Environment Horticulture Program Research Summaries

IR-4 Environmental Horticulture Program
Fusarium Efficacy: A Literature Review

Fusarium avenaceum
Fusarium commune
Fusarium oxysporum
Fusarium solani
***Fusarium* sp.**

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Abstract

From 2001 to 2019, numerous products representing 40 active ingredients were evaluated in greenhouse and field trials as soil drench, soil incorporation, foliar,in-furrow, drip irrigation or tuber soak applications against several *Fusarium* species causing rots (crown, stem and tuber rots) and wilt on ornamentals, and wilt and root rot on vegetables (Table 1, Table 2). *Fusarium* species tested included: *F. avenaceum, F. commune, F. oxysporum, F. solani* and *F*. sp. Most trials were conducted on *F. oxysporum* on larkspur, liriope, lisianthus and watermelon. Although there were insufficient data for definitive conclusions, several relatively new products showed promising, though inconsistent, efficacy comparable to the standards. These include Picatina/Adepidyn/Miravis (pydiflumetofen), Heritage (azoxystrobin), Compass (trifloxystrobin), Hurricane (fludioxonil+mefenoxam), Insignia (pyraclostrobin), Insimmo (acibenzolar), Postiva/Miravis Duo (pydiflumetofen + difenoconazole), SP2169, Tourney (metconazole) and Trinity (triticonazole). Astun, Broadform, BW240/RootShield Plus (*Trichoderma harzianum & T. virens*), CG100 (caprylic acid), Mural, Orkestra, Pageant (boscalid+pyraclostrobin), Palladium (cyprodinil+fludioxonil) and SP2550 provided no to mediocre efficacy. Proline (prothioconazole) provided consistently good control of *F. oxysporum* in watermelon trials. The established standards 3336, Medallion and Terraguard generally provided inconsistent efficacy.

Introduction

In 2010, IR-4 initiated a high priority project to determine efficacy of several fungicides on *Fusarium* species and obtain data supporting current and future registrations on ornamentals.There are many different species of *Fusarium* causing ornamental diseases and an extensive project may be required to generate sufficient efficacy data. We reviewed available ornamental and vegetable trials published in Biological & Cultural Tests, Fungicide & Nematicide Tests and Plant Disease Management Reports to check efficacy of experimental and registered fungicides on *Fusarium* species. This report is a brief summary of available data from 22 ornamental and 23 vegetable trial reports. The source of report is included under each data table. Fifteen trials from the IR-4 project are included in this report. Additional data will be added when received from researchers.

Materials and Methods

From 2001 to 2019, numerous products representing 40 active ingredients were evaluated in greenhouse and field trials as soil drench, soil incorporation, foliar, in-furrow, drip irrigation or tuber soak applications against several *Fusarium* species causing rots (crown, stem and tuber rots) and wilt on ornamentals, and wilt and root rot on vegetables (Table 1, Table 2). *Fusarium* species tested included: *F. avenaceum, F. communi, F. oxysporum, F. solani* and *F*. sp. Most trials were conducted on *F. oxysporum* on basil, corn flag, larkspur, liriope, lisianthus and watermelon. In greenhouse studies, treatments were generally applied as soil drench either a few days before *Fusarium* inoculation or immediately after inoculation and reapplied biweekly. In field trials, treatments were generally applied as soil drench or soil incorporation immediately after transplanting, through drip irrigation several times during the growing season, in-furrow at planting, tuber soak application or foliar spray for control of natural *Fusarium* infestations. 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. Fourteen researchers were involved in the testing (Appendix 1).

Products were supplied by their respective manufacturers.

For IR-4 testing, the following protocols were used: 10-016, 11-010, 12-016, 13-016 and 19-005. Please visit https://www.ir4project.org/ehc/ehc-registration-support-research/env-hort-researcher-resources/#Protocols to view and download these protocols.

Table 1. List of Products and Rates Tested on Environmental Horticulture Plants from 2001 to 2019.

Active Ingredient(s)	Trade Name(s)		Manufacturer	Rate(s) Tested		# Trials
	Food Crops	Env. Hort/ Turf				
Acibenzolar	Actigard	Insimmo	Syngenta	Corm Dip	0.125 oz per 100 gal	2
					0.25 oz per 100 gal	2
					0.5 oz per 100 gal	1
				Drench	0.125 oz per 100 gal 0.25 oz per 100 gal	5
				Foliar	0.5 oz per 100 gal	2
					0.75 oz per 100 gal	2
				Soil incorp.	0.08 g per 1000 ft^2	2
					0.25 oz per 100 gal	1
Azoxystrobin	Abound, Amistar, Quadris	Heritage	Syngenta	Corm Dip	0.45 oz per 100 gal	1
					0.9 oz per 100 gal	2
					1.8 oz per 100 gal	1
				Drench	0.9 oz per 100 ga1 1.8 oz per 100 gal 4 oz per 100 gal 8.7 oz per 100 gal 16 oz per 100 gal	7
				Foliar	1.8 oz per 100 gal	1
					2.7 oz per 100 gal	2
				Sprench	4 oz per 100 gal	1
				Soil incorp.	0.4 oz per 1000 ft^2	3
Azoxystrobin + benzovindiflupyr	Mural	Mural	Syngenta	Drench	3 oz per 100 gal	1
Bacillus amyloliquefaciens strain F727)	Stargus	Stargus	Marrone	Drench	1 % v/v 2 % v/v	1
Caprylic acid	CG100	CG100	Summerdale	Corm Dip	38.4 fl oz per 100 gal	1
				Drench	9.6 fl oz per 100 gal 0.6 pt per 100 gal 0.8 pt per 100 gal	4
				Foliar	38.4 fl oz per 100 gal	1
				Sprench	0.6 pt per 100 gal	1
				Soil incorp.	26 ml per 1000 ft^2	2
Copper sulfate pentahydrate	Phyton 35	Phyton 27	Phyton	Drench	25 oz per 100 gal	1
Chlorothalonil + thiophanate-methyl		Spectro	Cleary	Drench	12 oz per 100 gal 24 oz per 100 gal	2

Active Ingredient(s)	Trade Name(s)		Manufacturer	Rate(s) Tested		# Trials
	Food Crops	Env. Hort/ Turf				
Cyprodinil + fludioxonil	Switch	Palladium	Syngenta	Corm Dip	4 oz per 100 gal	1
					6 oz per 100 gal	2
				Drench	4 oz per 100 gal 6 oz per 100 gal	4
				Foliar	4 oz per 100 gal	1
					6 oz per 100 gal	2
				Sprench	4 oz per 100 gal	1
				Soil incorp.	1 oz per 1000 ft^2 2.7 lb per acre 4.1 lb per acre	3
Fluazinam	Omega	Fluazinam	Syngenta	Drench	6.4 fl oz per 100 gal	1
Fludioxonil	Cannonball, Scholar	Medallion	Syngenta	Corm Dip	8 oz per 100 gal	2
				Drench	2 oz per 100 gal	6
				Foliar	4 oz per 100 gal	2
				Sprench	2 oz per 100 gal	1
				Soil incorp.	4 oz per 100 gal	1
Fludioxonil + mefenoxam		Hurricane	Syngenta	Drench	0.75 oz per 100 gal 1.5 oz per 100 gal 12 oz per 100 gal	4
				Spray	1.5 oz per 100 gal	1
Fluopyram + trifloxystrobin	Luna	Broadform	Bayer	Sprench	4 fl oz per 100 gal	1
					6 fl oz per 100 gal	1
Fluoxastrobin	Evito	Disarm	Arysta, OHP	Corm Dip	4 fl oz per 100 gal	2
				Foliar	4 fl oz per 100 gal	2
Fluxapyroxad + pyraclostrobin	Priaxor	Orkestra	BASF	Drench	8 fl oz per 100 gal 10 fl oz per 100 gal 13 fl oz per 100 gal	1
Hydrogen peroxide, peroxyacetic & octanoic acids		X-3	Phyton	Drench	1:500 dilution	1
				Corm Dip	2 fl oz per 100 gal 4 fl oz per 100 gal	1
Isofetamid	Kenja	Astun	OHP	Drench	13.5 oz per 100 gal	1
Mefentrifluconazole	Revysol	BAS 750	BASF	Drench	3 fl oz per 100 gal	1
Metconazole	Caramba, Quash, V-10116	Tourney	BASF, Valent	Corm Dip	2 oz per 100 gal	1
					4 oz per 100 gal	1
				Drench	1 oz per 100 gal 2 oz per 100 gal 4 oz per 100 gal	5
				Foliar	1 oz per 100 gal 2 oz per 100 gal	1
					4.3 oz per 100 gal 8.6 oz per 100 gal	1
				Sprench	1 oz per 100 gal 2 oz per 100 gal	1
				Soil incorp.	2.8 g per 1000 ft^2 5.6 g per 1000 ft^2 4.3 oz per acre 8.6 oz per acre	4

Active Ingredient(s)	Trade Name(s)		Manufacturer	Rate(s) Tested		# Trials
	Food Crops	Env. Hort/ Turf				
Muscodor albus	MBI-601 strain SA-13	MBI-601 strain SA-13	Marrone	Soil incorp.	5 g per cu. ft. 10 g per cu. ft.	1
Propiconazole	Orbit, Tilt	Banner Maxx	Syngenta	Drench	5 fl oz per 100 gal	1
Pseudomonas chlororaphis	Howler	Zio	AgBiome SePRO	Drench	100 oz per 100 gal	1
Pydiflumetofen + difenoconozole	Miravis Duo	Postiva	Syngenta	Drench	28 fl oz per 100 gal	1
Pyraclostrobin	Cabrio, Headline	Empress, Insignia	BASF	Drench	3.1 fl oz per 100 gal 6.1 fl oz per 100 gal	1
				Soil incorp.	16.3 pt per acre	1
Pyraclostrobin Boscalid +	Pristine	Pageant	BASF	Drench	8 oz per 100 gal 12 oz per 100 gal 16 oz per 100 gal	4
				Soil incorp.	12 oz per acre	1
SP2169		SP2169	SePro	Corm Dip	12.3 fl oz per 100 gal	1
				Drench	12.3 fl oz per 100 gal	2
				Foliar	12.3 fl oz per 100 gal	1
				Soil incorp.	8.35 ml per 1000 ft^2	2
SP2550		SP2550	SePro	Corm Dip	32 fl oz per 100 gal	1
				Drench	32 fl oz per 100 gal	1
				Foliar	13.1 fl oz per 100 gal	1
				Soil incorp.	13.1 pt per acre	1
Tebuconazole	Folicur	Torque	Bayer, Cleary	Corm Dip	10 fl oz per 100 gal	1
				Drench	6 fl oz per 100 gal 10 fl oz per 100 gal	2
				Foliar	10 fl oz per 100 gal	1
				Soil incorp.	20.4 ml per 1000 ft^2	2
Thiamethoxam	Actara, Platinum	Flagship 0.22 G	Syngenta	Soil incorp.	44 oz per 1000 ft^2	2
		Flagship 25WG		Soil incorp.	0.55 oz per 1000 ft^2	2
Thiophanate methyl	Topsin	3336	UPI, Nufarm	Corm Dip	16 oz per 100 gal	2
				Drench	16 oz per 100 gal 24 oz per 100 gal	7
				Foliar	16 fl oz per 100 gal	1
					16 oz per 100 gal	1
				Sprench	12 fl oz per 100 gal	1
				Soil incorp.	16 fl oz per acre	2
Thyme Oil	T. GUARD	Promax	Biohumanetics, etc.	Soil incorp.	16.3 pt per acre	1
Trichoderma harziamum Rifai strain T-22 & *T. virens* strain G-41	RootShield Plus	RootShield Plus, BW240	BioWorks	Corm Dip	8 oz per 100 gal	2
				Drench	3 oz per 100 gal 6 oz per 100 gal 8 oz per 100 gal	5
				Foliar	8 oz per 100 gal	1
					54 oz per 100 gal	1
				Sprench	6 oz per 100 gal	1
				Soil incorp.	10 oz per 1000 ft^2 28 lb per acre 54 lb per acre	4

Active Ingredient(s)	Trade Name(s)		Manufacturer	Rate(s) Tested		# Trials
	Food Crops	Env. Hort/ Turf				
Trifloxystrobin	Flint, Gem	Compass	Bayer	Drench	0.5 fl oz per 100 gal 1 fl oz per 100 gal 4 fl oz per 100 gal	4
				Sprench	2 oz per 100 gal	1
				Soil incorp.	8 fl oz per acre	1
Triflumizole	Procure	Terraguard	Chemtura	Drench	6 oz per 100 gal	1
Triticonazole	Charter	Trinity	BASF	Drench	6 fl oz per 100 gal 8 fl oz per 100 gal 12 fl oz per 100 gal	5
				Foliar	8 fl oz per 100 gal 12 fl oz per 100 gal	2
				Sprench	6 fl oz per 100 gal 8 fl oz per 100 gal	1
				Soil incorp.	5.43 ml per 1000 ft^2 8.14 ml per 1000 ft^2 8 fl oz per acre 12 fl oz per acre	4

Table 2. List of Products and Rates Tested on Vegetables from 2002 to 2019.

Active Ingredient(s)	Trade Name(s)		Manufacturer	Rate(s) Tested		# Trials
	Food Crops	Env. Hort/ Turf				
Acibenzolar	Actigard		Syngenta	Banded	0.5 oz per acre	2
					0.75 oz per acre	
				Drench	0.33 oz per acre 0.25 oz per 100 gal 0.5 oz per 100 gal 0.75 oz per 100 gal	12
				Drip	0.25 oz per 100 gal	2
				Foliar	0.75 oz per acre	1
Azoxystrobin	Abound, Amistar, Quadris	Heritage	Syngenta	Banded	15.4 fl oz per acre	3
				Drench	15.4 fl oz per 100 gal	11
				In-furrow	0.8 pt per 1000 ft	1
				Foliar	15.4 fl oz per acre	1
Bacillus subtilis	Serenade	Rhapsody	AgraQuest	Drench	2 qt per 100 gal 4 qt per 100 gal	1
Bacillus subtilis var. *amyloliquefaciens* Strain FZB24	Taegro Eco	Taegro	Novozymes, Syngenta	Drench	5.2 oz per 100 gal	1
Chlorothalonil	Bravo	Daconil	Syngenta	In-furrow	1.5 pt per 1000 ft	1
Fludioxonil	Cannonball, Scholar	Medallion	Syngenta	Drench	0.5 lb per acre 16 oz per 100 gal	5
Fluopyram + prothioconazole	Propulse		Bayer	Drip	13.5 fl oz per acre	1
Hymexazol	Tachigaren	Hymexazol	Sankyo, Cleary	Drench	3 ml per sq m 6 ml per sq m	2
Metconazole	Caramba, Quash, V-10116	Tourney	BASF, Valent	Drench	4 oz per 100 gal 8 oz per 100 gal	5
				Foliar	1 oz per acre	1
					2 oz per acre	1
Prothioconazole	Proline	Proline	Bayer	Banded	5.7 fl oz per acre	2
				Drench	3 fl oz per 100 gal 5.7 fl oz per 100 gal	15
				Drip	5.7 fl oz per 100 gal	4
				Foliar	1 oz per acre	1
					5.7 fl oz per 100 gal	3
Pyraclostrobin	Cabrio, Headline	Insignia	BASF	Drench	16 oz per 100 gal	3
				In-furrow	0.77 pt per 1000 ft	1
Pydiflumetofen	Adepidyn, Miravis		Syngenta	Band	8.55 fl oz per 100 gal	1
				Drench	3.4 fl oz per 100 gal	1
					10.3 fl oz per 100 gal	3
					13.7 fl oz per 100 gal	1
				Drip	8.55 fl oz per 100 gal	2
				Foliar	10.3 fl oz per 100 gal	3
					13.7 fl oz per 100 gal	1

Active Ingredient(s)	Trade Name(s)		Manufacturer	Rate(s) Tested		# Trials
	Food Crops	Env. Hort/ Turf				
Thiophanate methyl	Topsin	3336	UPI, Cleary	Drench	10 fl oz per 100 gal	9
				Drip	10 fl oz per 100 gal	2
				Foliar	10 fl oz per acre	1
Tiadinil	Tiadinil		Nichino	Drench	5.3 fl oz per 100 gal 51.1 fl oz per 100 gal	3
Trifloxystrobin	Flint, Gem	Compass	Bayer	In-furrow	0.8 pt per 1000 ft	1
Triticonazole	Charter	Trinity	BASF	Drench	9.5 fl oz per 100 gal 76.7 fl oz per 100 gal	3

Results

Comparative Efficacy on Fusarium avenaceum

In 2001, McGovern conducted a trial to determine efficacy of several fungicides for control of Fusarium crown and stem rot (*F. avenaceum*) on lisianthus (*Eustoma grandiflorum)*. All products were applied as a soil drench 24-hr prior to inoculation, and reapplied biweekly, except for Medallion which was reapplied after 1 month. Heritage, 3336 WP, Banner Maxx and a reduced-rate combination of Heritage and Medallion significantly reduced a severe Fusarium crown and stem rot incidence and plant mortality, with Heritage and Heritage + Medallion being the most effective (Table 3). Medallion and Fluazinam were less effective, and Systhane was ineffective. No phytotoxicity was observed from any treatment.

Table 3. * Efficacy on FusariumCrown and Stem Rot (*Fusarium avenaceum*) on Lisianthus (*Eustoma grandiflorum*) 'Maurine Blue', McGovern, FL, 2001.

Treatment	Rate Per 100 Gal	Final Disease Incidence (%)[x]	Final Mortality (%)	AUDPC[y]	AUMPC[z]
3336 50WP (thiophanate methyl)	16 oz	58.5 b	29.2 bc	522 cd	96 a
Banner Maxx 1.3MEC (propiconazole)	5 fl oz	66.0 b	33.5 b	1972 ab	965 a
Fluazinam 4.17F (fluazinam)	6.4 fl oz	70.8 ab	37.5 b	1425 bc	728 a
Heritage 50WG (azoxystrobin)	8.7 oz	20.8 c	0.0 c	314 d	0 a
Heritage + Medallion	4.35 + 1 oz	21.0 c	0.0 c	244 d	0 a
Medallion 50WP (fludioxonil)	2 oz	66.5 ab	29.2 bc	921 cd	2139 a
Systhane 40WSP (myclobutanil)	4 oz	91.8 ab	54.5 a	1978 a	1002 a
Untreated inoculated	-	100 a	87.5 a	2844 a	1457 a

* Not an IR-4 Experiment: F&N Tests Vol 57:OT16.

[x] Means followed by same letter do not differ significantly based on Fisher's Protected LSD (P=0.01).

[y]AUDPC= area under the disease incidence progress curve.

[z]AUMPC = area under the mortality progress curve.

Comparative Efficacy on Fusarium commune

In 2010 and 2011, Chastagner conducted three greenhouse trials to test the efficacy of several fungicides applied mainly as drench for control of damping off and root rot caused by *F. commune* (Isolates 34, 39, 53, 101, MBL12015) on Douglas fir (*Pseudotsuga menziesii*). In 2010, all products were applied 5 days after disease inoculation of potting mix (15 Dec), except BW240 which was applied on 12 Dec. Plants were seeded on 22 Dec. Treatments were applied one to three times on 1 to 4-week intervals for various products. In 2011, all treatments, with the exception of BW240, foliar Pageant, and the initial application of Acibenzolar were applied as drenches. On November 3, 2011 all treatments were planted with 10 seeds per pot. The initial application of Acibenzolar was applied directly to the seeds at this time. This was done by soaking the seeds in the Acibenzolar solution for 10 minutes prior to planting. The initial foliar application of Pageant was applied on November 21, 2011, which was 4-7 days after germination. Data on symptom development was collected once per week for 4 weeks beginning 14-15 days after seeding. Notes on symptoms were taken and the number of "healthy" seedlings was recorded. Symptoms included damping off, which occurred shortly after emergence of the cotyledon, to root rot which killed the

seedlings during the experiment. Disease pressure was high in all trials. In 2010, only the drench applications of Tourney at 1 or 2 oz/100 gallons had significantly higher numbers of healthy seedlings per pot (Table 4). Promising activity was observed for Compass, Pageant and Trinity as they were comparable to the non-inoculated check. In 2011, the drench applications of Torque, Pageant, 3336, CG100, Insignia at the high rate and Tourney had significantly higher numbers of healthy seedlings (Table 5). BW240 was ineffective (Table 6). No phytotoxicity was observed from any treatment except SP2169 in which some plants appeared to be stunted with malformed needles.

Table 4. Efficacy on Damping-off and Root Rot Caused by *Fusarium commune* on Douglas Fir (*Pseudotsuga menziesii*), Chastagner WA, 2010.

Treatment	Rate Per 100 Gal	Application Dates[z]	Application Interval	No. of Healthy Seedlings[x,y]
Acibenzolar	0.125 oz	2, 4	21 Days	2.2 b
	0.25 oz	2, 4	21 Days	2.4 b
BW240 WP (*Trichoderma harziamum & T. virens)*	6 oz	1	1 application	1.6 b
CG100 (caprylic acid)	0.6 pt	2, 5	28 Days	3.0 b
Compass (trifloxystrobin)	0.5 oz	2, 5	28 Days	4.0 ab
Heritage (azoxystrobin)	1.8 oz	2, 5	28 Days	4.0 ab
	4 oz	2, 5	28 Days	2.2 b
Hurricane (fludioxonil+mefenoxam)	0.75 oz	2	1 application	3.0 b
Medallion (fludioxonil)	2 oz	2, 4	21 Days	2.6 b
Pageant 38WG (boscalid+pyraclostrobin)	12 oz	2, 3, 5	14 Days	4.4 ab
Palladium (cyprodinil+fludioxonil)	6 oz	2, 3, 5	14 Days	1.8 b
Tourney (metconazole)	1 oz	2, 4	21 Days	8.2 a
	2 oz	2, 4	21 Days	8.2 a
Trinity (triticonazole)	6 fl oz	2, 3, 5	14 Days	5.2 ab
	8 fl oz	2, 3, 5	14 Days	5.0 ab
Untreated non-inoculated	-	-	-	5.7 ab
Untreated inoculated	-	-	-	1.9 b

[x] Means followed by the same letter do not differ significantly based on Tukey's HSD Test, (P=0.001).
[y] Data collected 35 days after seeding (January 26, 2011).
[z] Dates: 1 = 12/12/10, 2 = 12/20/10, 3 = 1/3/11, 4 = 1/10/11, 5 = 1/18/11.

Table 5. Efficacy on Damping-off and Root Rot Caused by *Fusarium commune* on Douglas Fir (*Pseudotsuga menziesii*), Chastagner WA, 2011, Trial 1.

Treatment	Rate Per 100 Gal	Application Method	App. Dates[y]	App. Interval	Emergence Out of 10 Seeds[x]	No. of Healthy Seedlings	No. of Plants W/ Phyto Symptoms
3336 F (thiophanate-methyl)	16 fl oz	Drench	1, 2, 5	14 Days	8.8 abc	7.0 abc	0.0 b
Acibenzolar-s-methyl	0.25 oz	Seed soak & Drench	2, 4	21 Days	6.2 bc	0.2 f	0.0 b
CG100 (caprylic acid)	0.6 pints	Drench	1, 5	28 Days	8.6 abc	5.0 bcd	0.0 b
Compass 50WDG (trifloxystrobin)	0.5 oz	Drench	1, 4	21 Days	8.8 abc	4.0cde	0.0 b
Heritage 50WG (azoxystrobin)	1.8 oz	Drench	1, 5	28 Days	7.4 abc	1.6 def	0.0 b
Hurricane (fludioxonil+mefenoxam)	0.75 oz	Drench	1	1 app.	7.4 abc	1.6 def	0.0 b
Insignia SC (pyraclostrobin)	3.1 fl oz	Drench	1, 3, 5	14 Days	8.4 abc	2.4 def	0.0 b
	6.1 fl oz	Drench	1, 3, 5	14 Days	8.8 abc	4.8 bcd	0.0 b
Medallion (fludioxonil)	2 oz	Drench	1, 4	21 Days	7.8 abc	2.0 def	0.0 b
Pageant 38WG (boscalid+pyrclostrobin)	8 oz	Foliar	4	14 Days	7.2 abc	0.6 f	0.0 b
	12 oz	Drench	1, 3, 5	14 Days	9.4 a	7.2 abc	0.0 b
Palladium 62.5WG (cyprodinil+fludioxonil)	4 oz	Drench	1, 3, 5	14 Days	8.2 abc	2.4 def	0.0 b
SP2169	12.3 fl oz	Drench	1, 3, 5	14 Days	9.0 ab	4.4 cde	4.2 a
Torque (tebuconazole)	6 fl oz	Drench	1, 3, 5	14 Days	9.2 a	8.2 ab	0.0 b
Tourney 50 WDG (metconazole)	1 oz	Drench	1, 4	21 Days	8.8 abc	7.4 abc	0.0 b
	2 oz	Drench	1, 4	21 Days	9.8 a	9.0 a	0.0 b
Trinity 2 SC (triticonazole)	6 oz	Drench	1, 3, 5	14 Days	9.0 ab	2.4 def	0.0 b
	8 oz	Drench	1, 3, 5	14 Days	9.4 a	3.2 def	0.6 b
Untreated non-inoculated	-	-	-	-	8.8 abc	8.8 a	0.0 b
Untreated inoculated	-	-	-	-	6.0 c	1.2 ef	0.0 b

[x] Means followed by the same letter do not differ significantly based on Tukey's HSD Test, (P=0.001).
[y] Dates: 1 = 11/1/11, 2 = 11/3/11, 3 = 11/16/11, 4 = 11/21/11, 5 = 11/29/11.
Emergence data collected 28 days after seeding; no. of healthy seedlings and phytotoxicity collected 35 days after seeding (11/3/11).

Table 6. Efficacy on Damping-off and Root Rot Caused by *Fusarium commune* on Douglas Fir (*Pseudotsuga menziesii*), Chastagner WA, 2011, Trial 2.

Treatment	Rate Per 100 Gal	Application Method[y]	Emergence Out of 10 Seeds[x]	No. of Healthy Seedlings
BW240 WP (*Trichoderma harziamum & T. virens)*	8 oz	Soil incorp. and seed trt	0.0 b	0.0 b
Untreated non-inoculated	-	-	8.6 a	7.4 a
Untreated inoculated	-	-	7.6 a	0.4 b

[x] Means followed by the same letter do not differ significantly based on Tukey's HSD Test, (P=0.001).
[y] BW240 applied to soil 3 days before inoculation and to seeds before seeding 5 days after inoculation.
Emergence data collected 28 days after seeding; no. of healthy seedlings and phytotoxicity collected 35 days after seeding (11/3/11).

