopicolide)	30 ml	4.5*	57.8*	12.9*	11.2*	5.3*
	60 ml	5.0*	62.1*	7.9*	6.9*	3.1*
BioPhos (Dipotassium phosphate)	1 gal	4.6*	61.2*	34.5	18.8	4.9*
	2 gal	4.8*	69.9*	22.1*	8.7*	2.3*
Disarm (fluoxastrobin)	3 oz	5.0*	52.6*	31.3	12.7*	2.2*
Fenstop (fenamidone)	7 oz	3.9*	49.8*	17.9*	16.9	5.6*
	14 oz	4.7*	66.7*	11.3*	6.8*	3.1*
Hymexazole (hymexazole)	6 oz	4.5*	65.7*	25.8*	23.1	6.7
	12 oz	4.5*	75.6*	11.8*	7.9*	4.1*
Micora (mandipropamid)	2 oz	4.0*	49.5*	31.8	16.9	6.5
	8 oz	4.2*	65.1*	17.9*	5.4*	3.3*
Multiguard (furfural)	250 ppm	4.1*	58.2*	15.9*	8.9*	4.7*
	500 ppm	5.0*	68.7*	8.9*	4.2*	2.8*
Promax (thyme oil)	2 gal	4.5*	48.9*	22.6*	19.9	4.1*
Segway (cyazofamid)	1.5 oz	3.9*	58.9*	22.6*	11.3*	5.1*
	3.0 oz	4.5*	64.7*	12.8*	5.9*	2.3*
Vital (potassium phosphite)	2 pt	4.0*	58.7*	35.7	19.7	5.6
	4 pt	4.5*	67.9*	25.7*	7.8*	2.1*
Untreated uninoculated	-	4.3*	85.7*	12.2*	4.9*	1.3*
Untreated inoculated	-	2.2	31.6	41.1	21.9	7.1
LSD $P = 0.05$	-	0.9	11.2	12.3	6.5	1.5

^x Vigor is rated as 1 = very poor, 2 = Poor, 3 = better, 4 = Good, and 5 = very good.

^y Root rot severity rated on a scale of 1-10. 1 = no symptoms, very healthy. 2 = 10-20% discoloration, 3 = 20-30% discoloration, 4 = 30-40% discoloration, 5 = 40-50% discoloration, 6 = 50-60% discoloration, 7 = 60-70% discoloration, 8 = 70-80% discoloration, 9 = 80-90% discoloration, and 10 = dead.

*Significantly different from pathogen control according to Fisher's protected LSD at $P = 0.05$

Pre-emergence damping-off was rated 21 days after transplanting. Post-emergence was rated 45 days after transplanting.

Poinsettia

In 2000, Benson conducted a greenhouse trial to determine efficacy of 2 fungicides for the control of Rhizoctonia stem and root rot, *Rhizoctonia solani*, on poinsettia (*Euphorbia pulcherrima*). Both soak and spray treatments of Heritage even at the lowest rate provided very effective control of a severe Rhizoctonia stem rot pressure (Table 11). Rooted cuttings initially soaked or sprayed with Heritage and transplanted for finishing grew as well as plants in the non-infested control and did not develop stem or root rot. The standard 3336 provided inferior control.

In 2008, Beckerman conducted a greenhouse trial to determine efficacy of several fungicides for the control of Rhizoctonia crown rot, *Rhizoctonia solani*, on poinsettia (*Euphorbia pulcherrima*). Granular fungicides A14912A and A14912F were incorporated into the potting substrate prior to transplanting. Medallion and Heritage were applied as soil drenches 3 days after transplant. Plants were allowed to establish for 11 days prior to inoculation. Plants treated with fungicides showed no cankering or infection sites on either the stem or the leaves (Table 12). The lowest and highest rates of A14912A and the two lowest rates of A14912F had plant quality ratings statistically similar to Medallion and Heritage. The highest rate of A14912A and the middle rate of A14912F were statistically similar to the non-inoculated control in plant quality at the final evaluation date. No evidence of phytotoxicity was observed for any treatment.

Table 11. * Efficacy for Rhizoctonia Root Rot, *Rhizoctonia solani*, on Poinsettia (*Euphorbia pulcherrima*) 'Angelica White', Benson, NC, 2000.

Treatment	Rate Per 100 Gal	Applic Method	Propagation				Finishing			
			Stem Rot ^x			Root Rating ^y	Ht (cm)	Wt (g)	Root Rot ^z	Stem Rot
			Day 6	Day 27	Day 41	Day 41	Day 87	Day 88	Day 88	Day 88
Cleary's 3336 50W (thiophanate methyl)	16 oz	Spray	1.1 b	3.0 b	4.2 b	2.0 c	22.7 c	25.3 b	1.0 a	3.3 a
Heritage 50WG (azoxystrobin)	1 oz	Soak	1.0 b	1.2 c	1.8 c	4.0 b	27.0 a	45.7 a	1.1 a	1.1 b
Heritage 50WG	2 oz	Soak	1.2 b	1.3 c	1.5 cd	4.2 b	26.8 a	43.4 a	1.0 a	1.1 b
Heritage 50WG	2 oz	Spray	1.1 b	1.3 c	1.8 c	4.2 b	25.6 abc	46.2 a	1.2 a	1.3 b
Heritage 50WG	4 oz	Spray	1.2 b	1.2 c	1.7 c	4.1 b	26.3 ab	39.3 a	1.2 a	1.0 b
Untreated uninoculated	-		1.0 b	1.0 c	1.0 d	4.9 a	23.6 bc	36.7 ab	1.3 a	1.0 b
Untreated inoculated	-	-	4.2 a	5.0 a	5.0 a	1.0 d	n.a.	n.a.	n.a.	n.a.

* Not an IR-4 Experiment: F&N Tests 56:OT023.

^x Stem rot was on a 1-5 scale: 1 = healthy, no infection; 2 = stem lesions less than 25% of stem; 3 = stem lesions 25-50% of stem; 4 = stem girdled, but foliage still green; and 5 = stem girdled, plant dead. Means followed by same letter do not differ significantly based on Waller-Duncan k-ratio, t-test, k=100 (P=0.05).

^y Rooting of cuttings was rated as 1 = no roots visible on any of the four sides of the wedge; 2 = roots protruded through one side of the wedge; 3 = roots protruded through two sides of the wedge; 4 = roots protruded through three sides of the wedge; and 5 = roots protruded through all four sides of the wedge

^z Root rot was on a 1-5 scale: 1 = healthy, no infection; 2 = 25% of roots rotted; and 5 = plant dead.

Table 12. * Efficacy for Rhizoctonia Crown Rot, *Rhizoctonia solani*, on Poinsettia (*Euphorbia pulcherrima*) ‘Prestige Red’, Beckerman, IN, 2008.

Treatment	Rate Per 100 Gal	Disease Severity Rating ^x			Infected Area ^y	Plant Quality ^z
		Oct 28	Nov 4	Nov 11	Nov 11	Nov 11
A14912A	0.6 oz/ cu ft	1.0 a	1.0 a	1.0 a	1.0 a	1.6 cd
A14912A	1.2 oz/ cu ft	1.0 a	1.0 a	1.0 a	1.0 a	1.8 d
A14912A	1.8 oz/ cu ft	1.0 a	1.0 a	1.0 a	1.0 a	1.3 abc
A14912F	0.6 oz/ cu ft	1.0 a	1.0 a	1.0 a	1.0 a	1.4 bc
A14912F	1.2 oz/ cu ft	1.0 a	1.0 a	1.0 a	1.0 a	1.1 ab
A14912F	1.8 oz/ cu ft	1.0 a	1.0 a	1.0 a	1.0 a	1.8 d
Heritage 50WG (azoxystrobin)	0.9 oz	1.0 a	1.0 a	1.0 a	1.0 a	1.4 bc
Medallion 50WP (fludioxonil)	2 oz	1.0 a	1.0 a	1.0 a	1.0 a	1.4 bc
Untreated uninoculated	-	1.0 a	1.0 a	1.0 a	1.0 a	1.0 a
Untreated inoculated	-	1.8 b	2.0 b	4.2 b	2.4 b	4.1 e

* Not an IR-4 Experiment: Plant Disease Management Reports 3:OT028.

^x Disease severity was on a 1-6 scale: 1=0%, 2=20%, 3=40%, 4=60%, 5=80%, 6=100% stem infection. Means followed by same letter do not differ significantly based on Waller-Duncan *k*-ratio, *t*-test, *k*=100, (P=0.0001).

^y Infected leaf area was on a 1-6 scale: 1=0%, 2=20%, 3=40%, 4=60%, 5=80%, 6=100 leaf area infected.

^z Plant quality was on a 1-5 scale: 1=plant symptom free, 2=callusing visible on stem, 3=small canker visible at the base of plant, 4=cankering and lesions advanced along stem, 5=severe infection of the stem and leaves

Snapdragon

In 2003, Daughtrey conducted a greenhouse trial to determine efficacy of several fungicides applied as drench for the control of *Rhizoctonia* stem canker, *Rhizoctonia solani*, on snapdragon (*Antirrhinum majus*). Terraclor provided the best control of a severe disease pressure resulting in plant dry weights similar to the uninoculated control plants; Terraguard was less effective, while Banrot and Cleary 3336 were ineffective (Table 13). No evidence of phytotoxicity was observed with any of the treatments.

Table 13. * Efficacy for Rhizoctonia Stem Canker, *Rhizoctonia solani*, on Snapdragon (*Antirrhinum majus*) ‘Rocket Golden’, Daughtrey, NY, 2009.

Treatment	Rate Per 100 Gal	Stem Canker (%) ^x		Dry Wt (oz)
		Jun 2	Jun 17	Jun 17
Banrot 40WP (etridiazole + thiophanate methyl)	8 oz	45.0 c	65.0 d	0.05 a
Cleary 3336 50W (thiophanate methyl)	4 oz	40.0 c	45.0 cd	0.06 ab
Terraclor 75WP (PCNB)	4 oz	10.0 ab	10.0 ab	0.11 cd
Terraguard 50W (triflumizole)	4 oz	10.0 ab	25.0 abc	0.09 c
Untreated uninoculated	-	0.0 a	0.0 a	0.13 d
Untreated inoculated	-	55.0 c	70.0 d	0.05 a

* Not an IR-4 Experiment: F&N Tests 59:OT047. Not all treatments included in table.

^x Means followed by same letter do not differ significantly based on Fisher’s Protected LSD test (P=0.05).

Viburnum

In 2016, Baysal-Gurel conducted a field trial to determine efficacy of several fungicides for the control of Rhizoctonia root rot, *Rhizoctonia solani*, on viburnum (*Viburnum odoratissimum*). Treatments were applied as drench at various times from Jul 28 to Oct 20. All treatments significantly reduced Rhizoctonia root rot severity from a high disease pressure, with Mural, Empress Intrinsic and Pageant Intrinsic providing excellent control (Table 14). No evidence of phytotoxicity was observed for any treatment.

Table 14. *Efficacy for Rhizoctonia Root Rot, *Rhizoctonia solani*, on Viburnum (*Viburnum odoratissimum*), Baysal-Gurel, TN, 2016.

Treatment	Rate Per 100 Gal	Applic Interval	Disease severity (%) ^y	Plant weight (oz)	Root weight (oz)	Plant height (in)	Plant width (in)
Empress Intrinsic (pyraclostrobin)	3 fl oz	2, 5, 8, 11, 14	6.7 de	1.3 ab	0.8 ab	7.8 a	5.7 abc
IT-5103 WP	2 g/plant	2, 5, 8, 11, 14	37.7 b	0.9 c	0.5 bc	7.2 abc	5.4 bc
MBI 110 (<i>Bacillus amyloliquifaciens</i>)	1%	2-14	28.4 c	0.9 c	0.6 abc	6.5 bc	5.0 c
Mural 45WG (azoxystrobin + benzovindiflupyr)	3 oz	2, 5, 8, 11, 14	5.9 de	1.4 ab	0.9 a	8.5 a	6.1 abc
Pageant Intrinsic 38WG (pyraclostrobin + boscalid)	18 oz	2, 5, 8, 11, 14	13.6 d	1.5 a	0.8 ab	8.0 a	6.9 a
RootShield PLUS WP (<i>Trichoderma harzianum</i> + <i>T. virens</i>)	8 oz	2, 10	26.5 c	0.9 c	0.6 abc	7.8 a	5.5 bc
SoilGard (<i>Gliocladium virens</i>)	2 lb	2	24.3 c	1.0 bc	0.6 abc	7.4 abc	5.7 abc
Untreated uninoculated	-	-	3.7 e	1.5 a	0.8 ab	8.5 a	6.7 ab
Untreated inoculated	-	-	63.3 a	0.7 c	0.4 c	6.2 c	5.3 c
P-value	-	-	≤0.0001	0.0008	0.0643	0.0799	0.0150

* Not an IR-4 Experiment: Plant Disease Management Reports 11:OT003. Not all treatments included in table.

^z Application dates: 2=Jul 28; 3=Aug 4; 4=Aug 11; 5=Aug 18; 6=Aug 25; 7=Sep 8; 8=Sep 11; 9=Sep 15; 10=Sep 22; 11=Sep 29; 12=Oct 6; 13=Oct 13; 14=Oct 20.

^y Disease severity was based on the percentage of roots affected.

^x Columns means with a letter in common are not significantly different based on Fisher's LSD test.

In 2017, Baysal-Gurel conducted a greenhouse trial to determine efficacy of several fungicides for the control of Rhizoctonia root rot, on viburnum. Treatments were applied as drench weekly from Feb 27 to May 16. All treatments, except RootShield *PLUS*⁺, MBI 110 and SoilGard, significantly reduced Rhizoctonia root rot severity from a moderate to high disease pressure; Mural, Empress Intrinsic, Pageant Intrinsic, and IT-5103 provided the most effective control (Table 15). No evidence of phytotoxicity was observed for any treatment.

Table 15. *Efficacy for Rhizoctonia Root Rot, *Rhizoctonia solani*, on Viburnum (*Viburnum odoratissimum*), Baysal-Gurel, TN, 2017, Greenhouse Trial.

Treatment	Rate Per 100 Gal	Applic Dates ^y	Disease severity (%) ^x	Plant height (in)	Plant width (in)
Empress Intrinsic 23.8SC (pyraclostrobin)	3 fl oz	2,5,8,11	16.0 b	2.1	4.8
IT-5103 WP (<i>Trichoderma</i> spp.)	2g/plant	2,5,8,11	19.0 b	1.1	3.5
MBI 110 (<i>Bacillus amyloliquifaciens</i>)	1 %	2-13	26.0 ab	1.7	3.0
Mural 45WG (azoxystrobin + benzovindiflupyr)	3 oz	2,5,8,11	10.0 b	2.8	3.7
Pageant Intrinsic 38WG (pyraclostrobin + boscalid)	18 oz	2,5,8,11	22.0 b	2.2	5.6
RootShield Plus (<i>Trichoderma harzianum</i> + <i>T. virens</i>)	8 oz	2,10	38.0 ab	3.6	3.2
SoilGard (<i>Gliocladium virens</i> strain GL-21)	2 lb	2	32.0 ab	2.3	3.9
Untreated uninoculated	-	-	10.0 b	2.1	5.7
Untreated inoculated	-	-	60.0 a	2.3	4.4
<i>P</i> -value	-	-	0.0010	0.2139	0.2373

* Not an IR-4 Experiment: Plant Disease Management Reports 12:OT020. Not all treatments included in table.

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

^x Disease severity was based on the percentage of roots affected. Columns means with a letter in common are not significantly different based on Tukey test.

In 2017, Baysal-Gurel also conducted a field trial to determine efficacy of several fungicides for the control of *Rhizoctonia* root rot, on viburnum. Treatments were applied as drench at different time intervals starting after transplanting from Aug 8 to Oct 31 according to the table below. All treatments significantly reduced *Rhizoctonia* root rot severity from a high disease pressure; Mural, Empress Intrinsic and Pageant Intrinsic provided the most effective control (Table 16). No evidence of phytotoxicity was observed for any treatment.