In 2012, Chastagner conducted two greenhouse trials to test the efficacy of several fungicides applied as pre-plant soil incorporation for control of damping off and root rot caused by *F. commune* (Isolate MBL12015) on Douglas fir and a natural infection on bulbous iris (*Iris x hollandica*). For the Douglas fir experiment, *Fusarium* inoculation to soil from a commercial grower's nursery field that had been routinely used for Douglas fir production was done prior to fungicide applicationson Nov 30, except for the Rootshield Plus treatment which was applied to the soil on Nov 14. Ten seeds were planted for each pot on Dec 3. Based on isolations from symptomatic seedlings, the only treatment that did not yield any *Fusarium* was the field soil that was autoclaved. This suggests that the soil acquired from a commercial grower's nursery field was already infested with this pathogen. It is important to note that the steaming treatment used in this experiment did not eliminate the pathogen from the soil. The number of germinated seed, healthy seedlings and the height of healthy seedlings was highly variable from pot to pot within treatments during this test. Consequently, even though the number of germinated seeds and the height of the seedlings ranged from 4.3 to 8.0 and 2.4 to 6.0, respectively, there were no significant differences with these variables between any of the treatments (Table 7). The number of healthy seedlings ranged from 0.5 to 6.3. While there was still variability from pot to pot within treatments, the Flagship plus Heritage had a significantly higher number of healthy seedlings than the inoculated field soil, which is the appropriate check for this treatment. None the other fungicide treatments had any significant effect on the number of healthy seedlings.

For the bulbous iris experiment, fungicides were applied and incorporated on Aug 16 to soil that was acquired from a commercial grower's greenhouse that had been routinely used for iris production,except for Rootshield Plus which was applied and mixed on Aug 18. There were two checks included in the treatments. These were greenhouse soil that received treatment and greenhouse soil that was steamed for 2 hours at 200F to kill off inoculum in the soil. Bulbs were planted on Aug 21 (Reps 1and 2) and Aug 22 (Reps 3, 4, 5). Disease pressure in this trial was high. Treatments had no effect on the number of iris plants that emerged (Table 8). The number of marketable flowers per crate ranged from 32.4 to 12.2 for the bulbs planted in the steam pasteurized and non-pasteurized soils, respectively. Bulbs planted in soil treated with the high rate of Trinity, Flagship 0.22 G + Heritage, and the high rate of Tourney had significantly higher numbers of marketable flowers, flowers >18" tall, and significantly fewer culls than the bulbs planted in the non-pasteurized soil. The combinations of Flagship 25WG + Heritage and Acibenzolar + Heritage also significantly increased the number of flowers >18" tall. Flagship 0.22 G alone significantly increased the total number of marketable flowers and the number of flowers >18" tall. *Fusarium* was isolated from 88% of the cull flower bulbs in the non-pasteurized soil. *Fusarium* was also isolated from 22% of the cull flower bulbs in the steam pasteurized soil, which suggests that the pathogen was present on some of the bulbs at the time of planting. This may have reduced the efficacy of some fungicide treatments.

Table 7. Efficacy on Damping-off and Root Rot Caused by *Fusarium commune* on Douglas Fir (*Pseudotsuga menziesii*), Chastagner WA, 2012.

Treatment	Rate/1000ft^2	No. Germinated[x] 1/2/13	Healthy Seedlings 1/29/13	
			No. of Plants	Avg Ht (cm)
Acibenzolar + Heritage 50WDG	0.08g + 1oz	6.8 a	3.5 a-d	4.7 a
CG 100 (caprylic acid)	26.0 ml	6.5 a	2.8 bcd	3.7 a
Flagship 0.22G (thiamethoxam)	44 oz	6.3 a	4.0 abc	4.7 a
Flagship 0.22G +Heritage 50WDG	44 oz + 0.4oz	4.8 a	2.0 cd	4.5 a
Flagship 25WG (thiamethoxam)	0.55 oz	7.8 a	2.0 cd	4.9 a
Flagship 25WG+Heritage 50WDG	0.4 oz +0.4 oz	8.0 a	5.5 ab	4.2 a
Heritage 50WDG (azoxystrobin)	0.4 oz	5.8 a	3.5 a-d	5.0 a
Palladium 62.5WG (cyprodinil+fludioxonil)	1 oz	4.3 a	0.5 d	2.4 a
Rootshield Plus WP(*Trichoderma harziamum & T. virens)*	10 oz	4.0 a	2.5 bcd	5.7 a
SP2169	8.35 ml	6.3 a	1.3 cd	3.2 a
Torque 3.6SC (tebuconazole)	20.4 ml	4.5 a	1.0 cd	3.9 a
Tourney 50WDG (metconazole)	2.8 g	5.8 a	3.5 a-d	3.8 a
	5.6 g	5.3 a	2.5 bcd	4.2 a
Trinity 2SC (triticonazole)	5.43 ml	5.8 a	3.0 a-d	4.3 a
	8.14 ml	5.8 a	2.0 cd	3.3 a
Autoclaved field soil	-	7.5 a	6.3 a	6.0 a
Steamed field soil	-	6.8 a	4.3 abc	5.5 a
Non-inoculated field soil	-	7.0 a	3.3 a-d	3.9 a
Inoculated field soil	-	7.3 a	1.8 cd	4.1 a

[x] Means followed by the same letter do not differ significantly based on Tukey's HSD Test, (P<0.05).
Data collected 29 days after seeding (December 4, 2012).

Table 8. Efficacy on Damping-off and Root Rot Caused by *Fusarium commune* on Bulbous Iris (*Iris x hollandica*) 'Blue Diamond', Chastagner WA, 2012.

Treatment	Rate/1000ft^2	No. Emerged[x] 9/5/12	No. of Flowers Per Crate[y]		
			Marketable	18 Inch	Cull
Acibenzolar + Heritage 50WDG	0.08g + 1oz	44.4 a	22.4 a-d	21.6 abc	22.2 abc
CG 100 (caprylic acid)	26.0 ml	44.8 a	19.2 bcd	18.4 bcd	24.8 abc
Flagship 0.22G (thiamethoxam)	44 oz	45.0 a	23.0 abc	21.8 abc	22.0 abc
Flagship 0.22G +Heritage 50WDG	44 oz + 0.4oz	44.6 a	24.2 abc	23.4 ab	21.6 bc
Flagship 25WG	0.55 oz	44.4 a	17.6 bcd	17.4 bcd	26.8 abc
Flagship 25WG+Heritage 50WDG	0.4 oz +0.4 oz	44.8 a	22.6 a-d	21.8 abc	22.2 abc
Heritage 50WDG (azoxystrobin)	0.4 oz	44.6 a	19.0 bcd	18.6 bcd	25.0 abc
Palladium 62.5WG (cyprodinil+fludioxonil)	1 oz	44.4 a	21.2 bcd	20.8 bcd	22.8 abc
Rootshield Plus WP (*Trichoderma harziamum & T. virens)*	10 oz	44.8 a	13.6 bcd	12.8 cd	31.4 ab
SP2169	8.35 ml	44.0 a	21.0 bcd	20.8 bcd	22.0 abc
Torque 3.6SC (tebuconazole)	20.4 ml	44.4 a	21.8 a-d	20.6 bcd	22.2 abc
Tourney 50WDG (metconazole)	2.8 g	44.6 a	21.4 bcd	20.8 bcd	22.4 abc
	5.6 g	44.4 a	23.8 abc	23.2 abc	20.4 cd
Trinity 2SC (triticonazole)	5.43 ml	44.8 a	21.2 bcd	21.0 bcd	23.0 abc
	8.14 ml	44.0 a	24.5 ab	24.0 ab	21.5 cd
Steam pasteurized soil	-	43.8 a	32.4 a	32.0 a	10.8 d
Non-pasteurized soil	-	45.0 a	12.2 d	11.0 d	32.2 a

[x] Means followed by the same letter do not differ significantly based on Tukey's HSD Test, (P<0.05). Data collected 14 days after planting bulbs (August 21-22, 2012).
[y]Harvested between October 9, 2012 and November 9, 2012.

In 2013, Chastagner conducted a field trial at a commercial conifer nursery on a site that had not been previously fumigated. *Fusarium commune* inoculum was applied to soil on Jun 10, and Douglas fir seeds were planted on Jun 11. The first fungicide application was on Jun 19, and subsequent applications were applied on Jul 11, Jul 30, and Aug 23, with the exception of Rootshield Plus which was applied only on Jun 19 and Aug 23. Fungicides were sprayed to the soil surface and overhead irrigated in after all applications for 1.5-2 hours, receiving ¼" to ½"of water. The level of inoculum in the inoculated soil was 71.2 cfu/g compared to the non-inoculated soil, which had 58.7 cfu/g. Both of these numbers are considerably lower than the 500 cfu/g that nursery managers typically associate with high disease pressure. Compared to the inoculated Check, none of the treatments, and the non-inoculated Check, had any significant effect on the % of planted seeds producing a plant, the size of the seedlings and their dry weights (Table 9).

Table 9. Efficacy on Damping-off and Root Rot Caused by *Fusarium commune* on Douglas Fir (*Pseudotsuga menziesii*), Chastagner WA, 2013.

Treatment	Rate Per100 Gal/A	% Emergence[x]	Stem Diameter (mm)	Root Length (mm)	Dry Wt (g) for 'Grade' and 'Cull' Quality Plants on 12/19			
					Grade		Cull	
					Crown	Roots	Crown	Roots
3336 F (thiophanate-methyl)	16 fl oz	71.8 ab	1.19 bc	171.9 a	2.8 b	1.9 ab	0.6 a	0.5 a
Compass O (trifloxystrobin)	8 fl oz	74.5 ab	1.19 bc	177.3 a	3.2 ab	2.1 ab	1.1a	0.7 a
Empress SC (pyraclostrobin)	16.3 pt	61.6 ab	1.21 bc	171.9 a	3.0 ab	1.7 ab	0.6 a	0.4 a
Pageant 38WG (pyraclostrobin + boscalid)	12 oz	64.4 ab	1.21 bc	165.7 a	3.0 ab	1.8 ab	0.7 a	0.5 a
Palladium 62.5 WG	2.7 lb	57.4 b	1.16 c	174.1 a	2.4 b	1.4 ab	0.5 a	0.3 a
Palladium 62.5WG (cyprodinil+fludioxonil)	4.1 lb	68.5 ab	1.40 a	172.0 a	3.2 ab	1.9 ab	1.1 a	0.9 a
Promax (thyme oil)	16.3 pt	69.0 ab	1.24 bc	175.6 a	3.2 ab	2.0 ab	0.8 a	0.7 a
Rootshield Plus WP (*Trichodermia harzanium* & *T. virens*)	54 lb	67.1 ab	1.30 abc	167.5 a	4.1 ab	2.0 ab	0.8 a	0.6 a
SP2550	13.1 pt	87.5 a	1.24 bc	167.0 a	2.7 b	1.5 ab	1.1 a	0.8 a
Tourney 50 WDG (metconazole)	4.3 oz	60.6 ab	1.25 bc	155.8 a	2.5 b	1.3 b	0.7 a	0.8 a
	8.6 oz	81.5 ab	1.17 c	170.5 a	3.3 ab	3.0 a	1.0 a	1.1 a
Trinity 2 SC (triticonazole)	8 fl oz	64.4 ab	1.29 abc	177.9 a	2.5 b	2.1 ab	0.7 a	0.8 a
	12 fl oz	73.1 ab	1.30 abc	168.5 a	3.8 ab	2.1 ab	1.0 a	0.7 a
Non-inoculated Check	-	74.5 ab	1.24 bc	180.1 a	3.0 ab	1.8 ab	0.9 a	0.5 a
Inoculated Check	-	87.5 a	1.32 ab	174.5 a	6.0 a	2.9 ab	1.3 a	0.7 a

[x] % of planted seeds producing a plant. Means followed by the same letter do not differ significantly based on Tukey's HSD Test, (P=0.001).
Emergence data collected 28 days after seeding; no. of healthy seedlings and phytotoxicity collected 35 days after seeding (11/3/11).

In 2015, Chastagner conducted a field trial on beds were steam pasteurized using a Sioux Steam Flo Steam Generator to reduce any pathogens, insects and weeds. Douglas fir seeds were planted on Aug 19 and *Fusarium commune* inoculum was applied to soil. The first fungicide application was on Aug 19, and subsequent applications were applied on Sep 2 and 16, with the exception of Rootshield Plus which was applied only on Aug 11. Medallion + Heritage, Rootshield Plus, 3336 F, and Trinity increased numbers of healthy plants compared to the inoculated check and were not significantly different from the non-inoculated check; all other treatments were not significantly different from the inoculated and non-inoculated checks (Table 10). There was no significant difference between any of the treatments in the total number of seeds that emerged, the total number of plants that died or were considered unhealthy, or the average height of the healthy seedlings. None of the treatments still had a significant effect on the number of healthy seedlings compared to each other or the checks on May 31, 2016.

Table 10. Efficacy on Damping-off and Root Rot Caused by *Fusarium commune* on Douglas Fir (*Pseudotsuga menziesii*), Chastagner WA, 2015.

Treatment	Rate Per 100 Gal/A	Total Emerged by 10/9/16	Total Unhealthy and/or Dead 12/15	Avg. Healthy Ht (cm) 12/15	# Healthy Seedlings 12/15	Total Unhealthy and/or Dead 5/31/16	Avg. Healthy Ht (cm) 5/31/16	# Healthy Seedlings 5/31/16
3336 F (thiophanate-methyl)	16 fl oz	33.0 a	12.4 a	3.7 a	20.6 a	17.4 a	10.2a	15.8 ab
Flagship 25 WG + Heritage	17 oz + 4 oz	31.0 a	11.2 a	38.9 a	19.8 ab	16.2 a	10.0 a	15.0 ab
Heritage 50WG (azoxystrobin)	4 oz	25.4 a	10.8 a	3.4 a	14.6 ab	14.4 a	8.7 a	12.0 ab
Insimmo (acinbenzolar)	0.25 oz	33.4 a	18.0 a	3.5 a	15.4 ab	22.6 a	9.6 a	11.2 ab
Medallion 50WP (fludioxonil)	4 oz	35.2 a	19.2 a	3.5 a	16.0 ab	22.8 a	9.6 a	12.4 ab
Medallion WDG + Heritage	4 oz + 4 oz	34.0 a	12.2 a	3.3 a	21.6 a	18.8 a	9.2 a	15.6 ab
Rootshield Plus WP (*Trichodermia harzanium* & *T. virens*)	28 lbs	35.8 a	14.4 a	3.9 a	21.4 a	20.4 a	9.7 a	15.2 ab
Tourney 50 WDG (metconazole)	4 oz	32.2 a	14.2 a	3.3 a	18.0 ab	19.4 a	8.8 a	12.8 ab
Trinity 2 SC (triticonazole)	12 oz	35.8 a	15.6 a	3.5 a	20.2 a	21.0 a	9.9 a	15.0 ab
Inoculated Check	-	22.0 a	12.2 a	3.5 a	9.8 b	15.4 a	10.6 a	7.0 b
Non-inoculated Check	-	35.8 a	11.4 a	3.3 a	24.4 a	17.8 a	9.4 a	18.8 a

[x] Planted seeds producing a plant. Means followed by the same letter do not differ significantly based on Tukey's HSD Test, (P=0.05).

Comparative Efficacy on Fusarium oxysporum

In 2001, McGovern conducted two trials to determine efficacy of several fungicides for control of Fusarium wilt (*F. oxysporum*) on lisianthus (*Eustoma grandiflorum)*. Treatments were applied as a soil drench 24 hr prior to inoculation with *F. oxysporum*, and reapplied at 2-3 wk intervals. In the first trial, severe final disease incidence was significantly reduced by Medallion and Hurricane (Table 11). Final plant mortality was significantly reduced by all treatments, with Medallion, and Hurricane the most effective in increasing plant survival. Plant height was significantly increased by Medallion, Hurricane and Compass. In the second trial, Medallion, Terraguard, Heritage, Systhane and 3336 WP significantly reduced a severe disease incidence and plant mortality, with Medallion and Terraguard being the most effective (Table 12). Spectro 90 was ineffective. No phytotoxicity was observed from any treatment.

Table 11. * Efficacy on Fusarium Wilt (*Fusarium oxysporum*) on Lisianthus (*Eustoma grandiflorum)* 'Maurine Blue', McGovern, FL, 2001.

Treatment	Rate Per 100 Gal	Final Disease Incidence (%)[x]	Final Mortality (%)	AUDPC[y]	AUMPC[z]	Plant Height (cm)
Compass 50WDG (trifloxystrobin)	1 oz	88.9 a	39.4 bc	1698.0 b	508.5 b	18.2 c
Heritage 50WG (azoxystrobin)	0.9 oz	97.2 a	25.0 c	2085.7 b	295.0 bc	11.6 de
Hurricane 48WP (fludioxonil + mefenoxam)	1.5 oz	41.7 b	0.0 d	263.3 c	0.0 c	27.1 b
Medallion 50WP (fludioxonil)	2 oz	36.1 b	0.0 d	144.0 c	0.0 c	34.3 a
Untreated inoculated	-	100 a	69.4 a	3394.2 a	1220.2 a	10.5 de

* Not an IR-4 Experiment: F&N Tests Vol 57: OT17. Not all products tested included in table.
[x] Means followed by same letter do not differ significantly based on Fisher's Protected LSD (P=0.01).
[y] AUDPC = area under the disease incidence progress curve.
[z] AUMPC = area under the mortality progress curve.

Table 12. * Efficacy on Fusarium Wilt (*Fusarium oxysporum*) on Lisianthus (*Eustoma grandiflorum)* 'Maurine Blue', McGovern, FL, 2001.

Treatment	Rate Per 100 Gal	Final Disease Incidence (%)[x]	Final Mortality (%)	AUDPC[y]	AUMPC[z]
3336 50WP (thiophanate methyl)	16 oz	75.0 b	33.3 b	502 b	161 b
Heritage 50WG (azoxystrobin)	8.7 oz	44.4 c	25.0 bc	326 bc	102 b
Medallion 50WP (fludioxonil)	2 oz	8.3 d	5.5 c	82 c	62 b
Spectro 90WDG (chlorothalonil + thiophanate methyl)	12 oz	88.8 ab	72.2 a	1560 a	948 a
Systhane 40WSP (myclobutanil)	4 oz	43.8 c	27.8 b	408 bc	304 b
Terraguard 50W (triflumizole)	6 oz	13.9 d	5.5 c	104 c	54 b
Untreated inoculated	-	94.4 a	77.8 a	1456 a	1055 a

* Not an IR-4 Experiment: F&N Tests Vol 57: OT18.
[x] Means followed by same letter do not differ significantly based on Fisher's Protected LSD (P=0.01).
[y] AUDPC = area under the disease incidence progress curve.
[z] AUMPC = area under the mortality progress curve.

In 2010, Kirk conducted a greenhouse trial to test the efficacy of several fungicides for control of root rot caused by *F. oxysporum* on larkspur (*Delphinium sp.*). All treatments were applied as drench, except

BW240 which was applied to plant roots as an immersion in solution for 30 seconds prior to transplanting. Initial treatments were applied 4 days after transplanting, except Acibenzolar applied 14 days before, CG100 applied at transplanting and Trinity applied 21 days after transplanting. Plants were inoculated immediately after the application of fungicides on 20 Sep. Fusarium necrosis and root rot developed in the trial and about 150 days after transplanting, the inoculated check plants developed severe leaf necrosis and root necrosis. All treatments except Tourney significantly reduced the foliar and root necrosis in comparison to the non-treated inoculated control (Table 13). It is possible that plants treated with Tourney were excessively inoculated. The treatments with the greatest efficacy included the standards 3336, and Medallion, with Hurricane almost comparable; Acibenzolar at the lower rate also looked promising. All treatments caused transient leaf phytotoxicity.

Table 13. Efficacy on Fusarium Root Rot (*Fusarium oxysporum*) on Larkspur (*Delphinium sp.*), Kirk, MI, 2010.

Treatment	Rate Per 100 Gal	Application Dates[u]	Phytotoxicity[x, t] 74 DAP[v]	No. Leaves Per Plant 104 DAP	Plant Height (cm) 104 DAP	Leaf Necrosis[w] 148 DAP	RAUDPC[y] 148 DAP	Root Necrosis[z] 148 DAP
Acibenzolar	0.125 oz	A	1.1 ab	9.4 de	30.3 de	39.0 ef	9.2 e	3.9 e
	0.25 oz	A	1.4 a	9.0 def	35.2 cd	47.5 d	10.3 d	4.6 cd
3336 80WG (thiophanate methyl)	4 lb	D	0.9 bc	11.2 bc	42.5 bc	28.5 h	8.8 e	2.6 f
BW240 WP (*Trichoderma harziamum & T. virens)*	6 oz, 3 oz	B, H	1.1 ab	7.5 fgh	25.5 de	56.0 c	11.9 c	4.4 cde
CG100 20SC (caprylic acid)	0.8 pt	C	0.9 bc	8.7 d-g	23.7 e	55.8 c	12.1 c	5.5 b
Hurricane (fludioxonil+mefenoxam)	12 oz	D	1.4 a	12.6 ab	51.3 ab	35.1 fg	9.2 e	2.6 f
Medallion (fludioxonil)	2 oz	D	1.0 bc	13.6 a	54.4 a	31.3 gh	9.3 e	2.7 f
Pageant 38WG (boscalid+pyraclostrobin)	12 oz	D, E	0.5 d	7.3 gh	28.0 de	46.3 d	11.1 cd	4.2 de
Tourney (metconazole)	2 oz	D	1.0 bc	3.0 i	41.6 bc	78.5 a	14.5 b	7.6 a
Trinity (triticonazole)	6 fl oz	F, G	0.7 cd	10.0 cd	35.3 cd	43.8 de	10.6 d	5.0 bc
Untreated non-inoculated	-	-	0.0 e	8.0 efg	34.2 cd	16.4 i	2.4 f	2.3 f
Untreated inoculated	-	-	0.0 e	6.2 h	23.5 e	65.0 b	17.6 a	7.7 a

[x] Means followed by the same letter do not differ significantly based on Fisher's LSD (P=0.05).

[t] Phytotoxicity scale from 0 – 5; 0= no phytotoxicity; 1= ≈1mm of entire leaf margin yellow of at least one leaf; 2= 1-5% of entire leaf margin yellow of at least one leaf; 3= 1-5% of entire leaf margin yellow of all leaves; 4= 5-10% of entire leaf margin yellow of all leaves; 5= >10% of entire leaf margin yellow of all leaves.

[w] Leaf necrosis percentage over whole plant.

[y] RAUDPC, relative area under the disease progress curve calculated from day of appearance of initial symptoms.

[z] Root necrosis scale from 0 – 10; 0= no necrosis; 1= 0-5%; 2= 6-10%; 3= 11-15%; 4= 16-20%; 5= 20-30%; 6= 30-40%; 7= 40-50%; 8= 50-60%; 9= 60-75%; 10= 75-100% of root mass necrotic.

[v] Days after planting

[u] Application dates: A= 2 Sep (2 weeks prior to inoculation); B= 16 Sep (root dip before planting); C= 16 Sep (soil drench at planting); D= 16 Sep; E= 30 Sep; F= 7 Oct; G= 21 Oct; H= 25 Nov

In 2011, Chase conducted a greenhouse trial to test the efficacy of several fungicides applied as drench/sprench for control of Fusarium wilt caused by *F. oxysporum* on lisianthus (*Eustoma grandiflora)*. Plugs were planted on 21 March and all treatments applied as drench/sprench on Mar 28. Plants were inoculated on Apr 11. Additional treatments were applied at different intervals for various products on Apr 4, 18, 2, 9, 16 and May 23.Three weeks after test initiation, stunting due to either Fusarium or phytotoxicity had become apparent. The worst damage was seen with both rates of Tourney which caused severe stunting (Table 14). Only plants treated with acibenozolar at the low rate were as tall as the non-inoculated control. After 4 weeks, top grade was lowest for plants treated with Tourney. After about 4 weeks, severity of Fusarium wilt was low for all treatments except for the inoculated control, BW240 and Phyton 27 alone. After six weeks, only the higher rate of acibenzolar, SP2169 and Tourney at the 1 oz rate showed significantly lower disease severity.

Table 14. Efficacy on Fusarium wilt (*F. oxysporum*) on Lisianthus (*Eustoma grandiflora*), Chase, CA, 2011.

Treatment	Rate per 100 Gal	Applic. Interval (Days)	Height (cm) 5-4-11	Top Grade 5-4-11	Disease Severity [x]		
					5-9-11	5-16-11	5-23-11
Acibenzolar	0.125 oz	21	13.2 d	3.2 f	1.0 a	1.0 a	1.3 ab
	0.25 oz	21	10.9 bcd	3.0 def	1.0 a	1.1 a	1.0 a
3336 80WG (thiophanate methyl)	16 oz	14	9.8 bc	2.9 cdef	1.2 a	1.1 a	1.7 abc
BW240 WP (*Trichoderma harziamum & T. virens)*	6 oz, then 3 oz		8.0 bc	2.7 bcd	1.9 ab	2.4 d	2.2 abc
CG100 20SC (caprylic acid)	9.6 fl oz	14	9.4 bc	2.8 bcdef	1.2 a	1.5 abcd	2.4 abc
Palladium (cyprodinil + fludioxonil)	6 oz	14	10.6 bcd	2.9 cdef	1.1 a	1.2 ab	1.4 ab
Phyton 27 (copper sulfate pentahydrate)	25 oz	14	9.7 bc	2.8 bcde	2.1 b	2.4 cd	2.9 c
Phyton 27 + X3	25 oz + 1:500	14	10.1 bcd	3.0 cdef	1.1 a	1.7 abcd	1.9 ab
SP-2169	12.3 fl oz	14	8.3 bc	2.8 bcdef	1.0 a	1.0 a	1.0 a
Tourney (metconazole)	1 oz	14	3.9 a	2.5 ab	1.2 a	1.2 abc	1.0 a
	2 oz	14	3.4 a	2.3 a	1.1 a	1.3 abcd	1.3 ab
Trinity (triticonazole)	6 fl oz	14	8.2 bc	2.9 cdef	1.1 a	1.3 abcd	1.6 abc
	8 fl oz	14	7.4 b	2.7 bcd	1.0 a	1.0 a	1.3 ab
X3 (hydrogen peroxide, peroxyacetic & octanoic acids)	1:500	14	8.2 bc	2.6 bc	1.3 a	1.5 abcd	2.1 abc
Untreated non-inoculated			11.5 cd	3.1 ef	1.0 a	1.0 a	1.0 a
Untreated inoculated			9.6 bc	2.9 cdef	1.6 ab	2.3 bcd	2.7 bc

[x] Means followed by the same letter do not differ significantly (P=0.05).Disease severity was recorded using the following scale: 1 – no disease, 2 – slight, 3 – moderate, 4 – severe to 5 – plant dead.