Zinnia

In 2003, Hausbeck conducted a greenhouse trial to determine efficacy of several fungicides for the control of *Rhizoctonia* root rot, *Rhizoctonia solani*, on zinnia (*Zinnia elegans*). Treatments were applied as drench on Jun 27, Jul 3, 10, 18 and 25. All treatments, except Banrot, completely prevented plant death from a severe disease pressure (Table 17).

Table 16. *Efficacy for Rhizoctonia Root Rot, Rhizoctonia solani, on Viburnum (Viburnum odoratissimum), Baysal-Gurel, TN, 2017, Field Trial.

Treatment	Rate Per 100 Gal	Applic Interval	Disease severity (%) ^y	Plant weight (oz)	Root weight (oz)	Plant height (in)	Plant width (in)
Empress Intrinsic (pyraclostrobin)	3 fl oz	2, 5, 8, 11, 14	6.7 de	1.3 ab	0.8 ab	7.8 a	5.7 abc
IT-5103 WP	2 g/plant	2, 5, 8, 11, 14	37.7 b	0.9 c	0.5 bc	7.2 abc	5.4 bc
MBI 110 (<i>Bacillus amyloliquifaciens</i>)	1%	2-14	28.4 c	0.9 c	0.6 abc	6.5 bc	5.0 c
Mural 45WG (azoxystrobin + benzovindiflupyr)	3 oz	2, 5, 8, 11, 14	5.9 de	1.4 ab	0.9 a	8.5 a	6.1 abc
Pageant Intrinsic 38WG (pyraclostrobin + boscalid)	18 oz	2, 5, 8, 11, 14	13.6 d	1.5 a	0.8 ab	8.0 a	6.9 a
RootShield PLUS WP (<i>Trichoderma harzianum</i> + <i>T. virens</i>)	8 oz	2, 10	26.5 c	0.9 c	0.6 abc	7.8 a	5.5 bc
SoilGard (<i>Gliocladium virens</i>)	2 lb	2	24.3 c	1.0 bc	0.6 abc	7.4 abc	5.7 abc
Untreated uninoculated	-	-	3.7 e	1.5 a	0.8 ab	8.5 a	6.7 ab
Untreated inoculated	-	-	63.3 a	0.7 c	0.4 c	6.2 c	5.3 c
P-value	-	-	≤0.0001	0.0008	0.0643	0.0799	0.0150

* Not an IR-4 Experiment: Plant Disease Management Reports 12:OT025. Not all treatments included in table.

^z Application dates: 2=Jul 28; 3=Aug 4; 4=Aug 11; 5=Aug 18; 6=Aug 25; 7=Sep 8; 8=Sep 11; 9=Sep 15; 10=Sep 22; 11=Sep 29; 12=Oct 6; 13=Oct 13; 14=Oct 20.

^y Disease severity was based on the percentage of roots affected.

^x Columns means with a letter in common are not significantly different based on Fisher's LSD test.

Table 17. * Efficacy for Rhizoctonia Root Rot, *Rhizoctonia solani*, on Zinnia (*Zinnia elegans*) ‘Oklahoma Mix’, Hausbeck, MI, 2003.

Treatment	Rate Per 100 Gal	Applic Interval	Jul 3	Jul 10	Jul 17	Jul 25	Aug 4
<i>Plant Health^x</i>							
3336 50W (thiophanate methyl)	4.0 oz	14	1.3 a	1.3 a	1.3 a	1.3 a	1.3 a
Banrot 40WP (etrifiazole + thiophanate methyl)	8.0 oz	14	1.5 ab	1.6 a	1.6 a	1.6 a	1.6 a
Endorse (polyoxin D)	1.1 lb	7	1.0 a	1.1 a	1.1 a	1.3 a	1.3 a
Endorse (polyoxin D)	2.2 lb	14	1.0 a	1.1 a	1.1 a	1.3 a	1.3 a
Heritage 50WG (azoxystrobin)	4.0 oz	14	1.0 a	1.0 a	1.0 a	1.0 a	1.0 a
Medallion 50WP (fludioxonil)	2.0 oz	14	1.0 a	1.0 a	1.0 a	1.0 a	1.0 a
Terraclor 75WP (PCNB)	4.0 oz	14	1.3 a	1.3 a	1.3 a	1.3 a	1.3 a
Terraguard 50W (triflumizole)	4.0 oz	14	1.1 a	1.3 a	1.3 a	1.3 a	1.3 a
Untreated uninoculated	-	-	1.0 a	1.0 a	1.0 a	1.0 a	1.0 a
Untreated inoculated	-	-	1.5 ab	3.3 b	3.4 b	3.4 b	3.4 b
<i>Plant Death (%)</i>							
3336 50W (thiophanate methyl)	4.0 oz	14	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a
Banrot 40WP (etrifiazole + thiophanate methyl)	8.0 oz	14	12.5 b	12.5 b	12.5 b	12.5 b	12.5 b
Endorse (polyoxin D)	1.1 lb	7	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a
Endorse (polyoxin D)	2.2 lb	14	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a
Heritage 50WG (azoxystrobin)	4.0 oz	14	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a
Medallion 50WP (fludioxonil)	2.0 oz	14	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a
Terraclor 75WP (PCNB)	4.0 oz	14	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a
Terraguard 50W (triflumizole)	4.0 oz	14	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a
Untreated uninoculated	-	-	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a
Untreated inoculated	-	-	12.5 b	37.5 c	50.0 d	50.0 c	50.0 c

* Not an IR-4 Experiment: F&N Tests 59:OT015. Not all treatments included in table.

^x Rated on a scale of 1-5, where 1=healthy, 5=dead. Column means with a letter in common are not significantly different LSD test ($P=0.05$).

In 2010, Hausbeck conducted a greenhouse trial to determine efficacy of several fungicides for the control of *Rhizoctonia* crown and root rot, *Rhizoctonia solani*, on zinnia (*Zinnia elegans*). Fungicides were applied as drench on Apr 26 and May 24. All products provided excellent control a severe disease pressure (Table 18). No evidence of phytotoxicity was observed for any treatment.

In 2011, Hausbeck conducted a greenhouse trial to determine efficacy of several fungicides for the control of *Rhizoctonia* root rot, *Rhizoctonia solani*, on zinnia (*Zinnia elegans*). Fungicides were applied as drench on Mar 14 and 29. All treatments provided excellent control of a severe disease pressure, preventing death and resulting in significantly better plant health ratings (Table 19). A rate response was not observed among the 4 rates of Trinity tested. Only Trinity at 8 fl oz and Heritage had plant height

ratings statistically similar to the untreated uninoculated control. The biopesticide Veranda O was the only fungicide treatment that maintained a plant health rating of 1 by the Apr 5. No evidence of phytotoxicity was observed for any treatment.

In 2014, Hausbeck conducted a greenhouse trial to determine efficacy of several fungicides for the control of Rhizoctonia root rot, *Rhizoctonia solani*, on zinnia (*Zinnia elegans*). Fungicides were applied as drench on Jun 17. All treatments provided excellent control of a severe disease pressure (Table 20). BAS 703, Medallion and Pageant treated plants did not display any symptoms of *Rhizoctonia* infection throughout the trial. No evidence of phytotoxicity was observed for any treatment.

In 2016, Hausbeck conducted a greenhouse trial to determine efficacy of several fungicides for the control of Rhizoctonia root rot, *Rhizoctonia solani*, on zinnia (*Zinnia elegans*). Fungicides were applied as drench on Feb 24 and Mar 1. Except for RootShield, all treatments had significantly better disease severity ratings compared to the untreated control (Table 21). The industry standard Affirm was highly efficacious and resulted in symptomless plants for all rating dates. A rate response was observed between the Howler treatments with the 100 oz rate resulting in less plant death and a lower disease severity rating for all dates. No evidence of phytotoxicity was observed for any treatment.

Table 18. * Efficacy for Rhizoctonia Crown and Root Rot, *Rhizoctonia solani*, on Zinnia (*Zinnia elegans*) ‘Sahara Fire’, Hausbeck, MI, 2010.

Treatment	Rate Per 100 Gal	Health Rating ^x			Death (%)			Height (in.)
		May 6	May 12	Jun 8	May 6	May 12	Jun 8	Jun 8
Heritage 50WG (azoxystrobin)	0.9 oz	1.3 a	1.9 a	1.5 ab	0.0 a	0.0 a	0.0 a	5.6 abc
Medallion 50WP (fludioxonil)	2 oz	1.0 a	1.6 a	1.6 ab	0.0 a	0.0 a	0.0 a	5.8 abc
OHP 6672 4.5L (thiophanate methyl)	20 fl oz	1.0 a	1.1 a	1.4 ab	0.0 a	0.0 a	0.0 a	6.1 abc
Terraclor 75WP (PCNB)	8 oz	1.0 a	1.4 a	1.4 ab	0.0 a	0.0 a	0.0 a	5.4 bc
Tourney 50WDG (metconazole)	4 oz	1.1 a	1.6 a	2.1 ab	0.0 a	0.0 a	0.0 a	4.6 cd
V-10190 2.5SC	8 fl oz	1.3 a	3.0 b	3.3 c	0.0 a	25.0 b	50.0 b	3.1 de
V-10190 2.5SC	16 fl oz	1.0 a	1.6 a	1.5 ab	0.0 a	0.0 a	0.0 a	5.7 abc
Veranda O 11.3DF (polyoxin D)	8 oz	1.0 a	1.4 a	1.3 ab	0.0 a	0.0 a	0.0 a	6.8 ab
Untreated uninoculated	-	1.0 a	1.0 a	1.0 a	0.0 a	0.0 a	0.0 a	7.3 a
Untreated inoculated	-	3.1 b	3.5 b	3.6 c	25.0 b	50.0 c	62.5 b	2.4 e

* Not an IR-4 Experiment: Plant Disease Management Reports 5:OT016.

^x Rated on a scale of 1 to 5, where 1=healthy, 2=chlorosis/minor wilting, 3=moderate wilting, 4=severe wilting, 5=plant death. Column means with a letter in common are not significantly different based on Fishers Protected LSD test ($P=0.05$).

Table 19. * Efficacy for Rhizoctonia Root Rot, *Rhizoctonia solani*, on Zinnia (*Zinnia elegans*) ‘Exquisite Pink’, Hausbeck, MI, 2011.

Treatment	Rate Per 100 Gal	Health Rating ^x			Height (in.)	Death (%)
		Mar 24	Mar 31	Apr 5	Apr 5	Apr 5
Heritage 50WG (azoxystrobin)	4 oz	1.3 a	1.3 a	1.3 a	6.4 ab	0.0 a
Trinity SC (triticonazole)	6 fl oz	1.0 a	1.3 a	1.5 a	5.0 b	0.0 a
Trinity SC (triticonazole)	8 fl oz	1.0 a	1.0 a	1.3 a	6.7 ab	0.0 a
Trinity SC (triticonazole)	12 fl oz	1.0 a	1.0 a	1.2 a	4.5 b	0.0 a
Trinity SC (triticonazole)	24 fl oz	1.0 a	1.2 a	1.3 a	4.1 b	0.0 a
Veranda O 11.3DF (polyoxin D)	8 oz	1.0 a	1.0 a	1.0 a	5.3 b	0.0 a
Untreated uninoculated	-	1.0 a	1.0 a	1.0 a	8.4 a	0.0 a
Untreated inoculated	-	3.5 b	3.8 b	3.8 b	2.0 c	50.0 b

* Not an IR-4 Experiment: Plant Disease Management Reports 6:OT005.

^x Rated on a scale of 1 to 5, where 1=healthy, 2=chlorosis/stunting, 3=minor wilting, 4=moderate to severe wilting, 5=dead plant. Column means with a letter in common are not significantly different based on Student-Newman-Keuls test ($P=0.05$).

Table 20. * Efficacy for Rhizoctonia Root Rot, *Rhizoctonia solani*, on Zinnia (*Zinnia elegans*) ‘Exquisite Pink’, Hausbeck, MI, 2014.

Treatment	Rate Per 100 Gal	Health Rating ^x		Plant Death (%)	
		Jun 23	Jul 3	Jun 23	Jul 3
BAS 703 01F (fluxapyroxad + pyraclostrobin)	7 fl oz	1.0 a	1.0 a	0.0 a	0.0 a
BAS 703 01F	10 fl oz	1.0 a	1.0 a	0.0 a	0.0 a
BAS 703 01F	13 fl oz	1.0 a	1.0 a	0.0 a	0.0 a
Heritage 50WG (azoxystrobin)	0.9 oz	1.5 a	1.5 a	0.0 a	16.7 a
Medallion 50WP (fludioxonil)	2 oz	1.0 a	1.0 a	0.0 a	0.0 a
Pageant 38WG (pyraclostrobin + boscalid)	18 oz	1.0 a	1.0 a	0.0 a	0.0 a
Untreated uninoculated	-	1.0 a	1.0 a	0.0 a	0.0 a
Untreated inoculated	-	4.0 b	4.3 b	50.0 b	83.3 b

* Not an IR-4 Experiment: Plant Disease Management Reports 9:OT014.

^x Rated on a scale of 1 to 5, where 1=healthy, 2=stunting/chlorosis, 3=minor stunting, 4=moderate/severe stunting, 5=plant death. Column means with a letter in common are not significantly different based on LSD test ($P=0.05$).

Table 21. * Efficacy for Rhizoctonia Root Rot, *Rhizoctonia solani*, on Zinnia (*Zinnia elegans*) ‘Persian Carpet’, Hausbeck, MI, 2016.

Treatment	Rate Per 100 Gal	Health Rating ^x			Plant Death (%)		
		Mar 7	Mar 10	Mar 14	Mar 7	Mar 10	Mar 14
Affirm WDG (polyoxin D)	8 oz	1.0 a	1.0 a	1.0 a	0.0 a	0.0 a	0.0 a
Howler (<i>Pseudomonas chlororaphis</i>) + Capsil	67 oz + 6 fl oz	2.2 a	3.0 b	3.2 bc	16.7 ab	33.3 b	33.3 a
Howler + Capsil	100 oz + 6 fl oz	1.0 a	2.0 ab	1.8 ab	0.0 a	0.0 a	0.0 a
RootShield (<i>Trichoderma harzianum</i>)	5 oz	3.8 b	4.5 c	4.5 cd	50.0 b	83.3 c	83.3 b
Howler + Affirm WDG	67 oz + 4 oz	1.0 a	1.0 a	1.2 a	0.0 a	0.0 a	0.0 a
Untreated uninoculated	-	1.0 a	1.3 a	1.7 a	0.0 a	0.0 a	16.7 a
Untreated inoculated	-	4.2 b	5.0 c	5.0 d	50.0 b	100.0 c	100.0 b

* Not an IR-4 Experiment: Plant Disease Management Reports 6:OT005.

^x Rated on a scale of 1 to 5, where 1=healthy, 2=chlorosis/stunting, 3=minor wilting, 4=moderate to severe wilting, 5=dead plant. Column means with a letter in common are not significantly different based on Student-Newman-Keuls test ($P=0.05$).

Efficacy Summary by Product/Active Ingredient

A brief efficacy summary for select products is given below, with a reminder that there are very limited data available to draw definitive conclusions for product efficacy on *Rhizoctonia solani*. Products were selected based on interest in these products for testing in the 2019 Non-Oomycete Root Rot efficacy project, and on whether product is registered or not for this root rot species.