In 2012, Kirk conducted two field trials to determine the efficacy of several fungicides for control of stem based necrosis caused by *F. oxysporum* on corn flag (*Gladiolus sp.*). In the first trial, corms were dipped in the fungicide-water solutions for one minute a day before planting on June 26. The corms were not inoculated. In the second trial, plots were inoculated with a conidial/water suspension of *F.oxysporum* f.sp. *gladioli* before planting corms on June 27. All treatments were applied as foliar sprays twice on Jul 25 and Aug 15.In the first trial, Fusarium symptoms developed in the trial but did not greatly affect emergence, with the untreated check having 100% emergence 58 days after planting and generally no differences in emergence among treatments (Table 15). Acibenzolar, the lowest rate of Acibenzolar + Azoxystrobin and Disarm provided significant but poor reduction of stem based necrosis. However, overall data on Fusarium related symptoms showed no product providing consistently positive efficacy. The reduction in emergence, height and flowering rate may have been indicative of a physiological effect of the products applied. In the second trial, a check was planted in a non-inoculated area of the trial but more severe symptoms developed on these plants than on those in the inoculated area (Table 16). No treatments were significantly different from the untreated checks in terms of plant stand, % necrosis, plant height, lodging or flowering rate. In general, the plants from the foliar trial were visibly shorter than those in the corm dip trial.

Table 15. Efficacy on Stem Based Necrosis Caused By*Fusarium oxysporum* on Corn Flag (*Gladiolus sp.*) 'Sun-Kissed', Kirk, MI, 2012, Trial 1.

Treatment	Rate Per 100 Gal	Plant Stand (%)[x]				RAUEPC[v] 58 DAP	Fusarium Related Symptoms			
		21 DAP[u]	28 DAP	58 DAP	89 DAP		% Necrosis[w] 59 DAP	Plant Height (in) 59 DAP	% Lodging[y] 69 DAP	% Flowering[z] 89 DAP
3336 WP (thiophanate methyl)	16 oz	7.1 cd	67.9 a-d	96.4 ab	90.1 a-d	52.0 ab	28.6 abc	20.7 bc	28.6 def	50.0 c
Acibenzolar 50WG	0.125 oz	3.6 d	28.6 e	92.9 b	82.1 d	54.8 ab	17.9 c	19.5 c	57.1 abc	57.1 bc
	0.25 oz	35.7 ab	71.4 a-d	100.0 a	100.0 a	53.8 ab	21.4 bc	22.0 bc	50.0 a-e	60.7 abc
Acibenzolar + Heritage (azoxystrobin)	0.25 oz + 0.9 oz	10.7 bcd	78.6 abc	100.0 a	100.0 a	57.7 ab	28.6 abc	23.9 ab	60.7 ab	53.6 c
	0.125 oz + 0.45 oz	3.6 d	60.7 a-e	92.9 b	92.9 abc	46.0 b	10.7 c	23.3 bc	71.4 a	75.0 abc
	0.5 oz + 1.8 oz	21.4 a-d	82.1 ab	100.0 a	96.4 ab	63.0 ab	21.4 bc	22.4 bc	46.4 a-e	67.9 abc
BW240 WP (*Trichoderma harziamum & T. virens)*	80 oz	3.6 d	46.4 cde	100.0 a	92.9 abc	59.4 ab	21.4 bc	21.5 bc	35.7 b-f	85.7 a
CG100 20SC (caprylic acid)	38.4 fl oz	35.7 ab	89.3 a	96.4 ab	92.9 abc	59.1 ab	28.6 abc	21.8 bc	17.9 f	82.1 ab
Disarm (fluoxastrobin)	4 fl oz	32.1 abc	78.6 abc	100.0 a	92.9 abc	60.3 ab	14.3 c	23.9 ab	25.0 ef	64.3 abc
Medallion (fludioxonil)	8 oz	7.1 cd	75.0 abc	100.0 a	89.3 bcd	54.3 ab	32.1 abc	22.1 bc	53.6 a-d	75.0 abc
Palladium (cyprodinil + fludioxonil)	6 fl oz	10.7 bcd	50.0 b-e	96.4 ab	82.1 d	48.5 b	25.0 bc	21.6 bc	35.7 b-f	71.4 abc
SP-2169	12.3 fl oz	39.3 a	89.3 a	96.4 ab	100.0 a	61.4 ab	21.4 bc	22.1 bc	53.6 a-d	64.3 abc
Tourney (metconazole)	2 oz	7.1 cd	39.3 de	100.0 a	96.4 ab	54.7 ab	50.0 a	21.9 bc	60.7 ab	85.7 a
	4 oz	14.3 a-d	85.7 a	96.4 ab	85.7 cd	54.8 ab	32.1 abc	21.2 bc	32.1 c-f	50.0 c
Untreated	-	35.7 ab	85.7 a	100.0 a	96.4 ab	66.3 a	42.9 ab	28.1 a	42.9 b-f	53.6 c

[x] Means followed by the same letter do not differ significantly based on Fisher's LSD (P=0.05).
[w] Incidence of plants with visible stem base necrosis at least up to 0.5" above the soil line.
[y] Incidence of plants greater than 45° bending from the perpendicular.
[z] The percentage of plants with at least one inflorescence emerging from stem.
[u] Days after planting
[v]RAUDPC, relative area under the emergence progress curve.

Table 16. Efficacy on Stem Based Necrosis Caused by *Fusarium oxysporum* on Corn Flag (*Gladiolus sp.*) 'Sun-Kissed', Kirk, MI, 2012, Trial 2.

Treatment	Rate Per 100 Gal	Plant Stand (%)[x]		Fusarium Related Symptoms			
		58 DAP[v]	89 DAP	% Necrosis[w] 59 DAP	Plant Height (in) 59 DAP	% Lodging[y] 69 DAP	% Flowering[z] 89 DAP
3336 EC (thiophanate methyl)	16 fl oz	75.0 b	75.0 ab	21.4 a-d	14.0 abc	28.6 ab	39.3 a
Acibenzolar 50WG	0.50 oz	75.0 b	71.4 b	14.3 cd	14.3 abc	35.7 ab	21.4 ab
	0.75 oz	89.3 ab	75.0 ab	46.4 a	13.5 abc	50.0 a	21.4 ab
Acibenzolar + Heritage (azoxystrobin)	0.5 oz + 1.8 oz	82.1 ab	82.1 ab	42.9 ab	13.5 abc	39.3 ab	25.0 ab
	0.75 oz + 2.7 oz	92.9 ab	89.3 ab	46.4 a	12.5 bc	35.7 ab	21.4 ab
BW240 WP (*Trichoderma harziamum & T. virens)*	8 oz	89.3 ab	85.7 ab	32.1 a-d	15.2 abc	46.4 ab	14.3 b
CG100 20SC (caprylic acid)	38.4 fl oz	96.4 a	82.1 ab	39.3 abc	13.6 abc	32.1 ab	32.1 ab
Disarm (fluoxastrobin)	4 fl oz	92.9 ab	89.3 ab	7.1 d	14.0 abc	35.7 ab	28.6 ab
Medallion (fludioxonil)	4 oz	85.7 ab	75.0 ab	17.9 bcd	16.7 ab	35.7 ab	21.4 ab
Palladium (cyprodinil + fludioxonil)	6 fl oz	96.4 a	92.9 ab	25.0 a-d	11.9 c	28.6 ab	17.9 ab
SP-2169	12.3 fl oz	96.4 a	96.4 a	25.0 a-d	17.0 a	25.0 b	35.7 ab
Tourney (metconazole)	1 oz	89.3 ab	89.3 ab	35.7 abc	13.4 abc	25.0 b	14.3 b
	2 oz	85.7 ab	82.1 ab	7.1 d	14.2 abc	35.7 ab	21.4 ab
Trinity (triticonazole)	8 fl oz	96.4 a	92.9 ab	35.7 abc	14.1 abc	39.3 ab	39.3 a
	12 fl oz	85.7 ab	82.1 ab	25.0 a-d	17.6 a	25.0 b	25.0 ab
Untreated non-inoculated	-	96.4 a	78.6 ab	39.3 abc	14.0 abc	32.1 ab	21.4 ab
Untreated inoculated	-	89.3 ab	82.1 ab	17.9 bcd	14.4 abc	25.0 b	25.0 ab

[x] Means followed by the same letter do not differ significantly based on Fisher's LSD (P=0.05).
[w] Incidence of plants with visible stem base necrosis at least up to 0.5" above the soil line.
[y] Incidence of plants greater than 45° bending from the perpendicular.
[z] The percentage of plants with at least one inflorescence emerging from stem.
[v]Days after planting

In 2013, Kirk conducted another two field trials to determine the efficacy of several fungicides for control of stem based necrosis caused by *F. oxysporum* on corn flag. In the first trial, corms were dipped in the fungicide-water solutions for one minute 2 days before planting on Jun 5. The corms were not inoculated. In the second trial, plots were inoculated with a conidial/water suspension of *F.oxysporum* f.sp. *gladioli* before planting corms on Jun 27. All treatments were applied as foliar sprays twice on Jul 3 and Jul 24. In the first trial, Fusarium symptoms developed but did not greatly affect emergence, with the untreated check having 87% emergence 16 days after planting and generally no differences in emergence among treatments (Table 17). Acibenzolar and Acibenzolar + Azoxystrobin were the only treatments that provided significant reduction of stem based necrosis, with Acibenzolar at the higher rate providing the best control. All treatments had significantly greater flowering rate than the untreated check. The reduction in emergence, height and flowering rate may have been indicative of a physiological effect of the products applied. In the second trial, plant stand and % necrosis from all treatments were generally not significantly different from the untreated checks (Table 18). Acibenzolar at the lower rate significantly reduced percent lodging compared to the inoculated check, but it was inferior to the non-inoculated check. For flowering rate, all treatments were not significantly different from the inoculated check and were inferior to the non-inoculated check.

Table 17. Efficacy on Stem Based Necrosis Caused By*Fusarium oxysporum* on Corn Flag(*Gladiolus sp.*) 'Sun-Kissed', Kirk, MI, 2013, Trial 1.

Treatment	Rate Per 100 Gal	Plant Stand (%)[x]				RAUEPC[v] 19 DAP	Fusarium Related Symptoms			
		14 DAP[u]	16 DAP	19 DAP	72 DAP		% Necrosis[w] 72 DAP	Plant Height (in) 72 DAP	% Lodging[y] 69 DAP	% Flowering[z] 89 DAP
3336 WP (thiophanate methyl)	16 oz	79.0 a	83.3 a	87.5 a	87.5 a	49.3 ab	66.8 abc	51.5 a	23.4 cd	66.5 ab
Acibenzolar 50WG	0.125 oz	75.0 ab	83.5 a	100.0 a	100.0 a	48.2 ab	15.8 d-g	50.6 a	17.0 de	62.8 ab
	0.25 oz	66.5 a-d	83.3 a	100.0 a	95.8 a	44.5 a-d	1.1 g	51.0 a	17.7 de	66.8 ab
Acibenzolar 50WG + Heritage 50WG (azoxystrobin)	0.125 oz + 0.45 oz	45.8 b-e	62.8 a	95.8 a	95.8 a	32.7 b-e	17.4 d-g	52.1 a	17.7 de	65.8 ab
	0.25 oz + 0.9 oz	41.8 cde	62.5 a	91.5 a	87.3 a	30.6 cde	10.4 efg	50.7 a	32.7 bcd	59.3 ab
	0.5 oz + 1.8 oz	71.0 abc	79.0 a	91.5 a	87.3 a	45.4 abc	4.9 fg	52.6 a	49.9 ab	58.5 ab
Disarm 480SC (fluoxastrobin)	4 fl oz	70.8 abc	83.3 a	87.3 a	87.3 a	45.6 abc	69.8 ab	51.3 a	27.6 bcd	60.0 ab
Heritage 50WG (azoxystrobin)	0.9 oz	58.5 a-e	71.0 a	87.3 a	87.3 a	38.7 a-e	54.1 bcd	53.3 a	6.4 e	46.8 b
Medallion 50WDG (fludioxonil)	8 oz	58.3 a-e	62.3 a	87.3 a	83.0 a	37.7 a-e	37.7 b-f	52.0 a	24.4 bcd	47.5 b
Palladium WDG (cyprodinil + fludioxonil)	4 oz	79.0 a	83.3 a	87.3 a	83.0 a	49.3 ab	61.4 abc	50.8 a	19.7 de	48.3 b
	6 oz	58.3 a-e	75.3 a	83.3 a	79.0 a	38.9 a-e	26.6 c-g	53.0 a	15.8 de	59.3 ab
Rootshield PlusWP (*Trichoderma harziamum & T. virens)*	8 oz	83.3 a	87.5 a	75.0 a	75.0 a	50.9 a	94.0 a	51.7 a	22.4 cd	65.0 ab
SP2550 10SC	32 fl oz	37.5 de	54.0 a	87.5 a	83.3 a	27.5 de	76.5 ab	52.3 a	16.6 de	54.5 b
Torque 3SC (tebuconazole)	10 fl oz	29.3 e	50.0 a	79.3 a	79.3 a	22.9 e	37.1 b-f	51.5 a	44.7 abc	62.5 ab
Tourney 50WG (metconazole)	2 oz	66.5 a-d	79.3 a	91.5 a	87.3 a	43.6 a-d	43.6 b-e	51.5 a	28.2 bcd	77.5 a
	4 oz	37.5 de	79.0 a	87.5 a	83.3 a	30.3 cde	49.7 bcd	51.3 a	24.2 bcd	59.5 ab
Untreated	-	71.0 abc	87.3 a	83.3 a	75.0 a	45.8 abc	65.6 abc	30.0 b	72.0 a	9.3 c

[x]Means followed by the same letter do not differ significantly based on Fisher's LSD (P=0.05).
[w] Incidence of plants with visible stem base necrosis at least up to 0.5" above the soil line.
[y] Incidence of plants greater than 45° bending from the perpendicular.
[z] The percentage of plants with at least one inflorescence emerging from stem.
[u] Days after planting
[v]RAUDPC, relative area under the emergence progress curve.

Table 18. Efficacy on Stem Based Necrosis Caused by *Fusarium oxysporum* on Corn Flag (*Gladiolus sp.*) 'Sun-Kissed', Kirk, MI, 2013, Trial 2.

Treatment	Rate Per 100 Gal	Plant Stand (%)[x]		Fusarium Related Symptoms		
		58 DAP[v]	70 DAP	% Necrosis[w] 70 DAP	% Lodging[y] 70 DAP	% Flowering[z] 70 DAP
3336 WP (thiophanate methyl)	16 oz	83.3 a	71.0 abc	78.8 a	93.8 ab	5.0 b
Acibenzolar 50WG	0.50 oz	54.0 a	41.5 e	66.8 a	81.3 b	4.3 b
	0.75 oz	70.8 a	58.5 b-e	64.3 a	100.0 a	0.0 b
Acibenzolar 50WG + Heritage 50WG (azoxystrobin)	0.5 oz + 1.8 oz	58.3 a	54.3 cde	87.5 a	100.0 a	0.0 b
	0.75 oz + 2.7 oz	79.3 a	54.3 cde	65.0 a	100.0 a	0.0 b
Disarm 480SC (fluoxastrobin)	4 fl oz	83.0 a	71.0 abc	65.0 a	100.0 a	0.0 b
Heritage 50WG (azoxystrobin)	2.7 oz	62.5 a	58.5 b-e	67.0 a	93.8 ab	5.0 b
Medallion 50WDG (fludioxonil)	4 oz	71.0 a	58.5 b-e	81.3 a	100.0 a	0.0 b
Palladium WDG (cyprodinil + fludioxonil)	4 oz	71.0 a	66.8 a-d	89.5 a	91.8 ab	8.3 b
	6 oz	91.5 a	83.0 a	49.3 a	100.0 a	0.0 b
Rootshield PlusWP (*Trichoderma harziamum & T. virens)*	54 oz	66.8 a	58.5 b-e	68.0 a	100.0 a	5.0 b
SP2550 20SC	13.1 fl oz	75.0 a	41.5 e	73.8 a	100.0 a	0.0 b
Torque 3SC (tebuconazole)	10 fl oz	71.0 a	54.3 cde	70.8 a	100.0 a	0.0 b
Tourney 50WG (metconazole)	4.3 oz	83.3 a	74.8 ab	60.0 a	100.0 a	0.0 b
	8.6 oz	54.0 a	50.0 de	76.3 a	100.0 a	0.0 b
Trinity 200SC (triticonazole)	8 fl oz	70.8 a	62.5 bcd	65.8 a	100.0a	0.0 b
	12 fl oz	87.3 a	71.0 abc	46.8 a	87.5 ab	9.3 b
Untreated non-inoculated	-	87.3 a	74.8 ab	29.3 a	51.8 c	52.5 a
Untreated inoculated	-	74.8 a	58.5 b-e	61.8 a	100.0 a	0.0 b

[x]Means followed by the same letter do not differ significantly based on Fisher's LSD (P=0.05).
[w] Incidence of plants with visible stem base necrosis at least up to 0.5" above the soil line.
[y] Incidence of plants greater than 45° bending from the perpendicular.
[z] The percentage of plants with at least one inflorescence emerging from stem.
[v]Days after planting

In 2014, Wick conducted a greenhouse trial to test the efficacy of several fungicides for control of Fusarium wilt (root and crown rot) caused by *F. oxysporum* f. sp. *basilici* on basil (*Ocimum basilicum*) 'Genovese'.Fungicides were applied as drench to the potted plants on Apr 4, and inoculum applied 3days later. Fungicide applications were repeated according to the schedule below (Table19). Disease severity was rated at the conclusion of experiment on May 23. Basil plants treated with 3336 were all healthy at the conclusion of the experiment, comparable to the non-inoculated check. Tourney at both rates, and Palladium and Trinity at the lower rates provided good control, Torque was poor, while Rootshield Plus and SP2550 were both ineffective at providing protection against Fusarium wilt.

Table19. Efficacy on Fusarium Wilt (*Fusarium oxysporum* f. sp. *basilici*) on Basil (*Ocimum basilicum*) 'Genovese', Wick, MA, 2014.

Treatment	Rate Per 100 Gal	Reapplication Interval (days)	Disease Severity[x]
3336 WP (thiophanate methyl)	16 oz	14	5 a
Palladium WDG (cyprodinil + fludioxonil)	4 oz	14	3.8 ab
	6 oz	21	3.5 abc
Rootshield PlusWP (*Trichoderma harziamum & T. virens)*	8 oz	1/2 rate at 28 d	1.3 d
SP 2550	32 fl oz	14	1.0 d
Torque 3SC (tebuconazole)	10 fl oz	-	2.7 bcd
Tourney 50WG (metconazole)	2 oz	-	3.7 ab
	4 oz	-	3.8 ab
Trinity (triticonazole)	8 fl oz	-	4 ab
	12 fl oz	-	2.0 bcd
Untreated non-inoculated	-	-	5 a
Untreated inoculated	-	-	1.5 cd

[x]Disease severity was rated as: 1=dead, 2=completely wilted, 3=partial wilt, 4=stunting without wilt, 5=apparently healthy. Means followed by same letter do not differ significantly based on Tukey's HSD ($P \leq 0.05$).

From 2007 to 2008, five greenhouse studies were conducted to determine efficacy of several fungicides for control of Fusarium wilt (*F. oxysporum* f. sp. *niveum*) on watermelon (*Citrullus lanatus*). Treatments were applied as soil drench 72 hr prior to soil drench inoculation with *F. oxysporum*. In two trials conducted by Egel in 2007, Topsin provided the best control of Fusarium wilt, with Actigard and Tachigaren at the higher rate less effective (Table 20). Cannonball and Tachigaren at the lower rate provided significant control in one of two trials. No phytotoxicity was observed from treatments except Actigard which reduced seedling growth. In a 2008 experiment by Egel, Topsin, V-10116, Proline and Tiadinil provided 100 % control of a severe Fusarium wilt pressure, similar to uninoculated control (Table 21). Quadris was essentially as effective as these products, Charter and Cabrio were less effective and Actigard and Cannonball virtually ineffective.No phytotoxicity was observed from any treatment in this trial.

Table 20. * Efficacy on Fusarium Wilt (*Fusarium oxysporum* f. sp. *niveum*) on Watermelon (*Citrullus lanatus*) 'Black Diamond', Egel, IN, 2007.

Treatment	Rate Per Acre[w]	Test 1 Feb 2007		Test 2 March 2007	
		AUDPC[x,y]	Plant Size (cm^2)[z] 3/12/07	AUDPC	Plant Size (cm^2) 4/6/07
Actigard 50WG (acibenzolar)	0.33 oz	220.90 c	118.8 c	140.42 c	350.4 c
Cannonball 50WP (fludioxonil)	0.5 lb	607.62 a	310.2 a	353.51 b	756.8 a
Tachigaren 30L (hymexazol)	3 ml/sq m	365.37 b	311.7 a	563.76 a	712.4 a
Tachigaren 30L(hymexazol)	6 ml/sq m	252.13 c	307.5 a	348.22 b	653.8 ab
Topsin 4.5FL (thiophanate methyl)	10 fl oz	15.35 d	213.1 b	0.00 d	637.3 ab
Untreated non-inoculated	-	0.00 d	237.2 ab	0.00 d	501.8 bc
Untreated inoculated	-	679.89 a	-	531.10 a	-

* Not an IR-4 Experiment: IR-4 Food Crops Website (online).

[x] Means followed by same letter do not differ significantly (P=0.05, LSD).

[w] Rate per acre was calculated on the assumption of 1,400 plants per acre.

[y] AUDPC = area under the disease incidence progress curve.

[z]The height and the maximum width of the leaves were measured in cm and the result multiplied to give an area.

Table 21. * Efficacy on Fusarium Wilt (*Fusarium oxysporum* f. sp. *niveum*) on Watermelon (*Citrullus lanatus*) 'Black Diamond', Egel, IN, 2008.

Treatment	Rate Per 100 Gal	AUDPC[x,y]	Incidence[z]
Actigard 50WG (acibenzolar)	0.75 oz	32 b	0.74 ab
Cabrio EG (pyraclostrobin)	16 oz	91 b	0.25 de
Cannonball 50WP (fludioxonil)	16 oz	659 a	0.66 bc
Charter 25FS (triticonazole)	76.7 fl oz	45 b	0.16 de
Proline 480SC (prothioconazole)	5.7 fl oz	0 b	0 e
Quadris 2.08SC (azoxystrobin)	15.4 fl oz	6 b	0.08 e
Tiadinil (tiadinil)	51.1 fl oz	0 b	0 e
Topsin 4.5FL (thiophanate methyl)	10 fl oz	0 b	0 e
V-10116 (metconazole)	8 oz	0 b	0 e
Untreated non-inoculated	-	0 b	0 e
Untreated inoculated	-	646 a	1.00 a

* Not an IR-4 Experiment: IR-4 Food Crops Website (online). Not all products tested included in table.
[x] Means followed by same letter do not differ significantly (P=0.01, LSD).
[y] AUDPC = area under the disease incidence progress curve.
[z] 1.00 = 100 % disease incidence.

In a greenhouse trial conducted by Langston in 2008, Actigard, V-10116, Quadris, Proline and Topsin significantly reduced a very high Fusarium wilt pressure (Table 22). Significant stunting and phytotoxicity were observed in all treatments except Proline, with V-10116 treatments showing the most severe phytotoxcity. These data indicate that Proline, Actigard, Quadris and Topsin may have potential in watermelon production as at-planting applications for suppressing losses to Fusarium wilt. A greenhouse study conducted by Everts in 2008 showed that Quadris, Actigard at either high and low rate, Topsin, Proline and Metconazole were highly effective in reducing a very high Fusarium wilt pressure (Table 23). No phytotoxicity was observed for all treatments except Actigard and Metconazole. Actigard caused necrotic lesions, leaf yellowing, and slow plant growth although the symptoms were less with the low rate. Metconazole caused stunted plants with dark green leaves.

Table 22. * Efficacy on Fusarium Wilt (*Fusarium oxysporum* f. sp. *niveum*) on Watermelon (*Citrullus lanatus*) 'Black Diamond', Langston, GA, 2008.

Treatment	Rate Per 100 Gal	Disease Severity[x,y] 5/12/08	AUDPC[z]
Actigard 50WG (acibenzolar)	0.75 oz	3.2 c	34.2 e
Cabrio 20EG (pyraclostrobin)	16 oz	9.7 a	100.3 a-d
Cannonball 50WP (fludioxonil)	16 oz	9.8 a	105.2 a-c
Proline 4SC (prothioconazole)	5.7 fl oz	5.9 b	50.3 e
Quadris 2.08SC (azoxystrobin)	15.4 fl oz	5.5 b	46.6 e
Tiadinil 30% SC (tiadinil)	51.1 fl oz	9.9 a	112.8 a
Topsin 4.5F (thiophanate methyl)	10 fl oz	8.5 a	79.5 d
Trinity 1.69SC (triticonazole)	9.5 fl oz	9.9 a	109.0 a-c
V-10116 50WG (metconazole)	4 oz	5.2 bc	40.8 e
Untreated inoculated	-	9.8 a	108.3 a-c

* Not an IR-4 Experiment: PDM Reports Vol 3: V155. Not all products tested included in table.
[x] Means followed by same letter do not differ significantly based on Fisher's Protected LSD (P=0.05).
[y] 0-10 scale where 0= no foliar wilt symptoms, 5.0=50% of the foliage wilted, and 10.0= a dead plant.
[z] AUDPC = area under the disease progress curve calculated from severity ratings taken on May 1, 5, 8, 12 and 15.

Table 23. * Efficacy on Fusarium Wilt (*Fusarium oxysporum* f. sp. *niveum*) on Watermelon (*Citrullus lanatus*) 'Sugar Baby', Everts, MD, 2008.

Treatment	Rate Per 100 Gal	Wilt Incidence (%)[x]	Final Wilt Severity	AUWSPC (%.days)[y]
Actigard 50WG (acibenzolar)	0.25 oz	8 bc	1 cd	6 e
Actigard	0.75 oz	0 c	0 d	0 e
Cabrio 20EG (pyraclostrobin)	16 oz	58 a	68 ab	635 cd
Cannonball 50WP (fludioxonil)	16 oz	75 a	62 ab	707 bcd
Metconazole 50WG (metconazole)	4 oz	17 b	6 cd	16 e
Proline 480SC (prothioconazole)	5.7 fl oz	17 b	2 cd	12 e
Quadris 2.08SC (azoxystrobin)	15.4 fl oz	0 c	0 d	0 e
Tiadinil 30% SC(tiadinil)	5.3 fl oz	100 a	67 ab	977 bc
Topsin 4.5FL (thiophanate methyl)	10 fl oz	17 b	1 cd	1 e
Trinity 1.69SC (triticonazole)	9.5 fl oz	83 a	49 b	438 d
Untreated inoculated	-	100 a	99 a	1510 a

* Not an IR-4 Experiment: PDM Reports Vol 3: V092. Not all products tested included in table.
[x] Means followed by same letter do not differ significantly based on Fisher's Protected LSD (P=0.05).
[y]AUWSPC = area under wilt severity progress curve.