Azoxystrobin. Heritage applied as drench provided excellent efficacy on severe *Rhizoctonia* crown rot infections in 2 garden impatiens experiments and a poinsettia trial, and on a severe *Rhizoctonia* root rot infection in a petunia trial. It also provided excellent efficacy on *Rhizoctonia* stem rot in an impatiens greenhouse trial. When applied as a soak or spray, excellent *Rhizoctonia* root rot control was obtained in a poinsettia trial. When applied as drench, it provided excellent efficacy on severe *Rhizoctonia* root rot infections in 4 zinnia experiments.

Azoxystrobin + Benzovindiflupyr. Mural applied as drench provided excellent efficacy on severe *Rhizoctonia* root rot infection in 3 viburnum greenhouse and field trials.

Bacillus amyloliquifaciens. MBI 110/Stargus applied as drench provided excellent efficacy on severe *Rhizoctonia* root rot infection in a viburnum field trial, but mediocre efficacy in a begonia greenhouse trial. It provided poor efficacy on *Rhizoctonia* stem rot infection in a garden impatiens experiment and mediocre efficacy on severe *Rhizoctonia* root rot infections in 2 viburnum greenhouse and field trials.

Etridiazole + Thiophanate methyl. Banrot provided poor efficacy on a severe *Rhizoctonia* root rot infection in a petunia experiment and on a severe *Rhizoctonia* stem canker infection in a snapdragon trial.

Fludioxonil. Medallion applied as drench provided excellent efficacy on severe *Rhizoctonia* crown rot infections in an impatiens and a poinsettia experiment; it provided excellent efficacy on severe *Rhizoctonia* root rot infections in 3 zinnia experiments.

Fludioxonil+Mefenoxam. Hurricane applied as srench provided excellent efficacy on a moderate *Rhizoctonia* stem rot infection in a chrysanthemum experiment.

Fluopyram + Trifloxystrobin. Broadform applied as sprench provided excellent efficacy on Rhizoctonia root and crown rot in a begonia and an impatiens greenhouse trial.

Fluoxastrobin. Disarm applied as drench provided good efficacy on a severe Rhizoctonia root rot infection in a petunia experiment.

Flutolanil. Prostar applied as sprench provided excellent efficacy on Rhizoctonia root and crown rot in a begonia greenhouse trial.

Fluxapyroxad + Pyraclostrobin. BAS 703/Orkestra applied as drench provided excellent efficacy on a severe Rhizoctonia root rot infection in a zinnia trial, and good efficacy on Rhizoctonia stem rot in an impatiens greenhouse trial.

Furfural. Multiguard applied as drench provided good efficacy on a severe Rhizoctonia root rot infection in a petunia experiment.

Gliocladium catenulatum. Pvent applied as drench provided good efficacy on Rhizoctonia stem rot in an impatiens greenhouse trial.

Gliocladium virens. SoilGard applied as drench provided excellent efficacy on severe Rhizoctonia root rot infection in a viburnum field trial. It provided mediocre efficacy on severe Rhizoctonia root rot infections in 2 viburnum greenhouse and field trials.

Hydrogen dioxide + Peroxyacetic acid. ZeroTol applied as drench provided no efficacy on Rhizoctonia stem rot in an impatiens greenhouse trial.

Isofetamid. Astun applied as sprench provided poor efficacy on Rhizoctonia root and crown rot in a begonia greenhouse trial. Applied as spray or drench, it provided poor to mediocre efficacy in 3 impatiens trials.

Mefentriconazole. BAS 750 applied as sprench provided excellent efficacy Rhizoctonia root and crown rot in a begonia greenhouse trial; as a drench, it provided good efficacy on Rhizoctonia stem rot in an impatiens greenhouse trial.

Metconazole. Tourney applied as drench provided excellent efficacy on a severe Rhizoctonia root rot infection in a zinnia trial.

Muscodor albus strain SA-13. MBI-601 applied as pot substrate incorporation provided mixed efficacy (poor and excellent) on Rhizoctonia root and crown rot in a begonia greenhouse trial, and good efficacy on Rhizoctonia stem rot in an impatiens greenhouse trial.

Pentachloronitro-benzene. Terraclor applied as drench provided excellent efficacy on severe Rhizoctonia stem canker infection in a snapdragon trial, and on severe Rhizoctonia root rot infections in 2 zinnia trials.

Polyoxin D. This active ingredient applied as drench provided excellent efficacy on severe Rhizoctonia root rot infections in 4 zinnia trials.

Pseudomonas chlororaphis. Howler applied as drench provided good to excellent efficacy on a severe Rhizoctonia root rot infection in a zinnia trial. Zio applied as drench provided poor efficacy on Rhizoctonia stem rot in an impatiens greenhouse trial.

Pydiflumetofen. Picatina applied as drench provided good efficacy on Rhizoctonia stem rot in an impatiens greenhouse trial.

Pyraclostrobin. Empress Intrinsic applied as drench provided excellent efficacy on a severe Rhizoctonia root rot infection in 3 viburnum greenhouse and field trials.

Pyraclostrobin + Boscalid. Pageant Intrinsic applied as drench provided good to excellent efficacy on severe Rhizoctonia root rot infections in 3 viburnum greenhouse and field trials, and excellent efficacy on severe Rhizoctonia root rot infections in 2 zinnia trials.

SP2700. This active ingredient applied as drench provided good efficacy on Rhizoctonia stem rot infection in a garden impatiens experiment, but poor efficacy on Rhizoctonia root and crown rot in a begonia greenhouse trial.

Streptomyces lydicus. Actinovate applied as good provided excellent efficacy on a severe Rhizoctonia root rot infection in a petunia experiment.

Thiophanate methyl. Topsin applied as sprench provided excellent efficacy against a moderate Rhizoctonia stem rot infection in a chrysanthemum experiment. Applied as drench, 3336 provided excellent efficacy on severe Rhizoctonia root rot infections in 2 zinnia trials, excellent and poor efficacy on severe Rhizoctonia crown rot infections in 2 garden impatiens experiments, good efficacy on Rhizoctonia stem rot infection in a garden impatiens experiment, poor efficacy on severe Rhizoctonia root rot infections in a petunia and a poinsettia trial, and on a severe Rhizoctonia stem canker infection in a snapdragon trial.

Thyme oil. Promax applied as drench provided good efficacy on a severe Rhizoctonia root rot infection in a petunia experiment.

Trichoderma harzianum. RootShield applied as drench provided poor efficacy on a severe Rhizoctonia root rot infection in a zinnia trial.

Trichoderma harzianum & T. virens. RootShield PLUS applied as drench provided mediocre to excellent efficacy on severe Rhizoctonia root rot infections in 3 viburnum greenhouse and field trials.

Trichoderma spp. IT-5103 applied as drench provided excellent and mediocre efficacy on severe Rhizoctonia root rot infections in 2 viburnum greenhouse and field trials.

Trifloxystrobin. Compass applied as drench provided excellent efficacy on a severe Rhizoctonia crown rot infection in a garden impatiens experiment.

Triflumizole. Terraguard applied as drench provided good efficacy on severe Rhizoctonia stem canker infection in a snapdragon trial; and on a severe Rhizoctonia root rot infection in a zinnia trial. However it was ineffective in an impatiens trial.

Triticonazole. Trinity applied as drench provided excellent efficacy on a severe Rhizoctonia root rot infection in a zinnia trial.

V-10190. This active ingredient applied as drench provided excellent efficacy on a severe Rhizoctonia root rot infection in a zinnia trial.

Phytotoxicity

No phytotoxicity was observed with the products listed above with the exception of Heritage causing a slight chlorosis in a petunia trial and Orkestra causing some leaf burn in an impatiens experiment.

Table 22. Summary of product efficacy for *Rhizoctonia solani* by pathogen and crop.

Note: Table entries are sorted by product, pathogen Latin name, and then by crop Latin name. Only those IR-4 trials received by 8/11/2020 are included in the table below.

PR#	Product Actives	MOA Class	Crop	Production Site	Researcher	Trial State	Trial Year	Application Type	Results
34270	3336 F (Thiophanate-methyl)	FRAC 1	Impatiens, Common Garden; Buzzy Lizzy (<i>Impatiens walleriana</i>) 'Super Elfin Red'	Greenhouse	Norman	FL	2019	Drench	Good control with 8 fl oz per 100 gal applied once; inferior to uninoculated check.
28103	3336 WP (50%) (Thiophanate-methyl)	FRAC 1	American Evergreen (<i>Syngonium podophyllum</i>) 'Green Gold'	Greenhouse	Knauss	FL	1973	Drench	At 16 oz per 100 gal, the number of surviving cuttings was higher than the untreated controls.
27480	3336 WP (50%) (Thiophanate-methyl)	FRAC 1	Garden Snapdragon (<i>Antirrhinum majus</i>)	Greenhouse	Benson	NC	1997	Drench	Good efficacy at 8, 16, and 32 oz per 100 gal; no injury.
27480	3336 WP (50%) (Thiophanate-methyl)	FRAC 1	Garden Snapdragon (<i>Antirrhinum majus</i>)	Greenhouse	Benson	NC	1998	Drench	Good control of <i>Rhizoctonia solani</i> with 8, 16, and 32 oz per 100 gal; no injury at any rate.
27480	3336 WP (50%) (Thiophanate-methyl)	FRAC 1	Garden Snapdragon (<i>Antirrhinum majus</i>)	Greenhouse	Benson	NC	1999	Drench	Good control with 8, 16, and 32 oz per 100 gal; no injury.
27485	3336 WP (50%) (Thiophanate-methyl)	FRAC 1	Impatiens; Touch-me-not (<i>Impatiens</i> sp.) <i>I. wallerana</i>	Greenhouse	Benson	NC	1998	Drench	Good control with 8, 16, and 32 oz per 100 gal drenched at seeding into infested media.
27485	3336 WP (50%) (Thiophanate-methyl)	FRAC 1	Impatiens; Touch-me-not (<i>Impatiens</i> sp.) <i>I. wallerana</i>	Greenhouse	Benson	NC	1999	Drench	Great control with 8, 16, and 32 oz per 100 gal drenched at seeding into infested media.
27481	3336 WP (50%) (Thiophanate-methyl)	FRAC 1	Periwinkle, Madagascar (<i>Catharanthus roseus</i>)	Greenhouse	Benson	NC	1997	Drench	Good control of damping off with 8, 16, and 32 oz per 100 gal, but some germination inhibition was observed.
27481	3336 WP (50%) (Thiophanate-methyl)	FRAC 1	Periwinkle, Madagascar (<i>Catharanthus roseus</i>)	Greenhouse	Benson	NC	1998	Drench	Good control with 8, 16, and 32 oz per 100 gal; no injury observed.
27481	3336 WP (50%) (Thiophanate-methyl)	FRAC 1	Periwinkle, Madagascar (<i>Catharanthus roseus</i>)	Greenhouse	Benson	NC	1999	Drench	Good control with 8, 16, and 32 oz per 100 gal; no injury.
12261	3336 WP (50%) (Thiophanate-methyl)	FRAC 1	Petunia (<i>Petunia</i> sp.) <i>P. x hybrida</i>	Greenhouse	Benson	NC	1997	Drench	All three rates (8, 16, 32 oz per 100 gal) significantly improved seedling stands with no visible signs of phytotoxicity.
12261	3336 WP (50%) (Thiophanate-methyl)	FRAC 1	Petunia (<i>Petunia</i> sp.) <i>P. x hybrida</i>	Greenhouse	Benson	NC	1998	Drench	Good control with 8, 16, and 32 oz per 100 gal drenched at seeding; no injury.

PR#	Product Actives	MOA Class	Crop	Production Site	Researcher	Trial State	Trial Year	Application Type	Results
12261	3336 WP (50%) (Thiophanate-methyl)	FRAC 1	Petunia (Petunia sp.) P. x hybrida	Greenhouse	Benson	MD	1999	Drench	Good control with 8, 16, and 32 oz per 100 gal drenched at seeding; no injury.
11587	3336 WP 70% (Pennwalt) (Thiophanate-methyl)	FRAC 1	Holly, Chinese (Ilex cornuta) 'Rotunda'	Field Container	Gill	GA	1977	Drench	Not enough disease to rate; no injury at 0.7 and 1.4 lb product per 100 gal.
11586	3336 WP 70% (Pennwalt) (Thiophanate-methyl)	FRAC 1	Holly, Japanese (Ilex crenata) 'Rotundifolia'	Field Container	Gill	GA	1977	Drench	Not enough disease to rate; no injury at 0.7 and 1.4 lb product per 100 gal.
01329	3336 WP 70% (Pennwalt) (Thiophanate-methyl)	FRAC 1	Azalea (Rhododendron sp.) 'Hershey's Red'	Field Container	Gill	GA	1977	Drench	Good efficacy at 0.7 and 1.4 lb per 100 gal with 1 cup solution per container.
01329	3336 WP 70% (Pennwalt) (Thiophanate-methyl)	FRAC 1	Azalea (Rhododendron sp.) 'Hinodegiri'	Field Container	Gill	GA	1977	Drench	Good efficacy at 0.7 and 1.4 lb per 100 gal with 1 cup solution per container.
01330	3336 WP 70% (Pennwalt) (Thiophanate-methyl)	FRAC 1	Boxwood (Buxus sp.) B. microphylla	Field Container	Gill	GA	1977	Drench	Not enough disease to rate; no phytotoxicity.
01333	3336 WP 70% (Pennwalt) (Thiophanate-methyl)	FRAC 1	Juniper (Juniperus sp.) J. conferta	Field Container	Gill	GA	1977	Drench	Not enough disease to rate; no injury at 11.2 oz product per 100 gal.
26782	Actinovate Soluble (Streptomyces lydicus WYEC 108)	FRAC NC	Petunia (Petunia sp.)	Greenhouse	Reddy	AL	2006	Drench	Fair efficacy at 10 oz per 100 gal
26781	Adorn 4F (Fluopicolide)	FRAC 43	Petunia (Petunia sp.)	Greenhouse	Reddy	AL	2006	Drench	Fair efficacy at 30 and 60 ml per 100 gal
26788	Agrifos (Dipotassium phosphonate + Dipotassium phosphate)	FRAC 33	Petunia (Petunia sp.)	Greenhouse	Reddy	AL	2006	Drench	Fair and good efficacy at 1 and 2 gal per 100 gal
33776	Astun (isofentamid)	FRAC 7	Clubed Begonia (Begonia semperflorens) 'Bada Bing Scarlet'	Greenhouse	Norman	FL	2018	Sprench	No efficacy with 13.5 fl oz per 100 gal applied twice weekly.
34259	Astun (isofentamid)	FRAC 7	Impatiens, Common Garden; Buzzy Lizzy (Impatiens walleriana) 'Super Elfin Red'	Greenhouse	Norman	FL	2019	Drench	Poor control with 13.5 fl oz per 100 gal applied twice; inferior to uninoculated check.