Four field experiments were conducted from 2008 to 2009 to determine efficacy of several fungicides for control of natural populations of Fusarium wilt (*F. oxysporum* f. sp. *niveum*) on watermelon (*Citrullus lanatus*). Everts conducted two trials where treatments were drenched to the soil around each plant immediately after transplanting. In the first trial planted Jun 10, Actigard, Proline and Topsin significantly reduced wilt at 2½ weeks after transplanting (Table 24). The same 3 treatments that reduced wilt had the highest numerical vine length, although there were no significant differences among treatments. No phytotoxicity was observed for all treatments except Metconazole causing stunting and dark green leaves early in the season. In a second trial planted Jun 3, all treatments, except

Quadris, were effective in reducing wilt incidence at both 4 and 5 weeks after transplanting (Table 25). Watermelons treated with Actigard, Proline, Topsin and Quadris had longer vines than the untreated control. No phytotoxicity was observed for any treatment except Metconazole causing a significant reduction in growth of plants, and dark green leaves during the early growing season. In 2009, Everts determined the efficacy of Actigard, Proline and Topsin applied through drip irrigation immediately after transplanting on Jun 16, and again at 2 and 4 weeks after transplanting. Proline was the only product that significantly reduced a severe Fusarium wilt incidence where untreated plots had 78 % of plants with wilt symptoms by Aug 1. (Table 26). Plot vigor and yield were numerically highest in plots where Proline was applied alone or in combination with other fungicides, although not significantly higher than in some treatments. No phytotoxicity was observed in any treatment.

Table 24. * Efficacy on Fusarium Wilt (*Fusarium oxysporum* f. sp. *niveum*) on Watermelon (*Citrullus lanatus*) 'Sugar Baby', Everts, DE, 2008.

Treatment	Rate Per 100 Gal	Wilt Incidence (%)[x] at		Vine Length (in) 7/11/08	Plant Vigor (%) 7/22/08	Marketable Fruit	
		2 ½ wk	4 ½ wk			T/A	No./A
Actigard 50WG (acibenzolar)	0.25 oz	5 b	5	43	94	9.8	3449
Metconazole 50WG (metconazole)	4 oz	18 ab	15	30	76	7.0	2723
Proline 480SC (prothioconazole)	5.7 fl oz	5 b	10	44	92	7.5	3086
Quadris F (azoxystrobin)	15.4 fl oz	18 ab	20	33	72	6.6	2783
Topsin 4.5FL (thiophanate methyl)	10 fl oz	8 b	8	37	90	7.4	2602
Untreated	-	25 a	23	34	79	6.5	3086
P Values		0.0498	0.2893	0.0551	0.0516	0.4536	0.3631

* Not an IR-4 Experiment: PDM Reports Vol 3: V097. Not all products tested included in table.

[x] Means followed by same letter do not differ significantly based on Fisher's Protected LSD (P=0.05).

Table 25. * Efficacy on Fusarium Wilt (*Fusarium oxysporum* f. sp. *niveum*) on Watermelon (*Citrullus lanatus*) 'Sugar Baby', Everts, MD, 2008.

Treatment	Rate Per 100 Gal	Wilt Incidence (%)[x] at			AUWIPC (% days)[y]	Wilt Severity (%)[z]	Vine Length (in) 6/27/08	Marketable Fruit 7/29/08)	
		4 wk	5 wk	6 wk				T/A	No./A
Actigard 50WG (acibenzolar)	0.25 oz	0 b	2 b	25	734	61	72 ab	8.6	2133
Metconazole 50WG (metconazole)	4 oz	0 b	8 b	35	915	71	49 d	9.1	2042
Proline 480SC (prothioconazole)	5.7 fl oz	2 b	8 b	37	909	66	72 ab	8.7	2224
Quadris F (azoxystrobin)	15.4 fl oz	4 ab	15 ab	42	1057	60	70 ab	6.5	1679
Topsin 4.5FL (thiophanate methyl)	10 fl oz	2 b	6 b	33	875	63	73 a	8.5	2269
Untreated	-	8 a	29 a	58	1494	77	64 c	5.9	1588
P Values		0.0460	0.0212	0.2089	0.1267	0.2019	<0.0001	0.2956	0.4318

* Not an IR-4 Experiment: PDM Reports Vol 3: V093. Not all products tested included in table.

[x] Means followed by same letter do not differ significantly based on Fisher's Protected LSD (P=0.05).

[y] The area under wilt incidence progress curve (AUWIPC) was calculated from wilt incidence data made at 3 through 8 weeks after transplanting.

[z] Final wilt severity was rated at fruit harvest using the Horsfall-Barratt scale.

Table 26. * Efficacy on Fusarium Wilt (*Fusarium oxysporum* f. sp. *niveum*) on Watermelon (*Citrullus lanatus*) 'Sugar Baby', Everts, MD, 2009.

Treatment	Rate Per 100 Gal	Wilt Count Per Plot[x]		Plant Vigor (%) 8/7/09	Fruit Wt (Lb/Plot) 8/12/09
		7/17/09	8/1/09		
Actigard 50WG (acibenzolar)	0.25 oz	13 a	12.3 a	35.5 bcd	36.5 e
Actigard + Proline	0.25 oz + 5.7 fl oz	7.0 cd	8.5 b	38.0 bc	100.3 abc
Actigard + Topsin	0.25 oz + 10 fl oz	9.8 bc	12.3 a	26.0 cde	75.4 bcd
Proline 480SC (prothioconazole)	5.7 fl oz	5.0 d	6.3 b	45.0 b	105.7 a
Proline + Topsin	5.7 fl oz + 10 fl oz	7.3 cd	7.8 b	47.5 ab	102.8 ab
Topsin 4.5FL (thiophanate methyl)	10 fl oz	10.8 ab	14.0 a	19.0 e	73.4 cd
Untreated	-	10.0 abc	14.0 a	19.0 e	80.8 a-d

* Not an IR-4 Experiment: PDM Reports Vol 4: V065. Not all products tested included in table.
[x] Means followed by same letter do not differ significantly based on Fisher's Protected LSD (P=0.05).

In 2009, Engel conducted a field trial to determine efficacy of Actigard, Proline and Topsin applied through trickle irrigation. All products were equally effective against Fusarium wilt (Table 27). No phytotoxicity was observed in any treatment.

Table 27. * Efficacy on Fusarium Wilt (*Fusarium oxysporum* f. sp. *niveum*) on Watermelon (*Citrullus lanatus*) 'Imagination', Egel, IN, 2009.

Treatment[w]	Rate Per Acre	AUDPC[x,y]	Fruit Weight (Lb/A)[z]
Actigard 50WG (acibenzolar)	0.25 oz	257.4 c	32,125 a
Proline 480SC (prothioconazole)	5.7 fl oz	233.6 c	32,307 a
Topsin 4.5FL (thiophanate methyl)	10 fl oz	352.3 bc	31,581 a
Untreated Control	-	691.2 a	27,388 a

* Not an IR-4 Experiment: IR-4 Food Crops Website (online). Not all products tested included in table.
[w]Applied May 12, 26 and Jun 10.
[x] Means followed by same letter do not differ significantly (P=0.05,LSD).
[y]AUDPC = area under the disease incidence progress curve.
[z] Fruit was harvested Jul 20, 27, 3 and Aug 10.

In 2010, Langston conducted a field trial to determine efficacy of Actigard, Proline, Quadris, Topsin and V-10116 applied as drench at transplanting (4/7) followed by foliar spray 4 weeks later (5/5). All products significantly reduced Fusarium wilt incidence, with Actigard, Proline and V-10116 at the high rate providing superior control (Table 28). Significant phytotoxicity was observed with Actigard, Proline and V-10116, with V-10116 causing severe stunting. There was no difference in yields between treatments (data not shown).

Table 28. * Efficacy on Fusarium Wilt (*Fusarium oxysporum* f. sp. *niveum*) on Watermelon (*Citrullus lanatus*) 'Black Diamond', Langston, GA, 2010.

Treatment[w]	Rate[y]	Plant Vigor[z] 4/21	% Wilt Incidence[x]	
			4/21	5/10
Actigard 50WG (acibenzolar)	0.75 oz	7.3 b	0.0 b	11.2 cd
Proline 4SC (prothioconazole)	5.7 fl oz	6.3 c	0.0 b	5.7 d
Quadris 2.08SC (azoxystrobin)	15.4 fl oz	8.7 a	0.0 b	33.2 bc
Topsin 4.5F (thiophanate methyl)	10 fl oz	8.8 a	0.0 b	55.7 b
V-10116 50WG (metconazole)	1 oz	4.7 d	2.7 b	30.7 c
	2 oz	3.3 e	0.0 b	5.5 d
Untreated inoculated	-	8.7 a	33.3 a	94.3 a

* Not an IR-4 Experiment: PDM Reports Vol 5: V156. Not all products tested included in table.
[x] Means followed by same letter do not differ significantly based on Fisher's Protected LSD (P=0.05).
% wilt incidence was rated by counting the number of plants in each plant that showed signs of wilting and dividing that number by the total number of plants in each plot x100.
[w] Products were applied on 4/7 as transplant drench; 5/5 as foliar spray.
[y] Rates are in per 100 gal as transplant drench and per acre as foliar spray.
[z] Plant Vigor was rated on 1-10 scale where 1= a dead or dying plant, 5 = moderately stunted plant and 10 = a healthy non-stunted plant.

In 2011, Langston conducted 3 field trials to determine the efficacy of Actigard, Proline, Quadris, and Serenade. In the first 2 trials, plots were inoculated with *Fusarium* before transplanting, then products were applied as drench at transplanting. In the first trial, Quadris and Serenade provided poor and no control of a severe Fusarium wilt incidence, resulting in plant vigor and yield that were not different from inoculated check (Table 29).

Table 29. * Efficacy on Fusarium Wilt (*Fusarium oxysporum* f. sp. *niveum*) on Watermelon (*Citrullus lanatus*) 'Black Diamond', Langston, GA, 2011, Trial 1.

Treatment[w]	Rate Per 100 Gal	Plant Vigor[y] 4/1	% Wilt Incidence[x]		Yield (Lb/Plot)
			4/7	4/21	
Quadris 2.08SC (azoxystrobin)	15.4 fl oz	5.8 a	58.3 c	78.3 a	28.8 a
Serenade (*Bacillus subtilis*)	2 qt	6.7 a	95.0 a	96.7 a	10.8 a
	4 qt	6.7 a	96.7 a	95.0 a	3.5 a
Untreated inoculated	-	6.8 a	86.7 ab	95.0 a	14.5 a

* Not an IR-4 Experiment: PDM Reports Vol 6: V138. Not all products tested included in table.
[x] Means followed by same letter do not differ significantly based on Fisher's Protected LSD (P=0.05).
% wilt incidence was rated by counting the number of plants in each plant that showed signs of wilting and dividing that number by the total number of plants in each plot x100.
[w] Products applied as plant drenches at transplanting on 3/17.
[y] Plant Vigor was rated on 1-10 scale where 1= a dead or dying plant, 5 = moderately stunted plant and 10 = a healthy non-stunted plant.

In the second trial, all products significantly reduced a severe Fusarium wilt incidence, with Actigard at the high rate providing the best control (Table 30). All treatments had significantly higher stand counts but did not significantly increase yield. In the third trial, products were applied as incorporated spray applications a week before transplanting or drench applied at transplanting in a field that had a history of severe Fusarium wilt. The disease progressed rapidly and became severe before the watermelons reached maturity, and no harvestable fruit was produced in any plots. All treatments significantly reduced plant vigor when applied as drench but not when applied as soil incorporated treatments (Table 31). All of the drench treatments, and only the Proline soil incorporated treatment significantly reduced Fusarium wilt incidence. Only Proline and Actigard applied as drenches significantly reduced stand loss.

Table 30. * Efficacy on Fusarium Wilt (*Fusarium oxysporum* f. sp. *niveum*) on Watermelon (*Citrullus lanatus*) 'Black Diamond', Langston, GA, 2011, Trial 2.

Treatment[w]	Rate Per 100 Gal	Plant Vigor[y] 4/1	% Wilt Incidence[x]		Stand Count 4/27	Yield (Lb/Plot)
			4/7	4/21		
Actigard 50WG (acibenzolar)	0.25 oz	4.5 a	38.3 c	86.7 a-c	1.3 de	24.7 a
	0.50 oz	4.3 a	21.7 cd	63.3 b-e	4.2 ab	36.5 a
	0.75 oz	4.5 a	11.7 d	41.6 e	4.3 ab	37.2 a
Proline 4SC (prothioconazole)	3.0 fl oz	4.7 a	30.0 cd	70.0 b-d	4.0 ab	29.8 a
	5.7 fl oz	5.0 a	36.7 cd	55.0 de	3.7 ab	40.3 a
Quadris 2.08SC (azoxystrobin)	15.4 fl oz	5.0 a	36.7 cd	88.3 ab	1.8 cd	28.7 a
Untreated inoculated	-	5.3 a	100.0 a	100.0 a	0.0 e	0.0 a

* Not an IR-4 Experiment: PDM Reports Vol 6: V154. Not all products tested included in table.
[x] Means followed by same letter do not differ significantly based on Fisher's Protected LSD (P=0.05).
% wilt incidence was rated by counting the number of plants in each plant that showed signs of wilting and dividing that number by the total number of plants in each plot x100.
[w] Products applied as plant drenches at transplanting on 3/17.
[y] Plant Vigor was rated on 1-10 scale where 1= a dead or dying plant, 5 = moderately stunted plant and 10 = a healthy non-stunted plant.

Table 31. * Efficacy on Fusarium Wilt (*Fusarium oxysporum* f. sp. *niveum*) on Watermelon (*Citrullus lanatus*) 'Black Diamond', Langston, GA, 2011, Trial 3.

Treatment[w]	Rate[y]	Application Method	Plant Vigor[z] 3/28	% Wilt Incidence[x] 4/8	Stand Count
Actigard 50WG (acibenzolar)	0.50 oz	Drench	4.8 c	20.0 d	5.3 a
	0.25 oz	Incorp. spray	7.5 a	53.3 a-c	4.2 a-c
Proline 4SC (prothioconazole)	5.7 fl oz	Drench	6.0 b	33.3 cd	5.7 a
	5.7 fl oz	Incorp. spray	7.2 a	45.0 bc	4.7 ab
Quadris 2.08SC (azoxystrobin)	15.4 fl oz	Drench	5.8 bc	36.7 cd	4.5 ab
	15.4 fl oz	Incorp. spray	7.5 a	63.3 ab	2.7 c
Untreated inoculated	-		7.2 a	70.0 a	3.5 bc

* Not an IR-4 Experiment: PDM Reports Vol 6: V139. Not all products tested included in table.
[x] Means followed by same letter do not differ significantly based on Fisher's Protected LSD (P=0.05).
% wilt incidence was rated by counting the number of plants in each plant that showed signs of wilting and dividing that number by the total number of plants in each plot x100.
[w] Incorporated spray applications applied on 3/8 and drench applications applied after transplanting on 3/14.
[y] Rates were on per acre for incorporated spray applications and on per 100 gal for drench applications.
[z] Plant Vigor was rated on 1-10 scale where 1= a dead or dying plant, 5 = moderately stunted plant and 10 = a healthy non-stunted plant.

In 2013, Langston conducted 2 field trials to determine the efficacy of Actigard, Proline, Quadris, and Serenade. The first trial was a split plot design with the main plots either receiving or not receiving *Fusarium oxsysporum* f.sp. *niveum* race 1(FON1), and subplots were fungicide treatments. Plots that received FON1 were inoculated prior to transplanting on Mar 29. Drench fungicide treatments were applied after transplanting on Mar 29, and sprays applied in an 18-in band on Apr 15. Fusarium wilt incidence and stand loss were observed on May 28. Only inoculated plots treated with Proline drench or Proline drench followed by Proline banded spray had less Fusarium wilt incidence and less stand loss

than the untreated inoculated plots (Table 32). There was no difference in Fusarium wilt incidence or stand loss in the non-inoculated plots that received fungicides or Actigard.

The second trial was conducted in a field that had a history of Fusarium wilt. Drench fungicide treatments were applied after transplanting on Apr 11, and sprays applied in an 18-in band on Apr 11 or 25. On May 3, there was no difference in plant vigor between treated plots and the untreated check (Table 33). On May 16, only the plots treated with Proline drench followed by Proline banded spray or Actigard banded spray followed by Actigard banded spray had significantly less Fusarium wilt incidence than the untreated control; however, there was no difference in stand loss between treatments and the untreated plots. Watermelons were harvested twice, and there was no difference in yield between any of the treated plots and the untreated control. No phytotoxicity was observed from any treatment.

Table 32. * Efficacy on Fusarium Wilt (*Fusarium oxysporum* f. sp. *niveum*) on Watermelon (*Citrullus lanatus*) 'Black Diamond', Langston, GA, 2013, Trial 1.

Treatment	Rate[z]	Applic. Method, Timing[w]	% Wilt Incidence[x]		% Stand Loss[y]	
			Inoculated	Non-inoculated	Inoculated	Non-inoculated
Actigard 50WG (acibenzolar)	0.5 oz	Drench, 1	100.0 a	85.7 a	97.1 c	31.4 a
Actigard 50WG (acibenzolar)	0.5 oz	Drench, 1	95.7 a	67.1 a	97.1 c	10.0 a
	0.75 oz	Banded spray, 2				
Proline 4SC (prothioconazole)	3 fl oz	Drench, 1	67.1 b	71.4 a	67.1 b	18.8 a
Proline 4SC (prothioconazole)	3 fl oz	Drench, 1	71.4 b	57.1 a	45.7 a	25.7 a
	5.7 fl oz	Banded spray, 2				
Quadris 2.08SC (azoxystrobin)	15.4 fl oz	Drench, 1	95.7 a	74.2 a	92.8 c	35.7 a
Quadris 2.08SC (azoxystrobin)	15.4 fl oz	Drench, 1	92.9 a	74.2 a	90.0 c	18.6 a
	15.4 fl oz	Banded spray, 2				
Untreated	-	-	97.1 a	74.2 a	95.7 c	24.3 a

* Not an IR-4 Experiment: PDM Reports Vol 8: V298.

[x] Means followed by same letter do not differ significantly based on Fisher's Protected LSD (P=0.05).
% wilt incidence was rated by counting the number of plants in each plant that showed signs of wilting and dividing that number by the total number of plants in each plot x100.

[w] Application timings were:1= Mar 29, 2= Apr 15.

[y] Stand loss % was rated by counting the number of plants that were dead in each plot and dividing that number by the total number of plants in each plot x100.

[z] Rates are in per 100 gal as transplant drench and per acre as banded spray.

Table 33. * Efficacy on Fusarium Wilt (*Fusarium oxysporum* f. sp. *niveum*) on Watermelon (*Citrullus lanatus*) 'A&C 790', Langston, GA, 2013, Trial 2.

Treatment[w]	Rate[z]	Applic. Method, Timing[v]	Plant Vigor[y] 5/3	% Wilt Incidence[x] 5/16	% Stand Loss[w] 5/24	Yield
Actigard 50WG (acibenzolar)	0.5 oz	Banded spray, 1	8.0 a	51.4 bc	27.1 a	18.6 a
Actigard 50WG (acibenzolar)	0.5 oz	Banded spray, 1	7.6 a	42.9 cd	17.1 a	15.0 a
	0.75 oz	Banded spray, 2				
Proline 4SC (prothioconazole)	3 fl oz	Drench, 1	7.8 a	54.3 a-c	20.0 a	24.3 a
Proline 4SC (prothioconazole)	3 fl oz	Drench, 1	7.8 a	27.1 d	14.3 a	20.3 a
	5.7 fl oz	Banded spray, 2				
Quadris 2.08SC (azoxystrobin)	15.4 fl oz	Drench, 1	8.0 a	61.4 a-c	35.7 a	21.8 a
Quadris 2.08SC (azoxystrobin)	15.4 fl oz	Drench, 1	7.8 a	72.8 a	34.2 a	17.4 a
	15.4 fl oz	Banded spray, 2				
Untreated	-	-	8.0 a	65.7 ab	31.4 a	14.6 a

* Not an IR-4 Experiment: PDM Reports Vol 8: V300.

[x] Means followed by same letter do not differ significantly based on Fisher's Protected LSD (P=0.05).

% wilt incidence was rated by counting the number of plants in each plant that showed signs of wilting and dividing that number by the total number of plants in each plot x100.

[v]Application timings were:1= Apr 11, 2= Apr 25.

[w]Stand loss % was rated by counting the number of plants that were dead in each plot and dividing that number by the total number of plants in each plot x100.

[y] Plant Vigor was rated on 1-10 scale where 1= a dead or dying plant, 5 = moderately stunted plant and 10 = a healthy non-stunted plant.

[z] Rates are in per 100 gal as transplant drench and per acre as banded spray.

In 2015, Dufault conducted a field trial to determine the efficacy of several fungicides for the control of Fusarium wilt (*F. oxysporum* f. sp. *niveum*) on watermelon (*Citrullus lanatus*). Plants were inoculated at transplanting on Mar 24, and treatments applied as drench a week later. Disease incidence, severity, and and plant vigor were observed at various times during the season. Yield data were collected on Jun 2 and 9. Proline and Actigard provided the best control of a moderate disease pressure, resulting in increased yield (Table 34). No phytotoxicity was observed from any treatment.

Table 34. * Efficacy on Fusarium Wilt (*Fusarium oxysporum* f. sp. *niveum*) on Watermelon (*Citrullus lanatus*) 'Melody', Dufault, FL, 2015.

Treatment	Rate Per 100 Gal	% Incidence[x] 4/9	% Severity[y] 5/12	AUDPC[z]	% Plant Vigor[w] 4/28	Total Fruit		Marketable Fruit[v]	
						Lb/Plot	Lb/Fruit	Lb/Plot	Lb/Fruit
Actigard 50WG (acibenzolar)	0.25 oz	3 a	11 bc	341 bc	93 abc	302 a	15 a	268 ab	16 a
Proline 4SC (prothioconazole)	5.7 fl oz	10 a	7 c	187 c	100 a	328 a	15 a	307 a	16 ab
Quadris 2.08SC (azoxystrobin)	15.5 fl oz	30 a	19 ab	693 ab	77 cd	174 b	13 bc	144 c	14 c
Taegro Eco (*Bacillussubtilis* var. *amyloliquefaciens* Strain FZB24)	5.2 oz	23 a	16 ab	610 ab	87 bcd	258 ab	14 ab	236 abc	15 abc
Topsin 4.5 FL (thiophanate methyl)	10.0 fl oz	14 a	18 ab	524 abc	84 bcd	267 ab	14 ab	236 abc	16 ab
Untreated	-	27 a	32 a	889 a	75 d	194 b	12 c	158 c	4 c

* Not an IR-4 Experiment: PDM Reports Vol 10: V080. Not all products tested included in table.

[x] Means followed by same letter do not differ significantly based on Fisher's Protected LSD (P=0.05).

[y] Final wilt severity rated on 12 May as percentage of plot affected.

[z] AUDPC was calculated from wilt severity data made 2 - 7 weeks after transplanting.

[w] Plant vigor, percent of healthy foliage per plot, assessed on 28 Apr.

[v] Marketable fruit: fruit exceeding 10 lb harvested.

In 2016, Quesada conducted a field experiment to determine the efficacy of Adepidyn and Proline for management of Fusarium wilt on watermelon. The field was artificially infested with a spore suspension of two previously characterized *Fusarium oxysporum* f. sp. *niveum* (FON) race 1 isolates on before transplanting on May 11 and on May 18. The fungicide drench treatment was applied to the base of each plant on May 11, and foliar treatment applied on May 27. All treatments provided excellent control of a severe disease pressure, comparable to non-inoculated check (Table 35). For both products, yield was trending higher with the combination of drench + foliar treatment vs. drench treatment only.

Table 35. * Efficacy on Fusarium Wilt (*Fusarium oxysporum* f. sp. *niveum*) on Watermelon (*Citrullus lanatus*) 'Black Diamond', Quesada, NC, 2016.

Treatment	Rate Per Acre[z]	Applic. Method, Timing[w]	% Wilt Incidence[x]		Fruit Weight (kg)	Fruit Count
			Jul 5	Jul 14		
Adepidyn (pydiflumetofen)	10.3 fl oz	Drench	7.5 b	17.5 b	27.4 ab	9.3 ab
Adepidyn (pydiflumetofen)	13.7 fl oz	Drench	17.5 b	17.5 b	28.0 ab	9.5 ab
Adepidyn (pydiflumetofen)	10.3 fl oz	Drench	12.5 b	17.5 b	35.3 a	10.5 ab
	10.3 fl oz	Foliar				
Adepidyn (pydiflumetofen)	13.7 fl oz	Drench	5.0 b	15.0 b	37.2 a	11.0 ab
	13.7 fl oz	Foliar				
Proline (prothioconazole)	5.7 fl oz	Drench	15.0 b	15.0 b	10.6 bc	5.3 bc
Proline (prothioconazole)	5.7 fl oz	Drench	10.0 b	10.0 b	17.4 abc	6.5 abc
	5.7 fl oz	Foliar				
Non-treated Non-inoculated	-	-	0 b	0 b	36.9 a	13.0 a
Non-treated	-	-	95.0 a	95.0 a	0 c	0 c

* Not an IR-4 Experiment: PDM Reports Vol 11: V135.

[x] Means followed by same letter do not differ significantly based on Tukey's HSD (P=0.05).

[y] Drench treatments applied on May 11.

[z] Foliar spray treatments applied on May 27.

In 2017, Quesada conducted a field experiment to determine the efficacy of Adepidyn and Proline, combined with host resistance, for management of Fusarium wilt on watermelon. Three commercially available watermelon cultivars were used: 'Black Diamond' as a universally susceptible cultivar (diploid), 'Captivation' as an intermediately resistant cultivar (triploid), and 'SSX8585' as a highly resistant cultivar (diploid) to FON-1. Drench treatments were applied on Jul 27, two hours post-inoculation; foliar treatments were applied on Aug 10 and 24. Low levels of Fusarium wilt were first observed on Aug 11 in the 'Black Diamond' and 'Captivation' non-treated plots, and two of the treated plots. Disease progressed throughout the trial reaching over 75% incidence in the susceptible cultivars by Aug 31 (Table 36). The highly resistant cultivar 'SSX8585' consistently had lower Fusarium wilt incidence across all treatments and when no treatments were applied. Proline performed best when applied alone or as the initial drench followed by Adepidyn foliar sprays. The Proline drench plus Proline spray, and Proline drench plus Adepidyn spray treatments when combined with 'SSX8585' had the greatest reduction in Fusarium wilt incidence with 0% incidence observed by the end of the trial. Phytotoxicity was not observed.

Table 36. * Efficacy on Fusarium Wilt (*Fusarium oxysporum* f. sp. *niveum*) on Watermelon (*Citrullus lanatus*) , Quesada, NC, 2017.

Treatment and rate of product per acre	Disease incidence (%) [x]					
	11 Aug	14 Aug	18 Aug	25 Aug	31 Aug	8 Sep
Adepidyn (drench) 10.3 fl oz Adepidyn (spray) 10.3 fl oz Black Diamond	0.00 a	9.38 bc	46.88 ab	68.75 a	84.38 ab	90.63 ab
Adepidyn (drench) 10.3 fl oz Proline (spray) 5.7 fl oz Black Diamond	6.25 a	25.00 ab	46.88 ab	50.00 ab	60.71 bc	76.79 abc
Proline (drench) 5.7 fl oz Adepidyn (spray) 10.3 fl oz Black Diamond	0.00 a	3.13 c	15.63 cd	9.38 d	3.13 d	21.88 efg
Proline (drench) 5.7 fl oz Proline (spray) 5.7 fl oz Black Diamond	0.00 a	3.13 c	16.52 cd	21.88 cd	19.64 d	39.29 de
Untreated Black Diamond	12.50 a	34.38 a	43.75 ab	65.63 a	87.50 a	96.88 a
Adepidyn (drench) 10.3 fl oz Adepidyn (spray) 10.3 fl oz Captivation	0.00 a	3.13 c	31.25 bc	34.38 bc	46.88 c	53.13 cd
Adepidyn (drench) 10.3 fl oz Proline (spray) 5.7 fl oz Captivation	0.00 a	3.13 c	59.38 a	53.13 ab	59.38 bc	68.75 bc
Proline (drench) 5.7 fl oz Adepidyn (spray) 10.3 fl oz Captivation	3.57 a	3.13 c	28.13 bc	12.95 cd	12.95 d	28.58 def
Proline (drench) 5.7 fl oz Proline (spray) 5.7 fl oz Captivation	0.00 a	9.38 bc	34.38 bc	6.25 d	12.50 d	18.75 efg
Untreated Captivation	15.63 a	37.50 a	65.63 a	68.75 a	90.63 a	78.13 abc
Adepidyn (drench) 10.3 fl oz Adepidyn (spray) 10.3 fl oz SSX8585	0.00 a	0.00 c	0.00 d	0.00 d	3.13 d	3.13 fg
Adepidyn (drench) 10.3 fl oz Proline (spray) 5.7 fl oz SSX8585	0.00 a	0.00 c	12.50 cd	9.38 d	12.50 d	12.50 efg
Proline (drench) 5.7 fl oz Adepidyn (spray) 10.3 fl oz SSX8585	0.00 a	0.00 c	15.63 cd	0.00 d	0.00 d	0.00 g
Proline (drench) 5.7 fl oz Proline (spray) 5.7 fl oz SSX8585	0.00 a	0.00 c	0.00 d	0.00 d	0.00 d	0.00 g
Untreated SSX8585	0.00 a	3.13 c	28.13 bc	15.63 cd	18.75 d	3.13 fg

* Not an IR-4 Experiment: PDM Reports Vol 13: V150.

[x] Percent disease incidence was calculated for each treatment based on the percentage of diseased plants per plot. Means followed by the same letter within a column are not statistically different (P=0.05, Fisher's Protected LSD).

In 2017, Everts conducted a field trial to determine the efficacy of Miravis (pydiflumetofen) and Proline for the control of Fusarium wilt (*F. oxysporum* f. sp. *niveum*) on a susceptible variety ('Sugar Baby') and a resistant variety ('Crimson Sweet') of watermelon. Temperatures were high during the trial, and few plants had typical wilt symptoms. However infected plants exhibited stunting and yellowing symptoms and significant differences in growth occurred. Phytotoxicity was observed where Proline was applied through the drip at planting, and again as a band over the plastic on Jun 23. The longest vines in 'Crimson Sweet' occurred where plots were treated with Miravis in a 6 in band over the soil before the plastic was laid and again in a 6 in. band over the plastic on Jun 23; and where Miravis was applied through the drip just after transplanting and followed by a treatment of Proline through the drip on Jun 19 (Table 37). In the susceptible cultivar, 'Sugar Baby', the Miravis treatment through the drip on Jun 6 or 7 and again on Jun 19 resulted in the longest vines, which were significantly longer than the non-treated watermelons. There were no significant differences in yield between fungicide treatments and the non-treated control for both Crimson Sweet' and 'Sugar Baby'.

Table 37. * Efficacy on Fusarium Wilt (*Fusarium oxysporum* f. sp. *niveum*) on Watermelon (*Citrullus lanatus*), Everts, MD, 2017.

Treatment and rate/A (Application method and timing)[z]	'Crimson Sweet'			'Sugar Baby'		
	No plants Stunted Jun 26	Mean Vine length (in.) Jul 5	Yield lb/plot	No plants Stunted Jun 26	Mean Vine length (in.) Jul 5	Yield lb/plot
Miravis 8.55 fl oz (A, F)	20.7 bc[y]	54.4 a	110.2	50.0	34.7 ab	68.5
Miravis 8.55 fl oz (C) + Proline 5.70 fl oz (E)	26.0 bc	53.2 a	123.0	41.3	34.6 ab	78.2
Miravis 8.55 fl oz (B, D)	5.8 c	52.9 ab	99.6	46.8	36.1 ab	72.3
Miravis 8.55 fl oz (C, E)	12.0 bc	52.0 ab	107.5	37.2	43.4 a	59.1
Miravis 8.55 fl oz (C, F)	33.7 b	45.6 ab	107.0	70.5	34.0 ab	71.8
Proline 5.70 fl oz (C, F)	75.3 a	32.5 c	100.9	71.2	20.6 c	67.8
Non-treated control	26.0 bc	40.8 bc	107.8	58.2	33.3 b	68.3
P value[y]	0.0001	0.0115	0.8310	0.4518	0.0088	0.4956

* Not an IR-4 Experiment: PDM Reports Vol 12: V040.

[z] Application method and timing were: A = 6 in. band over soil on Jun 2 at 50 gpa; B = 3.4 fl oz (100 ml) poured at base of each plant on Jun 7; C = through drip on 6 and Jun 7; D = 3.4 fl oz poured at base of each plant on Jun 19; E = through drip on Jun 19; F = 6 in. directed spray over holes in plastic Jun 23 at 100 gpa.

[y] Numbers in each column with a letter in common are not significantly different from each other according to Fisher's protected LSD (*P* = 0.05).

[x] *P* values ≤ 0.05 indicate significant differences exist among treatments.

In 2018, Dutta conducted a field trial to determine the efficacy of pre-plant fumigant Pic-100 (which contains 99% chloropicrin) and post-plant fungicides (Proline, Miravis and Propulse) for the control of Fusarium wilt on watermelon. On Mar 27, Pic 100 was applied at a depth of 12 in. and subsequently the treated plots were covered with 30-in. black plastic mulch using Rain-flo plastic layer. A split-plot experimental design was adopted with 5 replications for each treatment. Fumigated plots served as a main effect whereas fungicide treated plots served as sub-effect. Watermelon was transplanted on Apr 17, and Proline, Miravis, or Propulse were applied through the drip-irrigation line on Apr 18, May 10 and May

23. Incidence of Fusarium wilt rating was taken at harvest maturity (Jun 13). All fungicides provided significant control, and combination with pre-plant fumigant significantly increased their efficacy (Table 38). Phytotoxicity was not observed with any of the treatments.

Table 38. * Efficacy on Fusarium Wilt (*Fusarium oxysporum* f. sp. *niveum*) on Watermelon (*Citrullus lanatus*) 'TriX-313', Dutta, GA, 2018.

Treatment and rate per acre	Application Dates [y]	Disease Incidence (%) [x]
Pic-100 (chloropicrin) 200 lb	1	17.2 c[w]
Proline (prothioconazole) 5.7 fl oz	2,3,4	40.0 b
Miravis (pydiflumetofen) 8.5 fl oz	2,3,4	48.5 b
Propulse (fluopyram + prothioconazole) 13.5 fl oz	2,3,4	40.0 b
Chloropicrin (Pic-100) 200 lb Proline 5.7 fl oz	1 2,3,4	8.5 d
Chloropicrin (Pic-100) 200 lb Miravis 8.5 fl oz	1 2,3,4	14.2 cd
Chloropicrin (Pic-100) 200 lb Propulse 13.5 fl oz	1 2,3,4	8.5 d
Untreated	-	68.5 a

* Not an IR-4 Experiment: PDM Reports Vol 13: V060.

[y] Application dates were: 1=Mar 27, 2=Apr 18, 3=May 10, and 4=May 23.

[x] Disease incidence was rated on a 0 to100 scale where 0=0% of plants affected in a plot and 100=100% of affected plants in a plot. Means followed by same letter do not differ significantly based on Fisher's Protected LSD (P=0.05).

In 2018, Quesada-Ocampo conducted a field experiment to determine the efficacy of Adepidyn and Proline for management of Fusarium wilt on watermelon. Transplants were inoculated on May 9 and May 16. Drench treatments were applied on May 9, two hours post-inoculation; foliar treatments were applied on May 24, Jun 7 and 21. Fusarium wilt progressed throughout the trial, reaching over 75% incidence in the non-treated plots 4 weeks after the first inoculation date. Ratings and fungicide spray treatments continued until Jun 21 to ensure a harvestable crop, but severity was found to stabilize within plots after Jun 11. Six out of eight fungicide programs, that included a drench treatment at transplant, performed better than programs lacking a drench treatment (

Table 39). Fungicide programs that used Proline as the initial drench, regardless of whether a spray treatment followed, provided the greatest reduction in the incidence of Fusarium wilt. The use of Proline only, as a drench, followed by two spray treatments resulted in the highest numerical total fruit count and numerical average fruit weight as well as numerical total fruit weight. Phytotoxicity was not observed. In the table, treatments are sorted by level of disease incidence on the last disease rating date shown: Jun 11.

Table 39. * Efficacy on Fusarium Wilt (*Fusarium oxysporum* f. sp. *niveum*) on Watermelon (*Citrullus lanatus*) 'Black Diamond', Quesada-Ocampo, NC, 2018.

Treatment and rate of product per acre	Spray Applic [y]	Disease incidence (%) [x]				Total Fruit Count	Total Fruit Wt (lb)	Ave Fruit Wt (lb)
		May 21	May 29	Jun 4	Jun 11	Jul 3	Jul 3	Jul 3
Proline (drench) 5.7 fl oz Proline (spray) 5.7 fl oz	1,2	0.00 b	6.25 c	6.25 d	6.25 c	8.5 a	87.81 a	10.03 a
Proline (drench) 10.3 fl oz	N/A	3.13 b	9.38 c	9.38 d	9.38 c	7.8 abc	57.98 abc	7.50 a
Proline (drench) 5.7 fl oz Adepidyn (spray) 10.3 fl oz	1,2	3.13 b	6.25 c	9.38 d	15.63 c	8.5 a	60.03 abc	7.17 a
Proline (drench) 5.7 fl oz Adepidyn (spray) 10.3 fl oz Proline (spray) 5.7 fl oz	1,3 2	3.13 b	12.50 bc	12.50 d	15.63 c	8.3 ab	63.56 ab	7.61a
Adepidyn (drench) 10.3 fl oz Proline (spray) 5.7 fl oz Adepidyn (spray) 10.3 fl oz	1,3 2	6.25 b	25.00 bc	40.63 c	68.75 b	5.3 cde	28.44 cd	5.62 a
Adepidyn (drench) 10.3 fl oz Adepidyn (spray) 10.3 fl oz	1,2	6.25 b	34.38 b	43.75 c	71.88 b	6.3 a-d	34.61 bcd	5.47 a
Adepidyn (drench) 10.3 fl oz Proline (spray) 5.7 fl oz	1,2	9.38 b	21.88 bc	53.13 bc	71.88 b	5.5 b-e	32.19 bcd	5.73 a
Adepidyn (drench) 10.3 fl oz		3.13 b	34.38 b	59.38 abc	71.88 b	4.8 de	18.41 d	3.42 a
Adepidyn (spray) 10.3 fl oz	1,2	16.53 ab	61.60 a	70.98 ab	74.10 ab	2.8 e	23.26 d	7.94 a
Untreated Check	N/A	6.25 b	65.63 a	78.13 a	81.25 ab	3.0 e	28.40 cd	7.67 a
Proline (spray) 5.7 fl oz	1,2	34.38 a	65.63 a	78.13 a	87.50 a	2.8 e	15.43 d	6.46 a

* Not an IR-4 Experiment: PDM Reports Vol 13: V056.

[y] Spray applications were made on 14-day intervals: 1=May 24, 2=Jun 7, and 3=Jun 21.

[x] Percent disease incidence was calculated for each treatment based on the percentage of diseased plants per plot. Means followed by the same letter(s) within a column are not statistically different (P=0.05, Fisher's Protected LSD).

In 2018, Quesada conducted another field experiment similar to that in 2017, to determine the efficacy of Adepidyn and Proline, combined with host resistance, for management of Fusarium wilt on watermelon. Transplants were inoculated on May 9 and 16. Drench treatments were applied on May 9, two hours post-inoculation; foliar treatments were applied on May 24 and Jun 7. Disease progressed throughout the trial reaching up to 74.10 % incidence in non-treated, susceptible cultivars, 4 weeks after transplant (the first inoculation date). The highly resistant cultivar 'SSX8585' consistently had lower Fusarium wilt incidence across treatments. The fungicide Proline performed best when applied alone or as the initial drench followed by Adepidyn foliar sprays (Table 40). The Proline only and Proline drench, Adepidyn foliar spray treatments when combined with 'SSX8585' had the greatest reduction in Fusarium wilt incidence and resulted in the most total fruit and total fruit weight as well as the highest average fruit weight. Four treatments (one 'Captivation' treatment, two 'SSX8585' treatments, and the non-treated 'SSX8585') displayed less wilting than previously recorded on the Jun 11 rating, leading to an overall reduction in disease incidence, indicating that these programs could allow for some degree of plant recovery over time. Phytotoxicity was not observed.

Table 40. * Efficacy on Fusarium Wilt (*Fusarium oxysporum* f. sp. *niveum*) on Watermelon (*Citrullus lanatus*), Quesada-Ocampo, NC, 2018.

Treatment and rate of product per acre	Spray Applic [y]	Disease incidence (%) [x]				Total Fruit Count	Total Fruit Wt (lb)	Ave Fruit Wt (lb)
		May 21	May 29	Jun 4	Jun 11	Jul 3	Jul 3	Jul 3
Adepidyn (drench) 10.3 fl oz Adepidyn (spray) 10.3 fl oz Black Diamond	1,2	6.25 a	34.38 ab	62.50 ab	75.00 a	6.5 d	38.14 def	5.73bcd
Adepidyn (drench) 10.3 fl oz Proline (spray) 5.7 fl oz Black Diamond	1,2	0.00 a	9.38 cd	46.88 bc	58.03 a	7.0 cd	30.86 ef	4.63 d
Proline (drench) 5.7 fl oz Adepidyn (spray) 10.3 fl oz Black Diamond	1,2	0.00 a	0.00 d	0.00 e	0.00 d	8.5 abcd	51.32 cdef	6.06 bcd
Proline (drench) 5.7 fl oz Proline (spray) 5.7 fl oz Black Diamond	1,2	0.00 a	0.00 d	0.00 e	0.00 d	9.5 abc	65.32 cde	6.90 bcd
Untreated Black Diamond	N/A	9.38 a	56.25 a	71.88 a	74.10 a	3.0 e	23.10 f	8.71 b
Adepidyn (drench) 10.3 fl oz Adepidyn (spray) 10.3 fl oz Captivation	1,2	3.13 a	18.75 bcd	18.75 de	25.00 b	9.8 ab	68.12 cd	6.68 bcd
Adepidyn (drench) 10.3 fl oz Proline (spray) 5.7 fl oz Captivation	1,2	3.13 a	25.00 bc	50.00 abc	59.38 a	8.0 bcd	40.08 def	5.03 cd
Proline (drench) 5.7 fl oz Adepidyn (spray) 10.3 fl oz Captivation	1,2	0.00 a	9.38 cd	3.13 e	6.25 bcd	10.0 ab	82.89 c	8.49 b
Proline (drench) 5.7 fl oz Proline (spray) 5.7 fl oz Captivation	1,2	0.00 a	6.25 cd	6.25 de	3.13 cd	10.3 ab	81.75 c	7.94 bc
Untreated Captivation	N/A	12.50 a	56.25 a	59.38 ab	59.38 a	8.0 bcd	56.33 cdef	7.12 bcd
Adepidyn (drench) 10.3 fl oz Adepidyn (spray) 10.3 fl oz SSX8585	1,2	0.00 a	3.13 cd	3.13 e	0.00 d	10.8 a	145.39 ab	13.45 a
Adepidyn (drench) 10.3 fl oz Proline (spray) 5.7 fl oz SSX8585	1,2	0.00 a	0.00 d	0.00 e	3.13 cd	10.5 ab	146.38 ab	13.85 a
Proline (drench) 5.7 fl oz Adepidyn (spray) 10.3 fl oz SSX8585	1,2	0.00 a	3.13 cd	3.13 e	0.00 d	10.3 ab	157.63 a	15.50 a
Proline (drench) 5.7 fl oz Proline (spray) 5.7 fl oz SSX8585	1,2	0.00 a	0.00 d	0.00 e	0.00 d	9.8 ab	132.89 ab	13.51 a
Untreated SSX8585	N/A	12.50 a	25.00 bc	28.13 cd	21.88 bc	8.8 abcd	121.21b	14.22 a

* Not an IR-4 Experiment: PDM Reports Vol 13: V076.

[y] Spray applications were made on 14-day intervals: 1=May 24 and 2=Jun 7.

[x] Percent disease incidence was calculated for each treatment based on the percentage of wilting plants per plot. Means followed by the same letter within a column are not statistically different (P=0.05, Fisher's Protected LSD).

In 2018, Jefffers conducted a greenhouse experiment to determine the efficacy of several products for management of Fusarium root and crown rot on liriope (*Liriope muscari*). All fungicides were applied 5 days before inoculation; Astun, Orkestra and Terraguard applied a second time 14 days later, and Empress applied a second time 14 days later at 3 fl oz and 28 days later for the 6 fl oz rate. Fungicides were applied as a soil drench, foliar spray, or sprench — a combination of the foliar spray and drench. At 56 DAI, Picatina at 7 fl oz + Medallion at 2 oz provided the best disease management with all plants symptom-free (Table 41). The other 4 treatments containing Picatina (alone or in combination) and Astun at 17 fl oz provided statistically similar levels of disease management. Final disease incidences on plants receiving the other 7 treatments were similar to that on the non-treated, inoculated plants, but 4 of these treatments (Empress at 3 and 6 fl oz, Orkestra at 8 fl oz, and Astun at 13 fl oz) had AUDPC values that were significantly less than that for the untreated, inoculated control treatment. There was no significant difference in visual assessment of root health among the 15 treatments, but there were numerical differences among treatments for plant quality. The 5 Picatina treatments produced 8 or 10 out of 10 plants that were commercially acceptable, and Astun at 17 fl oz produced 7 such plants. The other seven treatments produced only two to six commercially acceptable plants. There was no evidence of phytotoxicity from any treatment.

Table 41. * Efficacy on Fusarium Root and Crown Rot (*Fusarium oxysporum*) on Liriope (*Liriope muscari*) 'Big Blue', Jeffers, SC, 2018.

Treatment	Rate Per 100 Gal	Applic. Method	Disease Incidence (%) [x]	AUDPC	Root Health	Plant Quality, (Range) [y]
Astun 400SC (isofetamid)	13 fl oz	Sprench	29 a-d	416 bc	62 a	6 (1-9)
	17 fl oz	Sprench	8 de	57 de	80 a	7 (4-9)
Empress 2.08SC (pyraclostrobin)	3 fl oz	Drench	26 bcd	208 cde	70 a	5 (2-9)
	6 fl oz	Drench	35 abc	361 bcd	64 a	5 (1-9)
Mural 45WG (azoxystrobin + benzovindiflupyr)	3 oz	Drench	53 a	584 ab	70 a	2 (2-9)
Orkestra 4.18SC (fluxapyroxad + pyraclostrobin)	8 fl oz	Sprench	29 a-d	309 b-d	73 a	6 (3-9)
	10 fl oz	Sprench	41 ab	641 ab	66 a	2 (2-8)
Picatina 1.67SC (pydiflumetofen)	7 fl oz	Drench	6 de	91 cde	68 a	8 (4-9)
	13.7 fl oz	Drench	11cde	168 cde	70 a	8 (2-9)
Picatina 1.67SC + Medallion 50WG (fludioxonil)	7 fl oz + 2 oz	Drench	0 e	0 e	70 a	10 (7-9)
	7 fl oz + 4 oz	Drench	8 de	73 cde	69 a	8 a (4-9)
	13.7 fl oz + 2 oz	Drench	11 cde	87 cde	70 a	8 a (4-9)
Terraguard 4SC (triflumizole)	6 fl oz	Drench	45 ab	637 ab	71 a	4 a (1-9)
Uninoculated control	-	-	0 e	0 e	78 a	10 (8-9)
Inoculated control	-	-	50 ab	775 a	62 a	3 (2-9)

* Not an IR-4 Experiment: PDM Reports Vol 13: OT001.

[x] Disease incidence was evaluated weekly up to 56 DAI (days after inoculation). Means followed by same letter do not differ significantly based on Fisher's protected LSD (P=0.05).

[y] Plant quality was assessed using a visual categorical rating scale, so data were not analyzed statistically; rating scale: 1 = dead, 6 = commercially acceptable, 9 = perfect. Values are: no. of plants out of 10 rated commercially acceptable or better and the range of plant quality rating scores for the 10 plants.

In 2019, Jefffers conducted a greenhouse experiment to determine the efficacy of several products for management of Fusarium root and crown rot on liriope. All fungicides were applied 6 days before inoculation;

Astun and Broadform were applied a second time 14 days later. Fungicides were applied as a soil drench or sprench — a combination of the foliar spray and drench. At 49 DAI, the 3 highest rates of A20259G and the highest rate of Broadform provided the best disease management (Table 42). Treatment with A20259G at 14 fl oz and 28 fl oz each produced 5 plants that were symptom-free, and treatment with A20259G at 21 fl oz and Broadform at 6 fl oz produced 3 and 2 plants without symptoms, respectively. Astun at 17 fl oz applied as a sprench produced a level of disease management that was statistically similar to the best treatments but also statistically similar to the nontreated, inoculated control treatment. Final disease incidences and AUDPC values on plants receiving the other 7 treatments were statistically similar to those on the nontreated, inoculated control plants. There were numerical differences among treatments for plant quality. Three A20259G treatments (14, 21, and 28 fl oz) produced six out of eight plants that were commercially acceptable. The other nine fungicide treatments produced three or less commercially acceptable plants. There was no evidence of phytotoxicity from any treatment.

Table 42. * Efficacy on Fusarium Root and Crown Rot (*Fusarium oxysporum*) on Liriope (*Liriope muscari*) 'Big Blue', Jeffers, SC, 2019.

Treatment	Rate Per 100 Gal/A	Applic. Method	Disease Incidence (%) [x] at DAI (days after inoculation)					AUDPC	Plant Quality, (Range) [y]
			21	28	35	42	49		
A20259G 200SC/Miravis Duo (pydiflumetofen + difenoconazole)	10 fl oz	Drench	0	0	6	29	51 bc	421 bcd	2 (2-9)
	14 fl oz	Drench	0	0	0	6	14 d	90 d	6 (2-9)
	21 fl oz	Drench	0	1	5	22	27 cd	288 cd	6 (1-9)
	28 fl oz	Drench	0	0	0	19	29 cd	237 cd	6 (2-9)
Astun 400SC (isofetamid)	17 fl oz	Drench	3	8	25	65	80 ab	988 ab	1 (1-8)
	17 fl oz	Sprench	0	3	6	25	48 bcd	404 bcd	2 (3-8)
Broadform 4.2 SC (fluopyram + trifloxystrobin)	2 fl oz	Sprench	0	5	19	63	90 a	928 ab	1 (1-6)
	4 fl oz	Sprench	3	4	26	61	80 ab	942 ab	0 (1-5)
	6 fl oz	Sprench	0	1	4	16	37 cd	271 cd	3 (2-9)
Cleary 3336 6F (thiophanate methyl)	16 fl oz	Drench	9	25	39	68	78 ab	1258 a	1 (1-8)
Mural 45WG (azoxystrobin + benzovindiflupyr)	2 oz	Drench	5	20	38	66	78 ab	1176 a	1 (1-9)
Orkestra 4.18SC (fluxapyroxad + pyraclostrobin)	8 fl oz	Drench	3	11	22	47	62 abc	798 abc	2 (1-8)
Uninoculated control	-	-							8 (7-9)
Inoculated control	-	-	<1	11	33	58	80 ab	990 ab	0 (1-3)

* Not an IR-4 Experiment: PDM Reports Vol 14: OT014.

[x] Disease incidence was evaluated weekly to 49 DAI. Non-inoculated control plants were not used in analyses of disease incidence data because plants had no disease symptoms. Means followed by same letter do not differ significantly based on Fisher's protected LSD (P=0.05).

[y] Plant quality was assessed using a visual categorical rating scale, so data were not analyzed statistically; rating scale: 1 = dead, 6 = commercially acceptable, 9 = perfect. Values are: no. of plants out of 8 rated commercially acceptable or better and the range of plant quality rating scores for the 8 plants.

In 2019, Meadows conducted 2 greenhouse experiments to determine the efficacy of several products (3336F, Astun, BAS 750, Broadform, Heritage, MBI 601, Mural, SP2700, Stargus, and Zio) for management of Fusarium wilt on chrysanthemum (*Chrysanthemum morifolium*). Two trials were conducted on the same plants to determine the efficacy of various chemical and biological formulations for control of Fusarium wilt on chrysanthemum. Plants were inoculated three times total, but disease did not occur. There were no significant differences between treatments for the change in plant height and width. None of the treatments caused phytotoxicity. Because of the lack of disease infection, no table is presented for the experiments in this report.