PR#	Product Actives	MOA Class	Crop	Production Site	Researcher	Trial State	Trial Year	Application Type	Results
28101	Banrot I 30WP (Ethazole + thiabendazole)	FRAC 14 + FRAC 1	American Evergreen (Syngonium podophyllum) 'Green Gold'	Greenhouse	Knauss	FL	1973	Drench	At 500 ppm, there was no impact on root development, but the number of pots infested with foliar Rhizoctonia was reduced compared to the untreated and top weight was significantly higher than the untreated.
28102	Banrot II 40WP (Ethazole + thiophanate methyl)	FRAC 14 + FRAC 1	American Evergreen (Syngonium podophyllum) 'Green Gold'	Greenhouse	Knauss	FL	1973	Drench	At 12 oz per 100 gal, the number of surviving cuttings was higher than the untreated controls.
28102	Banrot II 40WP (Ethazole + thiophanate methyl)	FRAC 14 + FRAC 1	American Evergreen (Syngonium podophyllum) 'Green Gold'	Greenhouse	Knauss	FL	1973	Soil Incorporation	At 6 oz per cu yd, the number of surviving cuttings was equivalent to the untreated controls.
28102	Banrot II 40WP (Ethazole + thiophanate methyl)	FRAC 14 + FRAC 1	American Evergreen (Syngonium podophyllum) 'Green Gold'	Greenhouse	Knauss	FL	1973	Soil Incorporation	At 6 oz per cu yd, the number of surviving cuttings was higher than the untreated controls.
33777	BAS 750 02F (Mefentrifluconazole)	FRAC 3	Clubed Begonia (Begonia semperflorens) 'Bada Bing Scarlet'	Greenhouse	Norman	FL	2018	Sprenc	Excellent efficacy with 3 fl oz per 100 gal applied 3 times biweekly; comparable to non-inoculated check.
34260	BAS 750 02F (Mefentrifluconazole)	FRAC 3	Impatiens, Common Garden; Buzzy Lizzy (Impatiens walleriana) 'Super Elfin Red'	Greenhouse	Norman	FL	2019	Drench	Good control with 3 fl oz per 100 gal applied twice; inferior to uninoculated check.
27940	Benlate 50WP (Benomyl)	FRAC 1	American Evergreen (Syngonium podophyllum) 'Green Gold'	Greenhouse	Knauss	FL	1973	Drench	An equivalent number of roots between infested and uninfested treatments of 1.0 lb per 100 gal, both better than untreated infested and uninfested.
27940	Benlate 50WP (Benomyl)	FRAC 1	American Evergreen (Syngonium podophyllum) 'Green Gold'	Greenhouse	Knauss	FL	1973	Drench	An equivalent number of roots between infested and uninfested treatments of 1.0 lb per 100 gal, both better than untreated infested and uninfested. The top weights of the Benomyl treated plants were higher than the control plants.
27940	Benlate 50WP (Benomyl)	FRAC 1	American Evergreen (Syngonium podophyllum) 'Green Gold'	Greenhouse	Knauss	FL	1973	Drench	At 1.5 lb per 100 gal, there was no impact on root development, but the number of pots infested with foliar Rhizoctonia was reduced compared to the untreated and top weight was significantly higher than the untreated.

PR#	Product Actives	MOA Class	Crop	Production Site	Researcher	Trial State	Trial Year	Application Type	Results
27940	Benlate 50WP (Benomyl)	FRAC 1	American Evergreen (Syngonium podophyllum) 'Green Gold'	Greenhouse	Knauss	FL	1973	Drench	At 8 and 16 oz per 100 gal, the number of surviving cuttings was higher than the untreated controls.
27940	Benlate 50WP (Benomyl)	FRAC 1	American Evergreen (Syngonium podophyllum) 'Green Gold'	Greenhouse	Knauss	FL	1973	Soil Incorporation	At 6 and 12 oz per cu yd, the number of surviving cuttings was higher than the untreated controls.
27891	Benlate 50WP (Benomyl)	FRAC 1	Poinsettia (Euphorbia pulcherrima) 'Top Star'	Greenhouse	Neely	IL	1978	Drench	Excellent efficacy and no injury at 8, 16, and 32 oz per 100 gal.
33778	Broadform SC500 (Fluopyram + Trifloxystrobin)	FRAC 7 + 11	Clubed Begonia (Begonia semperflorens) 'Bada Bing Scarlet'	Greenhouse	Norman	FL	2018	Sprenc	Excellent efficacy with 3 fl oz per 100 gal applied twice biweekly; comparable to non-inoculated check.
34261	Broadform SC500 (Fluopyram + Trifloxystrobin)	FRAC 7 + 11	Impatiens, Common Garden; Buzzy Lizzy (Impatiens walleriana) 'Super Elfin Red'	Greenhouse	Norman	FL	2019	Drench	Excellent control with 4 and 6 fl oz per 100 gal applied twice; comparable to uninoculated check.
28074	Daconil 54EC (Chlorothalonil)	FRAC M5	American Evergreen (Syngonium podophyllum) 'Green Gold'	Greenhouse	Knauss	FL	1973	Drench	The treated (1.5 lb per 100 gal) infested plants had more roots than untreated infested plants but not as many as uninfested plants. Top weights of the Daconil treated plants were equivalent to infested untreated plants. Top weights of the Daconil treated
28075	Demosan 65WP (Chloroneb)		American Evergreen (Syngonium podophyllum) 'Green Gold'	Greenhouse	Knauss	FL	1973	Drench	At 1.5 lb per 100 gal, there was no impact on root development, but the number of pots infested with foliar Rhizoctonia was higher than the untreated but top weight was slightly higher than the untreated.
28075	Demosan 65WP (Chloroneb)		American Evergreen (Syngonium podophyllum) 'Green Gold'	Greenhouse	Knauss	FL	1973	Drench	At 1.5 lb per 100 gal, there was no impact on root development, but the number of pots infested with foliar Rhizoctonia was reduced compared to the untreated and top weight was slightly higher than the untreated.
28075	Demosan 65WP (Chloroneb)		American Evergreen (Syngonium podophyllum) 'Green Gold'	Greenhouse	Knauss	FL	1973	Drench	The treated (1.5 lb per 100 gal) infested plants had more roots than untreated infested plants but not as many as uninfested plants. Top weights of the Demosan treated plants were equivalent to infested untreated plants. Top weights of the Demosan treated

PR#	Product Actives	MOA Class	Crop	Production Site	Researcher	Trial State	Trial Year	Application Type	Results
26787	Disarm 480SC (Fluoxastrobin)	FRAC 11	Petunia (Petunia sp.)	Greenhouse	Reddy	AL	2006	Drench	Poor efficacy at 3 oz per 100 gal
26983	Endorse (Polyoxin D)	FRAC 19	Pink (Dianthus sp.) D. chinensis	Greenhouse	Hausbeck	MI	2002	Drench	No efficacy but also no injury.
26784	Fenstop (Fenamidone)	FRAC 11	Petunia (Petunia sp.)	Greenhouse	Reddy	AL	2006	Drench	Poor and fair efficacy at 7 and 14 oz per 100 gal
28076	Fermate 76WP (Ferbam)	FRAC M3	American Evergreen (Syngonium podophyllum) 'Green Gold'	Greenhouse	Knauss	FL	1973	Drench	An equivalent number of roots between infested and uninfested treatments of 3.0 lb per 100 gal, both better than untreated infested and uninfested.
28076	Fermate 76WP (Ferbam)	FRAC M3	American Evergreen (Syngonium podophyllum) 'Green Gold'	Greenhouse	Knauss	FL	1973	Drench	At 1.5 lb per 100 gal, the number of surviving cuttings was equivalent to the untreated controls and sprouting was delayed compared to the other treatments.
28076	Fermate 76WP (Ferbam)	FRAC M3	American Evergreen (Syngonium podophyllum) 'Green Gold'	Greenhouse	Knauss	FL	1973	Drench	At 1.5 lb per 100 gal, the number of surviving cuttings was lower than the untreated controls, plus sprouting was delayed when compared to other treatments.
26789	Hymexazol 30L (Hymexazol)	FRAC 32	Petunia (Petunia sp.)	Greenhouse	Reddy	AL	2006	Drench	Fair and good efficacy at 6 and 12 oz per 100 gal
33780	MBI 601 (Muscodor albus)		Clubed Begonia (Begonia semperflorens) 'Bada Bing Scarlet'	Greenhouse	Norman	FL	2018	Soil Incorporation	Good efficacy with 5, but poor with 10, g per cu ft soil applied before potting; inferior to non-inoculated check.
34263	MBI 601 (Muscodor albus)		Impatiens, Common Garden; Buzzy Lizzy (Impatiens walleriana) 'Super Elfin Red'	Greenhouse	Norman	FL	2019	Soil Incorporation	Good control with 5 and 10 g per cu ft soil applied once; inferior to uninoculated check.
28098	Mertect 160 (60 WP) (Thiabendazole)	FRAC 1	American Evergreen (Syngonium podophyllum) 'Green Gold'	Greenhouse	Knauss	FL	1973	Drench	At 1.5 lb per 100 gal, there was no impact on root development, but the number of pots infested with foliar Rhizoctonia was reduced compared to the untreated and top weight was equivalent to the untreated.
28098	Mertect 160 (60 WP) (Thiabendazole)	FRAC 1	American Evergreen (Syngonium podophyllum) 'Green Gold'	Greenhouse	Knauss	FL	1973	Drench	At 1.5 lb per 100 gal, there was no impact on root development, but the number of pots infested with foliar Rhizoctonia was reduced compared to the untreated and top weight was significantly higher than the untreated.