Comparative Efficacy on Fusarium solani

In 2001, McGovern conducted a trial to determine efficacy of several fungicides for control of Fusarium tuber rot (*F. solani*) on caladium (*Caladium* x *hortulanum*). Tubers were soaked overnight (~16 hr) at ambient temperature in each of the fungicides on May 16 2000, 3 days prior to planting. Tubers to be sprayed at planting with Hurricane initially were soaked overnight in water alone. Hurricane was applied at planting on May 19 2000 with a hand-powered hydraulic sprayer and an approximate volume of the diluted fungicide of 1500 gal/A. Plant emergence was significantly increased compared to the water control by preplant soak application of Spectro and Heritage and by Hurricane applied at planting (Table 43). Spectro significantly increased the number of marketable tubers per plot. Spectro, Heritage at 16 oz, or Hurricane applied as tuber soaks, and spray application of Hurricane at planting significantly increased total tuber weight per plot. Hurricane applied as a tuber soak or as a spray at planting was the only product that significantly reduced the severity of Fusarium tuber rot. No phytotoxicity was observed from any treatment.

Table 43. * Efficacy on Fusarium Tuber Rot (*Fusarium solani*) on Caladium (*Caladium x hortulanum*) 'Florida Cardinal', McGovern, FL, 2001.

Treatment[y]	Rate Per 100 Gal	% Emergence[x] 6/29/00	No Marketable Tubers 4/9/01	Tuber Weight (Lb/Plot) 4/9/01	Disease Severity[z] 3/27/01
3336 50WP (thiophanate methyl)	24 oz	67.7 ab	71.8 e	8.0 d	8.8 abcd
Compass 50WDG (trifloxystrobin)	4 oz	72.5 bc	78.2 bcde	8.8 bcd	7.5 bcd
Heritage 50WG (azoxystrobin)	4 oz	63.6 a	76.0 cde	8.8 bcd	10.6 a
Heritage	8 oz	77.7 cde	82.2 abcde	8.6 bcd	9.0 abc
Heritage	16 oz	74.2 bcd	90.6 ab	9.6 ab	9.3 abc
Hurricane 48WP (fludioxonil + mefenoxam)	1.5 oz	76.0 cd	87.5 abcd	10.1 a	6.3 d
Hurricane spray at planting	1.5 oz	85.7 f	83.4 abcde	9.7 ab	7.0 cd
Spectro 90WDG (chlorothalonil +thiophanate methyl)	24 oz	83.3 ef	92.6 a	9.8 ab	9.5 abc
Untreated	-	71.0 bc	77.8 bcde	8.2 cd	9.6 ab

* Not an IR-4 Experiment: F&N Tests Vol 57: OT05. Not all products tested included in table.

[x] Means followed by same letter do not differ significantly based on Fisher's Protected LSD.

[y] All fungicides were applied as tuber soaks unless otherwise indicated.

[z] Tuber rot severity was measured using a 1-5 rating scale where 1 = 0%, 2 = 1-10%, 3 = 11-25%, 4 = 26-50%, and 5 = 51-100% internal discoloration.

In 2011, Palmateer conducted a greenhouse trial to test the efficacy of several fungicides for control of stem rot caused by *F. solani* (isolate # 0110111067) on *Dracaena deremensis* (Table 45). Disease inoculation occurred after the first application, with the exception of Acibenzolar where inoculation occurred after the second application. Disease ratings were obtained weekly from 9/21 to 12/19, and plant marketability rating obtained with the help of a local grower on 12/19. Disease severity was moderate to severe throughout the trial. Disease levels for all fungicide treatments were statistically lower than the inoculated control. Though not statistically different from the other fungicide treatments, disease severity (stem rot) ratings for Heritage and 3336 were lowest and 100% of the canes treated with these products were in marketable condition. Also, disease severity from BW 240, CG100, Medallion, Palladium, and the higher rates of Tourney and Trinity were comparable to that from the non-inoculated check. No phytotoxicity was observed for any treatment.

Table 44. Efficacy on Stem Root Rot Caused by *Fusarium solani*on *Dracaena deremensis* 'Janet Craig', Palmateer FL, 2011.

Treatment	Rate Per 100 Gal	Application Method	Applic. Dates[y]	Applic. Interval	% Disease Severity[x]	Plant Marketability [z]
3336 F (thiophanate-methyl)	12 fl oz	Sprench	1, 4	21 Days	5 d	5
Acibenzolar-s-methyl	0.125	Drench	1, 4	21 Days	37 b	2
	0.25 oz	Drench	1, 4	21 Days	37 b	2
BW240 WP (*Trichoderma harziamum & T. virens)*	6 oz	Sprench	2, 4	14 Days	12 cd	4
CG100 (caprylic acid)	0.6 pints	Sprench	1, 3, 5, 6	14 Days	25 bc	3
Compass 50WDG (trifloxystrobin)	2 oz	Sprench	1, 3, 5, 6	14 Days	36 b	2
Heritage 50WG (azoxystrobin)	4 oz	Sprench	1, 5	28 Days	3 d	5
Medallion (fludioxonil)	2 oz	Sprench	1, 4	21 Days	23 bc	3
Palladium 62.5WG (cyprodinil+fludioxonil)	4 oz	Sprench	1, 3, 5, 6	14 Days	17 cd	4
Tourney 50 WDG (metconazole)	1 oz	Sprench	1, 3, 5, 6	14 Days	18 cd	4
	2 oz	Sprench	1, 3, 5, 6	14 Days	28 bc	3
Trinity 2 SC (triticonazole)	6 oz	Sprench	1, 3, 5, 6	14 Days	18 cd	4
	8 oz	Sprench	1, 3, 5, 6	14 Days	26 bc	3
Untreated non-inoculated	-	-	-	-	13 cd	4
Untreated inoculated	-	-	-	-	69 a	0

[x] Means followed by the same letter do not differ significantly based on based on Student Newman Keuls Test, (P=0.05).
[y] Dates: 1 = 9/1/11, 2 = 9/6/11, 3 = 9/15/11, 4 = 9/20/11, 5 = 9/29/11, 6 = 10/13/11.
[z] Rating of 0-5 where 0= not marketable, 5 = best marketability.

In 2002, Kirk conducted a field trial to determine efficacy of BAS 500, Bravo Zn, Gem and Quadris for control of root rot caused by *Fusarium solani* f. sp. *phaseoli* on snap bean (*Phaseolus vulgaris*). All plots were inoculated and in-furrow applications of fungicides were made over the seed at planting. No treatments were significantly different from each other as measured by root rot index at the first harvest (32 DAP) but at the second harvest (72 DAP) all treatments had a significantly lower root rot index value than the untreated control (Table 45). No treatments were significantly different from each other in plant emergence and marketable yield. No phytotoxicity was observed from any treatment.

Table 45. * Efficacy on Fusarium Root Rot (Fusarium solani f. sp. phaseoli) on Snap Bean (Phaseolus vulgaris) 'Hi-Style', Kirk, MI, 2002.

Treatment[y]	Rate Per 1000 ft	% Emergence[x]	Root Rot Index[y]		Marketable Yield (Lb/A)
			35 DAT	72 DAT	
BAS 500 2.09EC (pyraclostrobin)	0.77 pt	98.8 a	13.8 a	48.8 bcde	1104 a
Bravo ZN 6SC (chlorothalonil)	1.5 pt	96.3 a	21.3 a	55.0 bc	981 a
Gem 4EC (trifloxystrobin)	0.8 pt	96.3 a	16.9 a	52.5 bcde	1023 a
Quadris 2SC (azoxystrobin)	0.8 pt	98.8 a	16.9 a	51.3 bcde	1056 a
Untreated inoculated	-	96.9 a	30.0 a	78.8 a	1008 a

* Not an IR-4 Experiment: F&N Tests Vol 58: ST007. Not all products tested included in table.

[x] Means followed by same letter do not differ significantly based on Tukey Multiple Comparison (P = 0.05).

[y] Root rot index calculated by counting the number of roots from a sample of 10 plants falling onto class 0 = no visible root rot; 1 = 1 - 10% girdling of tap root; 2 = 11 - 20% girdling of tap root; 3 = 21 - 50% girdling of tap root; 4 = 51 - 100% girdling of tap root. The number in each class is multiplied by the class number and summed. The sum is multiplied by a constant to express as a percentage. Indices of 0 - 50 cover the range 0 - 20% girdling; 51 - 75 cover the range 21 - 50% girdling and > 75 cover the range 50 - 100% girdling

Comparative Efficacy on Fusarium sp.

In 2014, Buck conducted a greenhouse trial to determine efficacy of BAS 703 and Pageant for the control of Fusarium crown rot (*Fusarium* sp.) on hosta (*Hosta montana*) 'Areo-marginata'. Treatments were sprayed on a 14-day schedule on Aug 13 (two days prior to disease inoculation), Aug 27, Sep 10 and Sep 24. All fungicide treatments significantly reduced the number of symptomatic leaves on Sep 17, Sep 25 and Oct 9, with BAS 703 providing the best control (Table 46) by Oct 9. No phytotoxicity was observed from any treatment.

Table 46. * Efficacy on Fusarium Crown Rot (Fusarium sp.) on Hosta (Hosta montana) 'Areo-marginata', Buck, GA, 2014.

Treatment[y]	Rate Per 100 Gal	No. Symptomatic Leaves Per Plant[x]			
		9/5	9/17	9/25	10/9
BAS703 01F (fluxapyroxad + pyraclostrobin)	8 fl oz	0.4 a	1.9 b	2.0 b	2.7 b
	10 fl oz	0.0 a	0.8 b	0.8 b	1.5 bc
	13 fl oz	0.0 a	0.3 b	0.4 b	0.5 c
Pageant 38WG (pyraclostrobin + boscalid)	16 oz	0.4 a	1.2 b	1.8 b	3.2 b
Non-treated	-	1.0 a	5.2 a	6.6 a	7.5 a

* Not an IR-4 Experiment: PDM Reports Vol 9: OT010.

[x] Means followed by same letter do not differ significantly (Fisher's Protected LSD,*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 each product/pest species. Products were selected based on interest in these products for testing in the 2010 to 2013 Fusarium, and the 2018 Non-Oomycete Root and Crown Rot efficacy projects.

Acibenzolar. In greenhouse trials, Acibenzolar applied as drench provided good efficacy against Fusarium wilt (*F. oxysporum*) on lisianthus, promising efficacy against Fusarium root rot (*F. oxysporum*) on larkspur, and mediocre efficacy on stem root rot (*F. solani*) on *Dracaena deremensis*. When applied as corm dip on corn flag, Acibenzolar and Acibenzolar + Heritage provided poor and excellent efficacy against stem based necrosis (*F. oxysporum*) in 2 trials; in 2 other trials where products were applied as foliar sprays, results were inconclusive because % necrosis from all treatments were generally not significantly different from the untreated checks. On Douglas fir, drench or a combination of seed soak and drench applications provided no efficacy against damping-off and root rot (*F. commune).* Insimmo applied as soil incorporation provided virtually no and mediocre efficacy in single trials on Douglas fir; Actigard + Heritage provided poor efficacy on bulbous iris. Actigard applied as drench provided poor to excellent efficacy against *F. oxysporum* f. sp. *niveum* on watermelon in 5 greenhouse trials. In 6 of 7 field trials, Actigard provided good control when applied as drench to the soil immediately after transplanting, but variable control when applied through drip irrigation. In one trial where it was applied as drench 1 week after transplanting, poor control was obtained.

Azoxystrobin. Heritage applied as drench provided excellent efficacy against Fusarium crown and stem rot (*F. avenaceum*) on lisianthus, and on stem root rot (*F. solani*) on *Dracaena deremensis* in 2 greenhouse trials, but efficacy against severe Fusarium wilt (*F. oxysporum*) pressure was poor in 2 other trials. When applied as a corm dip or foliar spray on corn flag, it provided no efficacy against stem based necrosis (*F. oxysporum*) in a trial; in another trial where products were applied as foliar sprays, results were inconclusive because % necrosis from all treatments were generally not significantly different from the untreated checks. Trials on Douglas fir showed drench or soil incorporation providing no to mediocre efficacy against damping-off and root rot (*F. commune)*; mediocre efficacy was obtained with soil incorporation on bulbous iris. Used as a tuber soak, it did not significantly reduce disease severity of Fusarium tuber rot (*F. solani*) on caladium in one field trial. Quadris applied as drench provided good to excellent control of *F. oxysporum* f. sp. *niveum* on watermelon in three greenhouse trials; however, it provided no to poor control in 8 field trials.

Azoxystrobin + Benzovindiflupyr. Mural applied as drench provided no efficacy on *F. oxysporum* in a liriope greenhouse experiment.

Bacillus subtilis var. amyloliquefaciens Strain FZB24. In a watermelon field trial, Taegro Eco applied as drench 1 week after transplanting provided poor efficacy against*F. oxysporum* f. sp. *niveum*.

Caprylic Acid. In greenhouse trials, CG100 applied as drench provided promising efficacy against stem root rot (*F. solani*) on *Dracaena deremensis*, poor efficacy against Fusarium root rot (*F. oxysporum*) on larkspur and against Fusarium wilt (*F. oxysporum*) on lisianthus. It provided no efficacy against stem based necrosis (*F. oxysporum*) when applied as corm dip or foliar spray on corn flag.Similarly, it provided no to poor efficacy against damping-off and root rot (*F. commune*)was obtained on Douglas fir and bulbous iris when applied as drench or soil incorporation.

Cyprodinil+Fludioxonil. In greenhouse trials, Palladium applied as drench provided good efficacy against stem root rot (*F. solani*) on *Dracaena deremensis*, but mediocre efficacy against Fusarium wilt (*F. oxysporum*) on lisianthus. It provided no efficacy against stem based necrosis (*F. oxysporum*) when

applied as corm dip on corn flag in two trials; in two other trials where products were applied as foliar sprays, results were inconclusive because % necrosis from all treatments were generally not significantly different from the untreated checks. Similarly, it provided no efficacy against damping-off and root rot (*F. commune*) on Douglas fir and bulbous iris when applied as drench or soil incorporation. Results of a field trial for damping-off and root rot (*F. commune)* on Douglas fir showed no significant effect applied as a soil treatment due to very low level of disease inoculum.Applied as drench, it provided good efficacy against Fusarium wilt (*F. oxysporum* f. sp. *basilici*) in one basil greenhouse trial.

Fludioxonil. Medallion applied as drench provided excellent efficacy against severe Fusarium wilt (*F. oxysporum*) pressure on lisianthus in 2 greenhouse trials; however, it provided no efficacy against stem based necrosis (*F. oxysporum*) when applied as corm dip or foliar spray on corn flag in 2 trials; in 2 other trials where products were applied as foliar sprays, results were inconclusive because % necrosis from all treatments were generally not significantly different from the untreated checks. It also provided poor efficacy against Fusarium crown and stem rot (*F. avenaceum*) in a lisianthus trial. Promising efficacy on stem root rot (*F. solani*) was obtained in *Dracaena deremensis*. On larkspur, it provided good efficacy against Fusarium root rot (*F. oxysporum*), but no efficacy against damping-off and root rot (*F. commune*) on Douglas fir in 4 trials. In a Douglas fir trial, Medallion + Heritage applied as soil incorporation provided excellent efficacy against damping-off and root rot (*F. commune*). Cannonball applied as drench provided no to poor efficacy against *F. oxysporum* f. sp. *niveum* on watermelon in 5 greenhouse trials.

Fludioxonil+Mefenoxam. Hurricane applied as drench provided excellent efficacy against a severe Fusarium wilt (*F. oxysporum*) pressure on lisianthus in a greenhouse trial. In 3 trials, it provided good efficacy against Fusarium root rot (*F. oxysporum*) on larkspur, but no efficacy against damping-off and root rot (*F. commune*) on Douglas fir. When applied as a tuber soak or as a spray at planting, it significantly reduced the severity of Fusarium tuber rot rot (*F. solani*) on caladium in a field trial.

Fluopyram + Trifloxystrobin. Broadform applied as sprench provided poor efficacy on *F. oxysporum* in a liriope greenhouse experiment.

Fluxapyroxad + Pyraclostrobin. Orkestra applied as drench provided no significant efficacy on *F. oxysporum* in a liriope greenhouse experiment.

Fluoxastrobin. Disarm applied as a corm dip provided no and poor efficacy against stem based necrosis (*F. oxysporum*) on corn flag in 2 trials; in 2 other trials where it was applied as foliar spray, results were inconclusive because % necrosis from all treatments were generally not significantly different from the untreated checks.

Isofetamid. Astun applied as a sprench provided mediocre and poor efficacy on *F. oxysporum* in 2 liriope greenhouse experiments.

Metconazole. In greenhouse trials, Tourney applied as drench provided good to excellent efficacy against damping-off and root rot (*F. commune)* on Douglas fir; when applied as soil incorporation, it provided good efficacy on bulbous iris but no efficacy on Douglas fir. Results of 2 field trials applied as a soil treatment for damping-off and root rot (*Fusarium commune)* on Douglas fir showed fir showed no significant effect due to very low level of disease inoculum in 1 test, and mediocre efficacy in another test. It provided good efficacy against Fusarium wilt (*F. oxysporum*) on lisianthus, and against stem root rot (*F. solani*) on *Dracaena deremensis*, but poor efficacy against Fusarium root rot (*F. oxysporum*) on larkspur. Tourney provided no efficacy against stem based necrosis (*F. oxysporum*) when applied as corm dip on corn flag in 2 trials; in 2 other trials where products were applied as foliar sprays, results were inconclusive because % necrosis from all treatments were generally not significantly different from the untreated checks.V-10116 or Metconazole applied as drench provided good to excellent control of *F.*

oxysporum f. sp. *niveum* on watermelon in 3 greenhouse trials; however poor efficacy was observed in 2 field trials. Applied as drench, it provided good efficacy against Fusarium wilt (*F. oxysporum* f. sp. *basilici*) in one basil greenhouse trial.

Prothioconazole. Proline applied as drench provided good to excellent efficacy against *F. oxysporum* f. sp. *niveum* on watermelon in 3 greenhouse trials. It also provided good to excellent control in 14 field trials either applied as drench to the soil immediately after transplanting, drench + foliar or through drip irrigation. Good control was also obtained in one trial when it was applied as drench 1 week after transplanting.

Pydiflumetofen. Adepidyn or Miravis applied as drench, drench + foliar, or through drip irrigation provided excellent efficacy against *F. oxysporum* f. sp. *niveum* in 6 watermelon field trials.

***Pydiflumetofen + Difenoconazole*.** A20259G applied as drench, drench + foliar, or through drip irrigation

Pyraclostrobin. In a greenhouse trial, Insignia provided no to poor efficacy against damping-off and root rot (*F. commune)* on Douglas fir. Results of a field trial for damping-off and root rot (*F. commune)* on Douglas fir showed no significant effect of Empress applied as a soil treatment due to very low level of disease inoculum. Cabrio applied as drench provided good efficacy against *F. oxysporum* f. sp. *niveum* on watermelon in one trial but no efficacy in 2 other greenhouse trials. In a liriope trial, it provided mediocre efficacy on *F. oxysporum*. BAS 500 applied in-furrow significantly reduced Fusarium root rot caused by *F. solani* f. sp. *phaseoli* on snap bean in one field trial.

Pyraclostrobin + Boscalid. In a greenhouse trial, Pageant applied as drench provided mediocre efficacy against Fusarium root rot (*F. oxysporum*) on larkspur. It provided promising and good efficacy against damping-off and root rot (*F. commune)* applied as drench, and no efficacy as foliar, in 2 trials on Douglas fir. Results of a field trial for damping-off and root rot (*F. commune)* on Douglas fir showed no significant effect applied as a soil treatment due to very low level of disease inoculum. It provided mediocre efficacy on Fusarium crown rot (*Fusarium* sp.) when applied foliar on hosta in a greenhouse trial.

SP2169. In greenhouse trials, SP2169 applied as drench provided good efficacy against Fusarium wilt (*Fusarium oxysporum*) on lisianthus but no efficacy against stem based necrosis (*F. oxysporum*) when applied as corm dip or foliar spray on corn flag in 2 trials. Similarly, it provided no efficacy against damping-off and root rot (*F. commune)* on Douglas fir and bulbous iris when applied as drench or soil incorporation.

SP2550. Results of a field trial for damping-off and root rot (*F. commune)* on Douglas fir showed no significant effect applied as a soil treatment due to very low level of disease inoculum. When applied as a corm dip on corn flag, it provided no efficacy against stem based necrosis (*F. oxysporum*) in a trial; in another trial where products were applied as foliar sprays, results were inconclusive because % necrosis from all treatments were generally not significantly different from the untreated checks.Applied as drench, it provided poor efficacy against Fusarium wilt (*F. oxysporum* f. sp. *basilici*) in one basil greenhouse trial.

Thiamethoxam. In 2 greenhouse trials, Flagship 0.22G applied as soil incorporation provided good efficacy against damping-off and root rot (*F. commune)* on Douglas fir and bulbous iris; however, Flagship 25WG provided no efficacy. In the same trials, Flagship + Heritage generally provided slight improvement in efficacy compared to Flagship or Heritage alone.

Tebuconazole. In a greenhouse trial, Torque applied as drench provided excellent efficacy against damping-off and root rot (*F. commune)* on Douglas fir. However, Torque applied as soil incorporation in two other trials provided poor efficacy against damping-off and root rot on bulbous iris and no efficacy on Douglas fir. When applied as a corm dip on corn flag, it provided no efficacy against stem based necrosis (*F. oxysporum*) in a trial; in another trial where products were applied as foliar sprays, results were inconclusive because % necrosis from all treatments were generally not significantly different from the untreated checks. Applied as drench, it provided poor efficacy against Fusarium wilt (*F. oxysporum* f. sp. *basilici*) in one basil greenhouse trial.

Thiophanate methyl. In greenhouse trials, 3336 applied as drench provided excellent efficacy against stem root rot (*F. solani*) on *Dracaena deremensis*, and good efficacy against damping-off and root rot (*Fusarium commune)* on Douglas fir and against Fusarium root rot (*F. oxysporum*) on larkspur. Results of 2 field trials applied as a soil treatment for damping-off and root rot (*Fusarium commune)* on Douglas fir showed no significant effect due to very low level of disease inoculum in 1 test, and excellent efficacy in another test. It provided no efficacy against stem based necrosis (*F. oxysporum*) when applied as corm dip on corn flag in 2 trials; in 2 other trials where products were applied as foliar sprays, results were inconclusive because % necrosis from all treatments were generally not significantly different from the untreated checks. It provided poor efficacy against Fusarium crown and stem rot (*F. avenaceum*) and poor to mediocre efficacy against Fusarium wilt (*F. oxysporum*) on lisianthus in 3 greenhouse trials. Used as a tuber soak, it did not significantly reduce disease severity of Fusarium tuber rot (*F. solani*) on caladium in one field trial. Topsin applied as drench provided excellent efficacy against *Fusarium oxysporum* f. sp. *niveum* on watermelon in 4 of 5 greenhouse trials. In 4 field trials, it provided good control when applied as drench to the soil immediately after transplanting, but variable control when applied through drip irrigation. In another watermelon field trial, Topsin applied as drench 1 week after transplanting provided poor control. Applied as drench, it provided excellent efficacy against Fusarium wilt (*F. oxysporum* f. sp. *basilici*) in one basil greenhouse trial. In a liriope greenhouse trial, it provided no efficacy applied as drench.

Thyme Oil. Results of a field trial for damping-off and root rot (*Fusarium commune)* on Douglas fir showed no significant effect of Promax applied as a soil treatment due to very low level of disease inoculum.

Trichoderma harzianum & T. virens. In greenhouse trials, BW240 applied as drench or soil incorporation provided good efficacy against stem root rot (*F. solani*) on *Dracaena deremensis* and poor efficacy against Fusarium root rot (*F. oxysporum*) on larkspur. Results of 2 field trials applied as a soil treatment for damping-off and root rot (*Fusarium commune)* on Douglas fir showed no significant effect due to very low level of disease inoculum in 1 test, and excellent efficacy in another test. No efficacy was obtained against damping-off and root rot (*Fusarium commune)* on bulbous iris, and against Fusarium wilt (*F. oxysporum*) on lisianthus. Also it provided no efficacy against stem based necrosis (*F. oxysporum*) when applied as corm dip on corn flag in 2 trials; in 2 other trials where products were applied as foliar sprays, % necrosis from all treatments were generally not significantly different from the untreated checks. Applied as drench, it provided poor efficacyagainst Fusarium wilt (*F. oxysporum* f. sp. *basilici*) in one basil greenhouse trial.

Trifloxystrobin. In greenhouse trials, Compass applied as drench provided mediocre efficacy on stem root rot (*F. solani*) on *Dracaena deremensis*, no and promising activity against damping-off and root rot (*Fusarium commune*) on Douglas fir, and poor efficacy against a severe Fusarium wilt (*F. oxysporum*) pressure on lisianthus. Results of a field trial for damping-off and root rot (*Fusarium commune)* on Douglas fir showed no significant effect applied as a soil treatment due to very low level of disease inoculum. Used as a tuber soak, it did not significantly reduce disease severity of Fusarium tuber rot (*F. solani*) on caladium in one field trial. Gem applied in-furrow significantly reduced Fusarium root rot

caused by *Fusarium solani* f. sp. *phaseoli* on snap bean in one field trial.

Triflumizole. Terraguard applied as drench provided excellent efficacy against a severe Fusarium wilt (*F. oxysporum*) pressure on lisianthus in a greenhouse trial, but poor efficacy in 2 liriope trials.

Triticonazole. In greenhouse trials, Trinity applied as drench provided good efficacy against stem root rot (*F. solani*) on *Dracaena deremensis*, but no and promising efficacy against damping-off and root rot (*F. commune)* on Douglas fir. Results of 2 field trials applied as a soil treatment for damping-off and root rot (*Fusarium commune)* on Douglas fir showed no significant effect due to very low level of disease inoculum in 1 test, and excellent efficacy in another test. Efficacy was promising against Fusarium wilt (*F. oxysporum*) on lisianthus, but poor against Fusarium root rot (*F. oxysporum*) on larkspur in other trials. Trinity applied as soil incorporation provided good efficacy against damping-off and root rot (*F. commune*) on bulbous iris but no efficacy on Douglas fir. Results of two trials where products were applied as foliar sprays for stem based necrosis (*F. oxysporum*) on corn flag were inconclusive because % necrosis from all treatments were generally not significantly different from the untreated checks. This active ingredient applied as drench provided good control of *Fusarium oxysporum* f. sp. *niveum* on watermelon in one greenhouse trial but no control in 2 other trials. Applied as drench, it provided good efficacy against Fusarium wilt (*F. oxysporum* f. sp. *basilici*) in one basil greenhouse trial.

Phytotoxicity

No phytotoxicity was observed with the products listed above with the exception of acibenzolar (stunting, leaf yellowing), metconazole (stunting, dark green leaves) and prothioconazole (stunting) on watermelon in some trials. Significant stunting was also observed with metconazole on lisianthus and SP2169 on Douglas fir.

Table 47. Summary of product efficacy 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 6/30/2020 are included in the table below.

PR#	Product (Active Ingredients)	Target	Crop	Production Site	Researcher	State	Year	Application Type	Results
31280	3336 F (Thiophanate-methyl)	Fusarium commune (Fusarium commune)	Fir, Douglas (Pseudotsuga menziesii)	Seedbed	Chastagner	WA	2011	Drench	High disease pressure. Significantly increased healthy seedlings with 16 fl oz per 100 gal; comparable to non-inoculated Check.
31280	3336 F (Thiophanate-methyl)	Fusarium commune (Fusarium commune)	Fir, Douglas (Pseudotsuga menziesii)	Seedbed	Chastagner	WA	2013	Top Dress	Results inconclusive because of extremely low infection in both inoculated and non-inoculated checks.
31280	3336 F (Thiophanate-methyl)	Fusarium commune (Fusarium commune)	Fir, Douglas (Pseudotsuga menziesii)	Seedbed	Chastagner	WA	2015	Soil	Higher number of healthy seedlings 2 months postemergence but not different from untreated 5 months later with 16 fl oz per acre.
30475	3336 F (Thiophanate-methyl)	Fusarium oxysporum (Fusarium oxysporum)	Larkspur (Delphinium sp.)	Greenhouse	Kirk	MI	2010	Drench	Excellent control at 4 lb per 100 gal applied once; almost comparable to non-inoculated check; very minor, transient leaf phytotoxicity.
31661	3336 F (Thiophanate-methyl)	Fusarium oxysporum (Fusarium oxysporum)	Lisianthus (Lisianthus sp.) Eustoma grandiflora	Greenhouse	Chase	CA	2011	Drench	Some reduction of F. oxysporum severity with 16 oz per 100 gal.
32114	3336 F (Thiophanate-methyl)	Fusarium wilt of basil (Fusarium oxysporum f sp basilici)	Sweet Basil (Ocimum basilicum) 'Genovese'	Greenhouse	Wick	MA	2013	Drench	Excellent control of a severe disease pressure with 16 oz per 100 gal applied every 14 days; comparable to uninoculated check.
34189	3336 F (Thiophanate-methyl)	Fusarium wilt of chrysanthemum (Fusarium oxysporum f sp chrysanthemi)	Chrysanthemum, Garden (Chrysanthemum/Dendranthema sp.) 'Jasoda Orange'	Greenhouse	Meadows	NC	2019	Drench	Results inconclusive due to lack of disease; no phytotoxicity observed.
31380	3336 F (Thiophanate-methyl)	Fusarium solani (Fusarium solani)	Dracaena, Striped; Janet Craig Dracaena (Dracaena deremensis) 'Janet Craig'	Greenhouse	Palmateer (UF)	FL	2011	Sprench	Significantly reduced a moderate to severe disease severity with 12 oz per 100 gal applied twice; comparableto non-inoculated check.

31378	3336 F (Thiophanate-methyl)	Fusarium sp. (Fusarium sp.)	Gladiolus (Gladiolus sp.) 'Sun-Kissed'	Field In-Ground	Kirk	MI	2012	Bulb Dip	Did not significantly reduce stem base necrosis incidence with 16 fl oz per 100 gal.
31378	3336 F (Thiophanate-methyl)	Fusarium sp. (Fusarium sp.)	Gladiolus (Gladiolus sp.) 'Sun-Kissed'	Field In-Ground	Kirk	MI	2012	Foliar	Did not significantly reduce stem base necrosis incidence with 16 fl oz per 100 gal.
34182	Astun (isofetamid)	Fusarium wilt of chrysanthemum (Fusarium oxysporum f sp chrysanthemi)	Chrysanthemum, Garden (Chrysanthemum/Dendranthema sp.) 'Jasoda Orange'	Greenhouse	Meadows	NC	2019	Drench	Results inconclusive due to lack of disease; no phytotoxicity observed.
34183	BAS 750 02F (Mefentrifluconazole)	Fusarium wilt of chrysanthemum (Fusarium oxysporum f sp chrysanthemi)	Chrysanthemum, Garden (Chrysanthemum/Dendranthema sp.) 'Jasoda Orange'	Greenhouse	Meadows	NC	2019	Drench	Results inconclusive due to lack of disease; no phytotoxicity observed.
34184	Broadform SC500 (Fluopyram + Trifloxystrobin)	Fusarium wilt of chrysanthemum (Fusarium oxysporum f sp chrysanthemi)	Chrysanthemum, Garden (Chrysanthemum/Dendranthema sp.) 'Jasoda Orange'	Greenhouse	Meadows	NC	2019	Drench	Results inconclusive due to lack of disease; no phytotoxicity observed.
29747	CG100 (Caprylic acid)	Fusarium commune (Fusarium commune)	Fir, Douglas (Pseudotsuga menziesii)	Seedbed	Chastagner	WA	2010	Drench	Little reduction of high disease pressure with 0.6 pt pe 100 gal.
29747	CG100 (Caprylic acid)	Fusarium commune (Fusarium commune)	Fir, Douglas (Pseudotsuga menziesii)	Seedbed	Chastagner	WA	2011	Drench	High disease pressure. Significantly increased healthy seedlings with 0.6 pt per 100 gal; inferior to non-inoculated Check.
29747	CG100 (Caprylic acid)	Fusarium commune (Fusarium commune)	Fir, Douglas (Pseudotsuga menziesii)	Seedbed	Chastagner	WA	2012	Soil incorporation	Did not significantly increase number of healthy seedlings with 26 ml per 1000 sq ft.
30470	CG100 (Caprylic acid)	Fusarium oxysporum (Fusarium oxysporum)	Larkspur (Delphinium sp.)	Greenhouse	Kirk	MI	2010	Drench	Significantly reduced leaf and root necrosis at 0.8 pt per 100 gal applied once; inferior to Medallion; very minor, transient leaf phytotoxicity.
30193	CG100 (Caprylic acid)	Fusarium oxysporum (Fusarium oxysporum)	Lisianthus (Lisianthus sp.) Eustoma grandiflora	Greenhouse	Chase	CA	2011	Drench	Did not significantly reduce F. oxysporum severity with 0.6 pt per 100 gal applied every 14 days.
30246	CG100 (Caprylic acid)	Fusarium solani (Fusarium solani)	Dracaena, Striped; Janet Craig Dracaena (Dracaena deremensis) 'Janet Craig'	Greenhouse	Palmateer (UF)	FL	2011	Sprench	Some reduction with a moderate to severe disease severity with 0.8 pt per 100 gal applied 4 times; slightly inferior to non-inoculated check.

31371	CG100 (Caprylic acid)	Fusarium sp. (Fusarium sp.)	Gladiolus (Gladiolus sp.) 'Sun-Kissed'	Field In-Ground	Kirk	MI	2012	Bulb Dip	Did not significantly reduce stem base necrosis incidence with 38.4 fl oz per 100 gal.
31371	CG100 (Caprylic acid)	Fusarium sp. (Fusarium sp.)	Gladiolus (Gladiolus sp.) 'Sun-Kissed'	Field In-Ground	Kirk	MI	2012	Foliar	Did not significantly reduce stem base necrosis incidence with 38.4 fl oz per 100 gal.
31391	CG100 (Caprylic acid)	Fusarium sp. (Fusarium sp.)	Iris, Dutch (Iris x hollandica) 'Blue Diamond'	Field Container	Chastagner	WA	2012	Soil incorporation	No significant control with 26 ml per 1000 sq ft.
30000	Compass 0 50WDG (Trifloxystrobin)	Fusarium commune (Fusarium commune)	Fir, Douglas (Pseudotsuga menziesii)	Seedbed	Chastagner	WA	2010	Drench	Some control of a high disease pressure with 0.5 oz per 100 gal.
30000	Compass 0 50WDG (Trifloxystrobin)	Fusarium commune (Fusarium commune)	Fir, Douglas (Pseudotsuga menziesii)	Seedbed	Chastagner	WA	2011	Drench	High disease pressure. Some control with 0.5 oz per 100 gal.
30000	Compass 0 50WDG (Trifloxystrobin)	Fusarium commune (Fusarium commune)	Fir, Douglas (Pseudotsuga menziesii)	Seedbed	Chastagner	WA	2013	Top Dress	Results inconclusive because of extremely low infection in both inoculated and non-inoculated checks.
31382	Compass 0 50WDG (Trifloxystrobin)	Fusarium solani (Fusarium solani)	Dracaena, Striped; Janet Craig Dracaena (Dracaena deremensis) 'Janet Craig'	Greenhouse	Palmateer (UF)	FL	2011	Sprench	Some reduction with moderate to severe disease severity with 2 oz per 100 gal applied 4 times; inferior to non-inoculated check.
31377	Disarm 480SC (Fluoxastrobin)	Fusarium sp. (Fusarium sp.)	Gladiolus (Gladiolus sp.) 'Sun-Kissed'	Field In-Ground	Kirk	MI	2012	Bulb Dip	Significant, but mediocre, reduction of stem base necrosis incidence with 4 fl oz per 100 gal.
31377	Disarm 480SC (Fluoxastrobin)	Fusarium sp. (Fusarium sp.)	Gladiolus (Gladiolus sp.) 'Sun-Kissed'	Field In-Ground	Kirk	MI	2012	Foliar	Did not significantly reduce stem base necrosis incidence with 4 fl oz per 100 gal.
31377	Disarm 480SC (Fluoxastrobin)	Fusarium sp. (Fusarium sp.)	Gladiolus (Gladiolus sp.) 'Sun-Kissed'	Field In-Ground	Kirk	MI	2013	Corm Dip	Did not significantly reduce plant necrosis, but decreased lodging and increased plant height and flowering, with 4 fl oz per 100 gal.
31377	Disarm 480SC (Fluoxastrobin)	Fusarium sp. (Fusarium sp.)	Gladiolus (Gladiolus sp.) 'Sun-Kissed'	Field In-Ground	Kirk	MI	2013	Foliar	Did not reduce plant necrosis with 4 fl oz per 100 gal.
31613	Empress Intrinsic Brand Fungicide (Pyraclostrobin)	Fusarium commune (Fusarium commune)	Fir, Douglas (Pseudotsuga menziesii)	Seedbed	Chastagner	WA	2013	Top Dress	Results inconclusive because of extremely low infection in both inoculated and non-inoculated checks.
31384	Flagship 0.22G (Thiamethoxam)	Fusarium commune (Fusarium commune)	Fir, Douglas (Pseudotsuga menziesii)	Seedbed	Chastagner	WA	2012	Soil incorporation	Did not significantly increase number of healthy seedlings with 44 oz per 1000 sq ft.
31401	Flagship 0.22G (Thiamethoxam)	Fusarium sp. (Fusarium sp.)	Iris, Dutch (Iris x hollandica) 'Blue Diamond'	Field Container	Chastagner	WA	2012	Soil incorporation	Significantly increased total marketable and 18" tall flowers with 44 oz per 1000 sq ft.

31385	Flagship 25WG (Thiamethoxam)	Fusarium commune (Fusarium commune)	Fir, Douglas (Pseudotsuga menziesii)	Seedbed	Chastagner	WA	2012	Soil incorporation	Did not significantly increase number of healthy seedlings with 0.55 oz per 1000 sq ft.
29753	Heritage (Azoxystrobin)	Fusarium commune (Fusarium commune)	Fir, Douglas (Pseudotsuga menziesii)	Seedbed	Chastagner	WA	2010	Drench	Poor to some control of a high disease pressure with 1.8 and 4.0 oz per 100 gal.
29753	Heritage (Azoxystrobin)	Fusarium commune (Fusarium commune)	Fir, Douglas (Pseudotsuga menziesii)	Seedbed	Chastagner	WA	2011	Drench	High disease pressure. Did not significantly increase healthy seedlings with 1.8 oz per 100 gal.
29753	Heritage (Azoxystrobin)	Fusarium commune (Fusarium commune)	Fir, Douglas (Pseudotsuga menziesii)	Seedbed	Chastagner	WA	2012	Soil incorporation	Did not significantly increase number of healthy seedlings with 0.4 oz per 1000 sq ft.
29753	Heritage (Azoxystrobin)	Fusarium commune (Fusarium commune)	Fir, Douglas (Pseudotsuga menziesii)	Seedbed	Chastagner	WA	2015	Soil	Number of healthy seedlings with 4 oz per acre not significantly different from inoculated and non-inoculated checks.
34190	Heritage (Azoxystrobin)	Fusarium wilt of chrysanthemum (Fusarium oxysporum f sp chrysanthemi)	Chrysanthemum, Garden (Chrysanthemum/Dendranthema sp.) 'Jasoda Orange'	Greenhouse	Meadows	NC	2019	Drench	Results inconclusive due to lack of disease; no phytotoxicity observed.
31379	Heritage (Azoxystrobin)	Fusarium solani (Fusarium solani)	Dracaena, Striped; Janet Craig Dracaena (Dracaena deremensis) 'Janet Craig'	Greenhouse	Palmateer (UF)	FL	2011	Sprench	Significantly reduced a moderate to severe disease severity with 4 oz per 100 gal applied twice; comparable to non-inoculated check.
32055	Heritage (Azoxystrobin)	Fusarium sp. (Fusarium sp.)	Gladiolus (Gladiolus sp.) 'Sun-Kissed'	Field In-Ground	Kirk	MI	2013	Corm Dip	Significantly reduce plant necrosis, and increased plant height and flowering, with 1.8 oz per 100 gal.
32055	Heritage (Azoxystrobin)	Fusarium sp. (Fusarium sp.)	Gladiolus (Gladiolus sp.) 'Sun-Kissed'	Field In-Ground	Kirk	MI	2013	Foliar	Did not reduce plant necrosis with 2.7 oz per 100 gal.
31400	Heritage (Azoxystrobin)	Fusarium sp. (Fusarium sp.)	Iris, Dutch (Iris x hollandica) 'Blue Diamond'	Field Container	Chastagner	WA	2012	Soil incorporation	No significant control with 0.4 oz per 1000 sq ft.
30001	Hurricane (Fludioxonil + mefonaxam)	Fusarium commune (Fusarium commune)	Fir, Douglas (Pseudotsuga menziesii)	Seedbed	Chastagner	WA	2010	Drench	No control of a high disease pressure with 0.75 oz per 100 gal.
30001	Hurricane (Fludioxonil + mefonaxam)	Fusarium commune (Fusarium commune)	Fir, Douglas (Pseudotsuga menziesii)	Seedbed	Chastagner	WA	2011	Drench	High disease pressure. Did not significantly increase healthy seedlings with 0.75 oz per 100 gal.

30473	Hurricane (Fludioxonil + mefonaxam)	Fusarium oxysporum (Fusarium oxysporum)	Larkspur (Delphinium sp.)	Greenhouse	Kirk	MI	2010	Drench	Significantly reduced leaf and root necrosis at 12 oz per 100 gal applied once; comparable to Medallion; very minor, transient leaf phytotoxicity.
31281	Insignia SC Intrinsic Brand Fungicide (Pyraclostrobin)	Fusarium commune (Fusarium commune)	Fir, Douglas (Pseudotsuga menziesii)	Seedbed	Chastagner	WA	2011	Drench	High disease pressure. Significantly increased healthy seedlings with 6.1, but not with 3.1, fl oz per 100 gal; inferior to non-inoculated Check.
29745	Insimmo (Acibenzolar-S-methyl)	Fusarium commune (Fusarium commune)	Fir, Douglas (Pseudotsuga menziesii)	Seedbed	Chastagner	WA	2010	Drench	No control of a high disease pressure with 0.125 and 0.25 oz per 100 gal.
29745	Insimmo (Acibenzolar-S-methyl)	Fusarium commune (Fusarium commune)	Fir, Douglas (Pseudotsuga menziesii)	Seedbed	Chastagner	WA	2011	Seed soak and drench treatments.	High disease pressure. Did not increase healthy seedlings with 0.25 oz per 100 gal.
29745	Insimmo (Acibenzolar-S-methyl)	Fusarium commune (Fusarium commune)	Fir, Douglas (Pseudotsuga menziesii)	Seedbed	Chastagner	WA	2015	Soil	Number of healthy seedlings with 0.25 oz per acre not significantly different from inoculated and non-inoculated checks.
30468	Insimmo (Acibenzolar-S-methyl)	Fusarium oxysporum (Fusarium oxysporum)	Larkspur (Delphinium sp.)	Greenhouse	Kirk	MI	2010	Drench	Significantly reduced leaf and root necrosis at 0.25 oz per 100 gal applied once; inferior to Medallion; very minor, transient leaf phytotoxicity.
30191	Insimmo (Acibenzolar-S-methyl)	Fusarium oxysporum (Fusarium oxysporum)	Lisianthus (Lisianthus sp.) Eustoma grandiflora	Greenhouse	Chase	CA	2011	Drench	Significantly reduced F. oxysporum severity with 0.125 and 0.25 oz per 100 gal applied every 21 days; comparable to non-inoculated check.
30244	Insimmo (Acibenzolar-S-methyl)	Fusarium solani (Fusarium solani)	Dracaena, Striped; Janet Craig Dracaena (Dracaena deremensis) 'Janet Craig'	Greenhouse	Palmateer (UF)	FL	2011	Drench	Significantly reduced a moderate to severe disease severity with 0.125 and 0.25 oz per 100 gal applied twice; inferior to non-inoculated check.
31369	Insimmo (Acibenzolar-S-methyl)	Fusarium sp. (Fusarium sp.)	Gladiolus (Gladiolus sp.) 'Sun-Kissed'	Field In-Ground	Kirk	MI	2012	Bulb Dip	Poor reduction of stem base necrosis incidence with 0.125 and 0.25 oz per 100 gal.
31369	Insimmo (Acibenzolar-S-methyl)	Fusarium sp. (Fusarium sp.)	Gladiolus (Gladiolus sp.) 'Sun-Kissed'	Field In-Ground	Kirk	MI	2012	Foliar	Did not significantly reduce stem base necrosis incidence with 0.5 and 0.75 oz per 100 gal.

31369	Insimmo (Acibenzolar-S-methyl)	Fusarium sp. (Fusarium sp.)	Gladiolus (Gladiolus sp.) 'Sun-Kissed'	Field In-Ground	Kirk	MI	2013	Corm Dip	Significantly reduce plant necrosis and lodging, and increased plant height and flowering, with 0.125 and 0.25 oz per 100 gal; best treatment.
31369	Insimmo (Acibenzolar-S-methyl)	Fusarium sp. (Fusarium sp.)	Gladiolus (Gladiolus sp.) 'Sun-Kissed'	Field In-Ground	Kirk	MI	2013	Foliar	Did not reduce plant necrosis with 0.5 an 0.75 oz per 100 gal.
34185	MBI 601 (Muscodor albus)	Fusarium wilt of chrysanthemum (Fusarium oxysporum f sp chrysanthemi)	Chrysanthemum, Garden (Chrysanthemum/Dendranthema sp.) 'Jasoda Orange'	Greenhouse	Meadows	NC	2019	Soil Incorporation	Results inconclusive due to lack of disease; no phytotoxicity observed.
29755	Medallion (Fludioxonil)	Fusarium commune (Fusarium commune)	Fir, Douglas (Pseudotsuga menziesii)	Seedbed	Chastagner	WA	2010	Drench	No control of a high disease pressure with 2 oz per 100 gal.
29755	Medallion (Fludioxonil)	Fusarium commune (Fusarium commune)	Fir, Douglas (Pseudotsuga menziesii)	Seedbed	Chastagner	WA	2011	Drench	High disease pressure. Did not significantly increase healthy seedlings with 2 oz per 100 gal.
29755	Medallion (Fludioxonil)	Fusarium commune (Fusarium commune)	Fir, Douglas (Pseudotsuga menziesii)	Seedbed	Chastagner	WA	2015	Soil	Number of healthy seedlings with 4 oz per acre not significantly different from inoculated and non-inoculated checks.
30474	Medallion (Fludioxonil)	Fusarium oxysporum (Fusarium oxysporum)	Larkspur (Delphinium sp.)	Greenhouse	Kirk	MI	2010	Drench	Excellent control at 2 fl oz per 100 gal applied once; almost comparable to non-inoculated check; very minor, transient leaf phytotoxicity.
31381	Medallion (Fludioxonil)	Fusarium solani (Fusarium solani)	Dracaena, Striped; Janet Craig Dracaena (Dracaena deremensis) 'Janet Craig'	Greenhouse	Palmateer (UF)	FL	2011	Drench	Some reduction with a moderate to severe disease severity with 2 oz per 100 gal applied twice; inferior to non-inoculated check.
31376	Medallion (Fludioxonil)	Fusarium sp. (Fusarium sp.)	Gladiolus (Gladiolus sp.) 'Sun-Kissed'	Field In-Ground	Kirk	MI	2012	Bulb Dip	Did not significantly reduce stem base necrosis incidence with 8 oz per 100 gal.
31376	Medallion (Fludioxonil)	Fusarium sp. (Fusarium sp.)	Gladiolus (Gladiolus sp.) 'Sun-Kissed'	Field In-Ground	Kirk	MI	2012	Foliar	Did not significantly reduce stem base necrosis incidence with 4 oz per 100 gal.
31376	Medallion (Fludioxonil)	Fusarium sp. (Fusarium sp.)	Gladiolus (Gladiolus sp.) 'Sun-Kissed'	Field In-Ground	Kirk	MI	2013	Corm Dip	Significantly reduce plant necrosis and lodging, and increased plant height and flowering, with 8 oz per 100 gal.
31376	Medallion (Fludioxonil)	Fusarium sp. (Fusarium sp.)	Gladiolus (Gladiolus sp.) 'Sun-Kissed'	Field In-Ground	Kirk	MI	2013	Foliar	Did not reduce plant necrosis with 4 oz per 100 gal.

34294	Mural WDG (Azoxystrobin + benzovindiflupyr)	Fusarium wilt of chrysanthemum (Fusarium oxysporum f sp chrysanthemi)	Chrysanthemum, Garden (Chrysanthemum/Dendranthema sp.) 'Jasoda Orange'	Greenhouse	Meadows		2019	Drench	Results inconclusive due to lack of disease; no phytotoxicity observed.
29749	Pageant Intrinsic (Boscalid + Pyraclostrobin)	Fusarium commune (Fusarium commune)	Fir, Douglas (Pseudotsuga menziesii)	Seedbed	Chastagner	WA	2010	Drench	Good control of a high disease pressure with 12 oz per 100 gal.
29749	Pageant Intrinsic (Boscalid + Pyraclostrobin)	Fusarium commune (Fusarium commune)	Fir, Douglas (Pseudotsuga menziesii)	Seedbed	Chastagner	WA	2011	Drench	High disease pressure. Significantly increased healthy seedlings with 12 oz per 100 gal; comparable to non-inoculated Check.
29749	Pageant Intrinsic (Boscalid + Pyraclostrobin)	Fusarium commune (Fusarium commune)	Fir, Douglas (Pseudotsuga menziesii)	Seedbed	Chastagner	WA	2011	Foliar	High disease pressure. Comparable number of healthy seedlings to non-inoculated check with 12 oz per 100 gal.
29749	Pageant Intrinsic (Boscalid + Pyraclostrobin)	Fusarium commune (Fusarium commune)	Fir, Douglas (Pseudotsuga menziesii)	Seedbed	Chastagner	WA	2013	Top Dress	Results inconclusive because of extremely low infection in both inoculated and non-inoculated checks.
30476	Pageant Intrinsic (Boscalid + Pyraclostrobin)	Fusarium oxysporum (Fusarium oxysporum)	Larkspur (Delphinium sp.)	Greenhouse	Kirk	MI	2010	Drench	Significantly reduced leaf and root necrosis at 12 oz per 100 gal applied twice; inferior to Medallion; very minor, transient leaf phytotoxicity.
29750	Palladium (Cyprodinil + fludioxanil)	Fusarium commune (Fusarium commune)	Fir, Douglas (Pseudotsuga menziesii)	Seedbed	Chastagner	WA	2010	Drench	No control of a high disease pressure with 6 oz per 100 gal.
29750	Palladium (Cyprodinil + fludioxanil)	Fusarium commune (Fusarium commune)	Fir, Douglas (Pseudotsuga menziesii)	Seedbed	Chastagner	WA	2011	Drench	High disease pressure. Did not significantly increase healthy seedlings with 4 oz per 100 gal.
29750	Palladium (Cyprodinil + fludioxanil)	Fusarium commune (Fusarium commune)	Fir, Douglas (Pseudotsuga menziesii)	Seedbed	Chastagner	WA	2012	Soil incorporation	Did not increase number of healthy seedlings with 1 oz per 1000 sq ft.
29750	Palladium (Cyprodinil + fludioxanil)	Fusarium commune (Fusarium commune)	Fir, Douglas (Pseudotsuga menziesii)	Seedbed	Chastagner	WA	2013	Top Dress	Results inconclusive because of extremely low infection in both inoculated and non-inoculated checks.
30194	Palladium (Cyprodinil + fludioxanil)	Fusarium oxysporum (Fusarium oxysporum)	Lisianthus (Lisianthus sp.) Eustoma grandiflora	Greenhouse	Chase	CA	2011	Drench	Some reduction of F. oxysporum severity with 6 oz per 100 gal applied every 14 days.