PR#	Product Actives	MOA Class	Crop	Production Site	Researcher	Trial State	Trial Year	Application Type	Results
28098	Mertect 160 (60 WP) (Thiabendazole)	FRAC 1	American Evergreen (Syngonium podophyllum) 'Green Gold'	Greenhouse	Knauss	FL	1973	Drench	The treated (1.0 lb per 100 gal) infested plants had more roots than untreated infested plants equivalent to the uninfested plants. Top weights of the Mertect treated plants were almost equivalent to uninfested untreated plants.
26786	Micora (Mandipropamid)	FRAC 40	Petunia (Petunia sp.)	Greenhouse	Reddy	AL	2006	Drench	Poor and fair efficacy at 2 and 8 oz per 100 gal
26780	MultiGuard (Furfural)		Petunia (Petunia sp.)	Greenhouse	Reddy	AL	2006	Drench	Fair and good efficacy at 250 and 500 ppm
34265	Orkestra Intrinsic (Fluxapyroxad + pyraclostrobin)	FRAC7 + FRAC 11	Impatiens, Common Garden; Buzzy Lizzy (Impatiens walleriana) 'Super Elfin Red'	Greenhouse	Norman	FL	2019	Drench	Excellent control with 10 fl oz per 100 gal applied twice; comparable to uninoculated check. Some leaf injury.
34266	Picatina (Pydiflumetofen)	FRAC 7	Impatiens, Common Garden; Buzzy Lizzy (Impatiens walleriana) 'Super Elfin Red'	Greenhouse	Norman	FL	2019	Drench	Good control with 13.7 fl oz per 100 gal applied once; inferior to uninoculated check.
28077	Potassium azide (Potassium azide)		American Evergreen (Syngonium podophyllum) 'Green Gold'	Greenhouse	Knauss	FL	1973	Drench	At 1000 ppm, there were no roots on the treated plants.
33622	Promax (Thyme Oil (3%))		Petunia (Petunia hybrida)	Greenhouse	Reddy	AL	2006	Drench	Fair efficacy at 1 gal per 100 gal.
33782	ProStar 70WP/WG (Flutalonil)	FRAC 7	Clubed Begonia (Begonia semperflorens) 'Bada Bing Scarlet'	Greenhouse	Norman	FL	2018	Sprench	Excellent efficacy with 6 oz per 100 gal applied twice biweekly; comparable to non-inoculated check.
34267	Pvent (Gliocladium catenulatum Strain J1446)	FRAC NC	Impatiens, Common Garden; Buzzy Lizzy (Impatiens walleriana) 'Super Elfin Red'	Greenhouse	Norman	FL	2019	Drench	Good control with 0.1% w/v applied 3 times; inferior to uninoculated check.
26783	Segway (Cyazofamid)	FRAC 21	Petunia (Petunia sp.)	Greenhouse	Reddy	AL	2006	Drench	Poor and fair efficacy at 1.5 and 3 oz per 100 gal
33781	SP2700 AS (SP2700)		Clubed Begonia (Begonia semperflorens) 'Bada Bing Scarlet'	Greenhouse	Norman	FL	2018	Drench	Poor efficacy with 11 fl oz per 100 gal applied 3 times biweekly; inferior to non-inoculated check.
34264	SP2700 AS (SP2700)		Impatiens, Common Garden; Buzzy Lizzy (Impatiens walleriana) 'Super Elfin Red'	Greenhouse	Norman	FL	2019	Drench	Poor control with 11 fl oz per 100 gal applied twice; inferior to uninoculated check.
33779	Stargus (Bacillus amyloliquefaciens strain F727)		Clubed Begonia (Begonia semperflorens) 'Bada Bing Scarlet'	Greenhouse	Norman	FL	2018	Drench	Good efficacy with 1 and 2 % applied 3 times biweekly; inferior to non-inoculated check.

PR#	Product Actives	MOA Class	Crop	Production Site	Researcher	Trial State	Trial Year	Application Type	Results
34262	Stargus (Bacillus amyloliquefaciens strain F727)		Impatiens, Common Garden; Buzzy Lizzy (Impatiens walleriana) 'Super Elfin Red'	Greenhouse	Norman	FL	2019	Drench	Poor control with 2 % per 100 gal applied twice; inferior to uninoculated check.
28099	Terraclor 75WP (PCNB)	FRAC 14	American Evergreen (Syngonium podophyllum) 'Green Gold'	Greenhouse	Knauss	FL	1973	Drench	An equivalent number of roots between infested and uninfested treatments of 1.0 lb per 100 gal, both better than untreated infested and uninfested.
28099	Terraclor 75WP (PCNB)	FRAC 14	American Evergreen (Syngonium podophyllum) 'Green Gold'	Greenhouse	Knauss	FL	1973	Drench	At 1.5 lb per 100 gal, there was no impact on root development, but the number of pots infested with foliar Rhizoctonia was equivalent to the untreated but top weight was significantly higher than the untreated.
28099	Terraclor 75WP (PCNB)	FRAC 14	American Evergreen (Syngonium podophyllum) 'Green Gold'	Greenhouse	Knauss	FL	1973	Drench	At 1.5 lb per 100 gal, there was no impact on root development, but the number of pots infested with foliar Rhizoctonia was reduced compared to the untreated and top weight was slightly higher than the untreated.
28099	Terraclor 75WP (PCNB)	FRAC 14	American Evergreen (Syngonium podophyllum) 'Green Gold'	Greenhouse	Knauss	FL	1973	Drench	At 12 oz per 100 gal, the number of surviving cuttings was equivalent to the untreated controls.
28099	Terraclor 75WP (PCNB)	FRAC 14	American Evergreen (Syngonium podophyllum) 'Green Gold'	Greenhouse	Knauss	FL	1973	Drench	At 12 oz per 100 gal, the number of surviving cuttings was higher than the untreated controls.
28099	Terraclor 75WP (PCNB)	FRAC 14	American Evergreen (Syngonium podophyllum) 'Green Gold'	Greenhouse	Knauss	FL	1973	Drench	The treated (1.5 lb per 100 gal) infested plants had more roots than untreated infested plants but not as many as uninfested plants. Top weights of the Terraclor treated plants were equivalent to infested untreated plants. Top weights of the Terrachlor tr
26785	Vital 4L (Potassium phosphite)	FRAC 33	Petunia (Petunia sp.)	Greenhouse	Reddy	AL	2006	Drench	Poor and fair efficacy at 2 and 8 oz per 100 gal
34269	ZeroTol (Hydrogen dioxide)		Impatiens, Common Garden; Buzzy Lizzy (Impatiens walleriana) 'Super Elfin Red'	Greenhouse	Norman	FL	2019	Drench	No control with 1 gal per 100 gal applied twice; inferior to uninoculated check.
34268	Zio (Pseudomonas chlororaphis strain AFS009)		Impatiens, Common Garden; Buzzy Lizzy (Impatiens walleriana) 'Super Elfin Red'	Greenhouse	Norman	FL	2019	Drench	Poor control 100 oz per 100 gal applied twice; inferior to uninoculated check.

PR#	Product Actives	MOA Class	Crop	Production Site	Researcher	Trial State	Trial Year	Application Type	Results
28100	Zyban 25WP (Thiophanate-methyl)	FRAC 1	American Evergreen (Syngonium podophyllum) 'Green Gold'	Greenhouse	Knauss	FL	1973	Drench	At 3.5 lb per 100 gal, there was no impact on root development, but the number of pots infested with foliar Rhizoctonia was reduced compared to the untreated but top weight was drastically lower than the untreated.

Appendix 1: Contributing Researchers

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