32110	Palladium (Cyprodinil + fludioxanil)	Fusarium wilt of basil (Fusarium oxysporum f sp basilici)	Sweet Basil (Ocimum basilicum) 'Genovese'	Greenhouse	Wick	MA	2013	Drench	Good control of a severe disease pressure with 4 oz per 100 gal applied every 14 days, fair control with 6 oz every 21 days; inferior to uninoculated check.
30247	Palladium (Cyprodinil + fludioxanil)	Fusarium solani (Fusarium solani)	Dracaena, Striped; Janet Craig Dracaena (Dracaena deremensis) 'Janet Craig'	Greenhouse	Palmateer (UF)	FL	2011	Sprench	Significantly reduced a moderate to severe disease severity with 6 oz per 100 gal applied 4 times; comparable to non-inoculated check.
31372	Palladium (Cyprodinil + fludioxanil)	Fusarium sp. (Fusarium sp.)	Gladiolus (Gladiolus sp.) 'Sun-Kissed'	Field In-Ground	Kirk	MI	2012	Bulb Dip	Did not significantly reduce stem base necrosis incidence with 6 fl oz per 100 gal.
31372	Palladium (Cyprodinil + fludioxanil)	Fusarium sp. (Fusarium sp.)	Gladiolus (Gladiolus sp.) 'Sun-Kissed'	Field In-Ground	Kirk	MI	2012	Foliar	Did not significantly reduce stem base necrosis incidence with 6 fl oz per 100 gal.
31372	Palladium (Cyprodinil + fludioxanil)	Fusarium sp. (Fusarium sp.)	Gladiolus (Gladiolus sp.) 'Sun-Kissed'	Field In-Ground	Kirk	MI	2013	Corm Dip	Significantly reduced plant necrosis and lodging, and increased plant height and flowering, with 0.125 and 0.25 oz per 100 gal.
31372	Palladium (Cyprodinil + fludioxanil)	Fusarium sp. (Fusarium sp.)	Gladiolus (Gladiolus sp.) 'Sun-Kissed'	Field In-Ground	Kirk	MI	2013	Foliar	Did not reduce plant necrosis with 4 and 6 oz per 100 gal.
31392	Palladium (Cyprodinil + fludioxanil)	Fusarium sp. (Fusarium sp.)	Iris, Dutch (Iris x hollandica) 'Blue Diamond'	Field Container	Chastagner	WA	2012	Soil incorporation	No significant control with 1 oz per 1000 sq ft.
31595	Promax (Thyme Oil (3%))	Fusarium commune (Fusarium commune)	Fir, Douglas (Pseudotsuga menziesii)	Seedbed	Chastagner	WA	2013	Top Dress	Results inconclusive because of extremely low infection in both inoculated and non-inoculated checks.
29744	RootShield Plus WP (aka BW240) (Trichoderma harzianum T-22 + Trichoderma virens G-41)	Fusarium commune (Fusarium commune)	Fir, Douglas (Pseudotsuga menziesii)	Seedbed	Chastagner	WA	2010	Drench	No control of a high disease pressure with 8 oz per 100 gal.
29744	RootShield Plus WP (aka BW240) (Trichoderma harzianum T-22 + Trichoderma virens G-41)	Fusarium commune (Fusarium commune)	Fir, Douglas (Pseudotsuga menziesii)	Seedbed	Chastagner	WA	2011	Potting mix and seed treatments	High disease pressure. No control with 6 oz per 100 gal potting mix and seed treatments.

29744	RootShield Plus WP (aka BW240) (Trichoderma harzianum T-22 + Trichoderma virens G-41)	Fusarium commune (Fusarium commune)	Fir, Douglas (Pseudotsuga menziesii)	Seedbed	Chastagner	WA	2012	Soil incorporation	Did not significantly increase number of healthy seedlings with 10 per 1000 sq ft.
29744	RootShield Plus WP (aka BW240) (Trichoderma harzianum T-22 + Trichoderma virens G-41)	Fusarium commune (Fusarium commune)	Fir, Douglas (Pseudotsuga menziesii)	Seedbed	Chastagner	WA	2013	Top Dress	Results inconclusive because of extremely low infection in both inoculated and non-inoculated checks.
29744	RootShield Plus WP (aka BW240) (Trichoderma harzianum T-22 + Trichoderma virens G-41)	Fusarium commune (Fusarium commune)	Fir, Douglas (Pseudotsuga menziesii)	Seedbed	Chastagner	WA	2015	Soil	Higher number of healthy seedlings 2 months postemergence but not different from untreated 5 months later with 28 lb per acre.
30469	RootShield Plus WP (aka BW240) (Trichoderma harzianum T-22 + Trichoderma virens G-41)	Fusarium oxysporum (Fusarium oxysporum)	Larkspur (Delphinium sp.)	Greenhouse	Kirk	MI	2010	Root dip, Drench	Significantly reduced leaf and root necrosis at 6, then 3 oz per 100 gal; inferior to Medallion; very minor, transient leaf phytotoxicity.
30192	RootShield Plus WP (aka BW240) (Trichoderma harzianum T-22 + Trichoderma virens G-41)	Fusarium oxysporum (Fusarium oxysporum)	Lisianthus (Lisianthus sp.) Eustoma grandiflora	Greenhouse	Chase	CA	2011	Drench	Did not significantly reduce F. oxysporum severity with 6 oz, then 3 oz per 100 gal.
32109	RootShield Plus WP (aka BW240) (Trichoderma harzianum T-22 + Trichoderma virens G-41)	Fusarium wilt of basil (Fusarium oxysporum f sp basilici)	Sweet Basil (Ocimum basilicum) 'Genovese'	Greenhouse	Wick	MA	2013	Drench	No control of a severe disease pressure with 8 oz per 100 gal applied every 28 days.
30245	RootShield Plus WP (aka BW240) (Trichoderma harzianum T-22 + Trichoderma virens G-41)	Fusarium solani (Fusarium solani)	Dracaena, Striped; Janet Craig Dracaena (Dracaena deremensis) 'Janet Craig'	Greenhouse	Palmateer (UF)	FL	2011	Sprench	Significantly reduced a moderate to severe disease severity with 6 oz per 100 gal applied twice; comparable to non-inoculated check.

31370	RootShield Plus WP (aka BW240) (Trichoderma harzianum T-22 + Trichoderma virens G-41)	Fusarium sp. (Fusarium sp.)	Gladiolus (Gladiolus sp.) 'Sun-Kissed'	Field In-Ground	Kirk	MI	2012	Bulb Dip	Did not significantly reduce stem base necrosis incidence with 80 oz per 100 gal.
31370	RootShield Plus WP (aka BW240) (Trichoderma harzianum T-22 + Trichoderma virens G-41)	Fusarium sp. (Fusarium sp.)	Gladiolus (Gladiolus sp.) 'Sun-Kissed'	Field In-Ground	Kirk	MI	2012	Foliar	Did not significantly reduce stem base necrosis incidence with 8 oz per 100 gal.
31370	RootShield Plus WP (aka BW240) (Trichoderma harzianum T-22 + Trichoderma virens G-41)	Fusarium sp. (Fusarium sp.)	Gladiolus (Gladiolus sp.) 'Sun-Kissed'	Field In-Ground	Kirk	MI	2013	Corm Dip	Did not significantly reduce plant necrosis, but decreased lodging and increased plant height and flowering, with 8 oz per 100 gal.
31370	RootShield Plus WP (aka BW240) (Trichoderma harzianum T-22 + Trichoderma virens G-41)	Fusarium sp. (Fusarium sp.)	Gladiolus (Gladiolus sp.) 'Sun-Kissed'	Field In-Ground	Kirk	MI	2013	Foliar	Did not significantly reduce plant necrosis with 54 oz per 100 gal.
31390	RootShield Plus WP (aka BW240) (Trichoderma harzianum T-22 + Trichoderma virens G-41)	Fusarium sp. (Fusarium sp.)	Iris, Dutch (Iris x hollandica) 'Blue Diamond'	Field Container	Chastagner	WA	2012	Soil incorporation	No significant control with 10 oz per 1000 sq ft.
30222	SP2169 (SP2169)	Fusarium commune (Fusarium commune)	Fir, Douglas (Pseudotsuga menziesii)	Seedbed	Chastagner	WA	2011	Drench	High disease pressure. Did not significantly increase healthy seedlings with 12.3 oz per 100 gal; significant phhytotoxicity.
30222	SP2169 (SP2169)	Fusarium commune (Fusarium commune)	Fir, Douglas (Pseudotsuga menziesii)	Seedbed	Chastagner	WA	2012	Soil incorporation	Did not significantly increase number of healthy seedlings with 8.35 ml per 1000 sq ft.
30195	SP2169 (SP2169)	Fusarium oxysporum (Fusarium oxysporum)	Lisianthus (Lisianthus sp.) Eustoma grandiflora	Greenhouse	Chase	CA	2011	Drench	Significantly reduced F. oxysporum severity with 12.3 oz per 100 gal applied every 14 days; comparable to non-inoculated check.

31373	SP2169 (SP2169)	Fusarium sp. (Fusarium sp.)	Gladiolus (Gladiolus sp.) 'Sun-Kissed'	Field In-Ground	Kirk	MI	2012	Bulb Dip	Did not significantly reduce stem base necrosis incidence with 12.3 fl oz per 100 gal.
31373	SP2169 (SP2169)	Fusarium sp. (Fusarium sp.)	Gladiolus (Gladiolus sp.) 'Sun-Kissed'	Field In-Ground	Kirk	MI	2012	Foliar	Did not significantly reduce stem base necrosis incidence with 12.3 fl oz per 100 gal.
31393	SP2169 (SP2169)	Fusarium sp. (Fusarium sp.)	Iris, Dutch (Iris x hollandica) 'Blue Diamond'	Field Container	Chastagner	WA	2012	Soil incorporation	No significant control with 8.35 ml per 1000 sq ft.
31611	SP2550 (SP2550)	Fusarium commune (Fusarium commune)	Fir, Douglas (Pseudotsuga menziesii)	Seedbed	Chastagner	WA	2013	Top Dress	Results inconclusive because of extremely low infection in both inoculated and non-inoculated checks.
32111	SP2550 (SP2550)	Fusarium wilt of basil (Fusarium oxysporum f sp basilici)	Sweet Basil (Ocimum basilicum) 'Genovese'	Greenhouse	Wick	MA	2013	Drench	No control of a severe disease pressure with 32 fl oz per 100 gal applied every 14 days.
31612	SP2550 (SP2550)	Fusarium sp. (Fusarium sp.)	Gladiolus (Gladiolus sp.) 'Sun-Kissed'	Field In-Ground	Kirk	MI	2013	Corm Dip	Did not significantly reduce plant necrosis, but decreased lodging and increased plant height and flowering, with 32 fl oz per 100 gal.
31612	SP2550 (SP2550)	Fusarium sp. (Fusarium sp.)	Gladiolus (Gladiolus sp.) 'Sun-Kissed'	Field In-Ground	Kirk	MI	2013	Foliar	Did not reduce plant necrosis with 13.1 fl oz per 100 gal.
34186	SP2700 WP (SP2700)	Fusarium wilt of chrysanthemum (Fusarium oxysporum f sp chrysanthemi)	Chrysanthemum, Garden (Chrysanthemum/Dendranthema sp.) 'Jasoda Orange'	Greenhouse	Meadows	NC	2019	Drench	Results inconclusive due to lack of disease; no phytotoxicity observed.
34187	Stargus (Bacillus amyloliquefaciens strain F727)	Fusarium wilt of chrysanthemum (Fusarium oxysporum f sp chrysanthemi)	Chrysanthemum, Garden (Chrysanthemum/Dendranthema sp.) 'Jasoda Orange'	Greenhouse	Meadows	NC	2019	Drench	Results inconclusive due to lack of disease; no phytotoxicity observed.
32056	Tank Mix: 3336 50WP + Insimmo (Thiophanate-methyl + acibenzolar-S-methyl)	Fusarium sp. (Fusarium sp.)	Gladiolus (Gladiolus sp.) 'Sun-Kissed'	Field In-Ground	Kirk	MI	2013	Corm Dip	Did not reduce plant necrosis, but reduced lodging and increased plant height and flowering, with 16 + 0.25 oz per 100 gal.
32056	Tank Mix: 3336 50WP + Insimmo (Thiophanate-methyl + acibenzolar-S-methyl)	Fusarium sp. (Fusarium sp.)	Gladiolus (Gladiolus sp.) 'Sun-Kissed'	Field In-Ground	Kirk	MI	2013	Foliar	Did not reduce plant necrosis with 16 fl oz + 0.5 oz per 100 gal.

31383	Tank Mix: Acibenzolar + Heritage (Acibenzolar + Azoxystrobin)	Fusarium commune (Fusarium commune)	Fir, Douglas (Pseudotsuga menziesii)	Seedbed	Chastagner	WA	2012	Soil incorporation	Did not increase number of healthy seedlings with 0.08 g + 1 oz per 1000 sq ft.
31546	Tank Mix: Acibenzolar + Heritage (Acibenzolar + Azoxystrobin)	Fusarium sp. (Fusarium sp.)	Gladiolus (Gladiolus sp.) 'Sun-Kissed'	Field In-Ground	Kirk	MI	2012	Bulb Dip	Reduction of stem base necrosis incidence mediocre with 0.125 + 0.45, poor with 0.25 + 0.9 and 0.5 + 1.8, oz per 100 gal.
31546	Tank Mix: Acibenzolar + Heritage (Acibenzolar + Azoxystrobin)	Fusarium sp. (Fusarium sp.)	Gladiolus (Gladiolus sp.) 'Sun-Kissed'	Field In-Ground	Kirk	MI	2012	Foliar	Did not reduce stem base necrosis incidence with 0.5 + 1.8 and 0.75 + 2.7 oz per 100 gal.
31546	Tank Mix: Acibenzolar + Heritage (Acibenzolar + Azoxystrobin)	Fusarium sp. (Fusarium sp.)	Gladiolus (Gladiolus sp.) 'Sun-Kissed'	Field In-Ground	Kirk	MI	2013	Corm Dip	Significantly reduced plant necrosis and lodging, and increased plant height and flowering, with 0.125 + 0.9 and 0.5 + 0.45 oz per 100 gal.
31546	Tank Mix: Acibenzolar + Heritage (Acibenzolar + Azoxystrobin)	Fusarium sp. (Fusarium sp.)	Gladiolus (Gladiolus sp.) 'Sun-Kissed'	Field In-Ground	Kirk	MI	2013	Foliar	Did not reduce plant necrosis with 0.75 + 1.8 oz per 100 gal.
31397	Tank Mix: Acibenzolar + Heritage (Acibenzolar + Azoxystrobin)	Fusarium sp. (Fusarium sp.)	Iris, Dutch (Iris x hollandica) 'Blue Diamond'	Field Container	Chastagner	WA	2012	Soil incorporation	Significantly increased 18" tall flowers with 0.08 g + 1 oz per 1000 sq ft.
31386	Tank Mix: Flagship 0.22G + Heritage (Thiamethoxam + azoxystrobin)	Fusarium commune (Fusarium commune)	Fir, Douglas (Pseudotsuga menziesii)	Seedbed	Chastagner	WA	2012	Soil incorporation	Did not significantly increase number of healthy seedlings with 44 + 0.4 oz per 1000 sq ft.
31398	Tank Mix: Flagship 0.22G + Heritage (Thiamethoxam + azoxystrobin)	Fusarium sp. (Fusarium sp.)	Iris, Dutch (Iris x hollandica) 'Blue Diamond'	Field Container	Chastagner	WA	2012	Soil incorporation	Significantly increased total marketable and 18" tall flowers, and decrease culls with 44 oz + 0.4 oz per 1000 sq ft.
31387	Tank Mix: Flagship 25WG + Heritage (Thiamethoxam + azoxystrobin)	Fusarium commune (Fusarium commune)	Fir, Douglas (Pseudotsuga menziesii)	Seedbed	Chastagner	WA	2012	Soil incorporation	Only treatment that significantly increased number of healthy seedlings with 0.4 oz + 0.4 oz per 1000 sq ft.

31387	Tank Mix: Flagship 25WG + Heritage (Thiamethoxam + azoxystrobin)	Fusarium commune (Fusarium commune)	Fir, Douglas (Pseudotsuga menziesii)	Seedbed	Chastagner	WA	2015	Soil	Number of healthy seedlings with 17 oz + 4 oz per acre not significantly different from inoculated and non-inoculated checks.
31399	Tank Mix: Flagship 25WG + Heritage (Thiamethoxam + azoxystrobin)	Fusarium sp. (Fusarium sp.)	Iris, Dutch (Iris x hollandica) 'Blue Diamond'	Field Container	Chastagner	WA	2012	Soil incorporation	Significantly increased 18" tall flowers with 0.4 oz + 0.4 oz per 1000 sq ft.
32102	Tank Mix: Heritage + Medallion WDG (Azoystrobin + fludioxonil)	Fusarium commune (Fusarium commune)	Fir, Douglas (Pseudotsuga menziesii)	Seedbed	Chastagner	WA	2015	Soil	Higher number of healthy seedlings 2 months postemergence but not different from untreated 5 months later with 4 oz + 4 oz per acre.
31282	Torque 3.6SC (Tebuconazole)	Fusarium commune (Fusarium commune)	Fir, Douglas (Pseudotsuga menziesii)	Seedbed	Chastagner	WA	2011	Drench	High disease pressure. Significantly increased healthy seedlings with 6 fl oz per 100 gal; comparable to non-inoculated Check.
31282	Torque 3.6SC (Tebuconazole)	Fusarium commune (Fusarium commune)	Fir, Douglas (Pseudotsuga menziesii)	Seedbed	Chastagner	WA	2012	Soil incorporation	Did not increase number of healthy seedlings with 20.4 ml per 1000 sq ft.
32115	Torque 3.6SC (Tebuconazole)	Fusarium wilt of basil (Fusarium oxysporum f sp basilici)	Sweet Basil (Ocimum basilicum) 'Genovese'	Greenhouse	Wick	MA	2013	Drench	Poor control of a severe disease pressure with 10 fl oz per 100 gal applied once; inferior to uninoculated check.
32057	Torque 3.6SC (Tebuconazole)	Fusarium sp. (Fusarium sp.)	Gladiolus (Gladiolus sp.) 'Sun-Kissed'	Field In-Ground	Kirk	MI	2013	Corm Dip	Significantly reduced plant necrosis, and increased plant height and flowering, with 10 fl oz per 100 gal.
32057	Torque 3.6SC (Tebuconazole)	Fusarium sp. (Fusarium sp.)	Gladiolus (Gladiolus sp.) 'Sun-Kissed'	Field In-Ground	Kirk	MI	2013	Foliar	Did not reduce plant necrosis with 10 fl oz per 100 gal.
29751	Tourney 50WDG (Metconazole)	Fusarium commune (Fusarium commune)	Fir, Douglas (Pseudotsuga menziesii)	Seedbed	Chastagner	WA	2010	Drench	Excellent control of a high disease pressure with 1 and 2 oz per 100 gal; best treatment.
29751	Tourney 50WDG (Metconazole)	Fusarium commune (Fusarium commune)	Fir, Douglas (Pseudotsuga menziesii)	Seedbed	Chastagner	WA	2011	Drench	High disease pressure. Significantly increased healthy seedlings with 1 and 2 oz per 100 gal; comparable to non-inoculated Check.
29751	Tourney 50WDG (Metconazole)	Fusarium commune (Fusarium commune)	Fir, Douglas (Pseudotsuga menziesii)	Seedbed	Chastagner	WA	2012	Soil incorporation	Did not significantly increase number of healthy seedlings with 2.8 and 5.6 g per 1000 sq ft.

29751	Tourney 50WDG (Metconazole)	Fusarium commune (Fusarium commune)	Fir, Douglas (Pseudotsuga menziesii)	Seedbed	Chastagner	WA	2013	Top Dress	Results inconclusive because of extremely low infection in both inoculated and non-inoculated checks.
29751	Tourney 50WDG (Metconazole)	Fusarium commune (Fusarium commune)	Fir, Douglas (Pseudotsuga menziesii)	Seedbed	Chastagner	WA	2015	Soil	Number of healthy seedlings with 4 oz per acre not significantly different from inoculated and non-inoculated checks.
30471	Tourney 50WDG (Metconazole)	Fusarium oxysporum (Fusarium oxysporum)	Larkspur (Delphinium sp.)	Greenhouse	Kirk	MI	2010	Drench	Did not significantly reduce leaf and root necrosis at 2 fl oz per 100 gal applied once; very minor, transient leaf phytotoxicity.
30196	Tourney 50WDG (Metconazole)	Fusarium oxysporum (Fusarium oxysporum)	Lisianthus (Lisianthus sp.) Eustoma grandiflora	Greenhouse	Chase	CA	2011	Drench	Some reduction of F. oxysporum severity with 1 and 2 oz per 100 gal applied every 14 days; severe stunting.
32112	Tourney 50WDG (Metconazole)	Fusarium wilt of basil (Fusarium oxysporum f sp basilici)	Sweet Basil (Ocimum basilicum) 'Genovese'	Greenhouse	Wick	MA	2013	Drench	Good control of a severe disease pressure with 2 and 4 oz per 100 gal applied once; inferior to uninoculated check.
30249	Tourney 50WDG (Metconazole)	Fusarium solani (Fusarium solani)	Dracaena, Striped; Janet Craig Dracaena (Dracaena deremensis) 'Janet Craig'	Greenhouse	Palmateer (UF)	FL	2011	Sprench	Significantly reduced a moderate to severe disease severity with 1 and 2 oz per 100 gal applied 4 times; slightly inferior to non-inoculated check.
31374	Tourney 50WDG (Metconazole)	Fusarium sp. (Fusarium sp.)	Gladiolus (Gladiolus sp.) 'Sun-Kissed'	Field In-Ground	Kirk	MI	2012	Bulb Dip	Did not significantly reduce stem base necrosis incidence with 2 and 4 fl oz per 100 gal.
31374	Tourney 50WDG (Metconazole)	Fusarium sp. (Fusarium sp.)	Gladiolus (Gladiolus sp.) 'Sun-Kissed'	Field In-Ground	Kirk	MI	2012	Foliar	Did not significantly reduce stem base necrosis incidence with 1 and 2 fl oz per 100 gal.
31374	Tourney 50WDG (Metconazole)	Fusarium sp. (Fusarium sp.)	Gladiolus (Gladiolus sp.) 'Sun-Kissed'	Field In-Ground	Kirk	MI	2013	Corm Dip	Did not significantly reduce plant necrosis, but reduced lodging, and increased plant height and flowering, with 2 and 4 fl oz per 100 gal.
31374	Tourney 50WDG (Metconazole)	Fusarium sp. (Fusarium sp.)	Gladiolus (Gladiolus sp.) 'Sun-Kissed'	Field In-Ground	Kirk	MI	2013	Foliar	Did not reduce plant necrosis with 4.3 an 8.6 oz per 100 gal.
31394	Tourney 50WDG (Metconazole)	Fusarium sp. (Fusarium sp.)	Iris, Dutch (Iris x hollandica) 'Blue Diamond'	Field Container	Chastagner	WA	2012	Soil incorporation	Significantly increased total marketable and 18" tall flowers, and decrease culls with 5.6 g per 1000 sq ft; lower rate less effective.

29752	Trinity 2SC (Triticonazole)	Fusarium commune (Fusarium commune)	Fir, Douglas (Pseudotsuga menziesii)	Seedbed	Chastagner	WA	2010	Drench	Great control (comparable to non inoculated) of a high disease pressure with 6 and 8 fl oz per 100 gal.
29752	Trinity 2SC (Triticonazole)	Fusarium commune (Fusarium commune)	Fir, Douglas (Pseudotsuga menziesii)	Seedbed	Chastagner	WA	2011	Drench	High disease pressure. Did not significantly increase healthy seedlings with 6 and 8 fl oz per 100 gal; slight phyto at the higher rate.
29752	Trinity 2SC (Triticonazole)	Fusarium commune (Fusarium commune)	Fir, Douglas (Pseudotsuga menziesii)	Seedbed	Chastagner	WA	2012	Soil incorporation	Did not significantly increase number of healthy seedlings with 5.43 and 8.14 ml per 1000 sq ft.
29752	Trinity 2SC (Triticonazole)	Fusarium commune (Fusarium commune)	Fir, Douglas (Pseudotsuga menziesii)	Seedbed	Chastagner	WA	2013	Top Dress	Results inconclusive because of extremely low infection in both inoculated and non-inoculated checks.
29752	Trinity 2SC (Triticonazole)	Fusarium commune (Fusarium commune)	Fir, Douglas (Pseudotsuga menziesii)	Seedbed	Chastagner	WA	2015	Soil	Higher number of healthy seedlings 2 months postemergence but not different from untreated 5 months later with 12 fl oz per acre.
30472	Trinity 2SC (Triticonazole)	Fusarium oxysporum (Fusarium oxysporum)	Larkspur (Delphinium sp.)	Greenhouse	Kirk	MI	2010	Drench	Significantly reduced leaf and root necrosis at 11.8 oz per 100 gal applied as curative twice; inferior to Medallion; very minor, transient leaf phytotoxicity.
30197	Trinity 2SC (Triticonazole)	Fusarium oxysporum (Fusarium oxysporum)	Lisianthus (Lisianthus sp.) Eustoma grandiflora	Greenhouse	Chase	CA	2011	Drench	Some reduction of F. oxysporum severity with 6 and 8 oz per 100 gal applied every 14 days; significant stunting at the higher rate.
32113	Trinity 2SC (Triticonazole)	Fusarium wilt of basil (Fusarium oxysporum f sp basilici)	Sweet Basil (Ocimum basilicum) 'Genovese'	Greenhouse	Wick	MA	2013	Drench	Good control of a severe disease pressure with 8 fl oz per 100 gal applied once, poor with 12 fl oz; inferior to uninoculated check.
30250	Trinity 2SC (Triticonazole)	Fusarium solani (Fusarium solani)	Dracaena, Striped; Janet Craig Dracaena (Dracaena deremensis) 'Janet Craig'	Greenhouse	Palmateer (UF)	FL	2011	Sprench	Significantly reduced a moderate to severe disease severity with 6 and 8 oz per 100 gal applied 4 times; slightly inferior to non-inoculated check.
31375	Trinity 2SC (Triticonazole)	Fusarium sp. (Fusarium sp.)	Gladiolus (Gladiolus sp.) 'Sun-Kissed'	Field In-Ground	Kirk	MI	2012	Foliar	Did not significantly reduce stem base necrosis incidence with 8 and 12 fl oz per 100 gal.

31375	Trinity 2SC (Triticonazole)	Fusarium sp. (Fusarium sp.)	Gladiolus (Gladiolus sp.) 'Sun-Kissed'	Field In-Ground	Kirk	MI	2013	Foliar	Did not reduce plant necrosis with 8 and 12 fl oz per 100 gal.
31395	Trinity 2SC (Triticonazole)	Fusarium sp. (Fusarium sp.)	Iris, Dutch (Iris x hollandica) 'Blue Diamond'	Field Container	Chastagner	WA	2012	Soil incorporation	Significantly increased total marketable and 18" tall flowers, and decrease culls with 8.14 ml per 1000 sq ft; best treatment; lower rate less effective.
34293	Zio (Pseudomonas chlororaphis strain AFS009)	Fusarium wilt of chrysanthemum (Fusarium oxysporum f sp chrysanthemi)	Chrysanthemum, Garden (Chrysanthemum/Dendranthema sp.) 'Jasoda Orange'	Greenhouse	Meadows	NC	2019	Drench	Results inconclusive due to lack of disease; no phytotoxicity observed.

Appendix 1: Contributing Researchers

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