

Project Name: **Non-Oomycete Root and Crown Rot Efficacy (Fusarium Efficacy, Rhizoctonia Efficacy, Sclerotium Efficacy, Thielaviopsis Efficacy)**

New		Ongoing	X	Completed		Duration if ongoing or completed:	2012-2013, 2018-2021
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Project Description:

This project arose out of the 2011 IR-4 Ornamental Horticulture Workshop as one of several projects focusing on root diseases. *Fusarium* and *Pythium* were the two pathogen genera chosen for study. *Fusarium* species can infect roots, crown and stems causing root and crown rots and canker diseases.

Research Project Abstract (if available):

Abstract from 2020 Fusarium Efficacy Summary & Literature Review

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. *Fusarium* species tested included: *F. avenaceum*, *F. commune*, *F. oxysporum*, *F. solani* and *F. sp.* Most trials were conducted on *F. oxysporum* on larkspur, liriopse, 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.

Abstract from 2020 Rhizoctonia Efficacy Summary & Literature Review

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

Abstract from 2020 Thielaviopsis Literature Review

From 2003 to 2018, numerous products representing 31 active ingredients were evaluated in greenhouse trials as soil drench against *Thielaviopsis basicola* causing black root rot on ornamentals. Although there were insufficient data for definitive conclusions, two new experimentals (BAS 750 - mefentrifluconazole) and A20808C showed promising efficacy comparable to the standards. Several products that are not yet labeled for *Thielaviopsis basicola* also showed promising efficacy in single trials. These include Empress Intrinsic (pyraclostrobin), Endorse/Veranda O (polyoxin D), Mural (azoxystrobin + benzovindiflupyr), Picatina Flora (Pydiflumetofen + fludioxonil), Stargus (*Bacillus amyloliquefaciens* strain F727), Tourney (metconazole) and Vital (potassium phosphite). The established standards 3336 and Terraguard generally provided excellent efficacy.

Target Species (Phytotoxicity, or common and Latin name of arthropod, pathogen, weed):

<i>Chalara elegans</i>	<i>Fusarium oxysporum</i>	<i>Rhizoctonia solani</i>
<i>Fusarium avenaceum</i>	<i>Fusarium solani</i>	<i>Sclerotium rolfsii</i> var <i>delphinii</i>

<i>Fusarium commune</i>		<i>Fusarium sp</i>	
Target Crops (list tested crops if ongoing or completed project)			
<i>Eustoma grandiflora</i> <i>Begonia (Begonia semperflorens)</i> Fir, Douglas (<i>Pseudotsuga menziesii</i>) <i>Larkspur (Delphinium sp.)</i> <i>Dracaena deremensis</i> <i>Gladiolus sp.</i>		<i>Impatiens (Impatiens walleriana)</i> <i>Iris, Dutch (Iris x hollandica)</i> <i>Liriope (Liriope muscari)</i> <i>Lisianthus (Lisianthus sp.)</i> <i>Lily (Lilium sp.)</i> <i>Pansy (Viola x. wittrockiana)</i> <i>Sweet Basil (Ocimum basilicum)</i> <i>Viburnum (Viburnum odoratissimum))</i>	
Target Product(s)(list tested products or numbered compounds if ongoing or completed project)			
3336 F (thiophanate-methyl) CG100 (caprylic acid) Compass O 50WDG (trifloxystrobin) Contrast 70WSP (flutaloniol) Disarm 480SC (fluoxastrobin) Flagship 0.22G (thiamethoxam) Flagship 25WG (thiamethoxam) Heritage (azoxystrobin) Hurricane (fludioxonil + mefenoxam) Insignia/Empress Intrinsic (pyraclostrobin) Insimmo (Acibenzolar-S-methyl) LEM17 (penthiopyrad) Medallion (fludioxonil)		Pageant Intrinsic 38WG (boscalid + pyraclostrobin) Palladium (cyprodinil + fludioxonil) Promax (thyme oil) RootShield Plus (<i>Trichoderma harzianum</i> T-22 + <i>Trichoderma virens</i> G-41) SP2169 SP2550 SP2770 Switch 62.5WG (cyprodinil + fludioxonil) Terraclor 75WSP (PCNB) Torque 3.6SC (tebuconazole) Tourney (metconazole) Trinity (triticonazole)	
Product Registration and Research Status			
	Fully Screened (also includes standards)	Partially Screened through IR-4 ¹	Need Data Across Species ?
Labeled Generally & Commercialized	3336 Medallion	Orchestra Tourney Trinity *	Disarm Pageant Intrinsic Hurricane Palladium PlantShield, RootShield RootShield Plus *
Labeled Generally But NOT Commercialized			
Labeled for Specific Diseases & Commercialized	Terraguard	Heritage	26/36 Chipco 26019 Empress Intrinsic * MycoStop Trinity SC
Labeled for Specific Diseases but NOT Commercialized			Picatina
Not yet registered or Labeled			BAS 750 Compass O Insimmo MBI 601 Promax SP2550 SP2770 Torque

No longer available for development		CG100 SP2169	
* IR-4 Data contributed to registration decision – either adding pest to label or not pursuing further research 1 At least one species screened fully			

Area	Characteristic	Pro	Con
Availability & effectiveness of alternative management tools	New unregistered active ingredients	x	
	Wide range of FRAC mode of actions to test, including biologicals	x	
	Alternative application methods	x	
	Loss of methyl bromide – need alternatives	x	
	Fusarium diseases impact different portions of plant tissues necessitating different application patterns and protocol refinements		x
	Many labels already list Fusarium diseases generally without detailing species		x
	Biopesticides better as preventative		x
	Multiple applications considerations required		x
Damage potential of target	Fusarium and Thielaviopsis root and crown diseases remain major issues	x	
Performance and crop safety of proposed products (from other systems)			
Compatibility with IPM, resistance management programs			
Economics			
Geographic distribution			
Manufacturer interest in labeling products			
Other			

IR-4 Efficacy Trials to Date

Average rating on a scale of 1 – 5 with 1 = 0 to about 50% efficacy (not effective) and 5 = 95 to 100 efficacy (very effective); minimum to maximum rating; number of trials (See table on next page). For product/insect combinations that are blank, IR-4 has not screened this combination.

‘Labeled’ indicates that this disease species or genera is listed on the label. A rating of 2 or lower is considered unacceptable efficacy (**red text**). A rating of 3 or higher is considered commercially acceptable (black text). Non-labeled, completed product/disease combinations (3 or more trials) with an average rating of 3 or higher are highlighted with **green text**. For disease/product combinations that are blank, IR-4 has not screened this combination.

MOA Class	Product (Active Ingredients)	<i>Fusarium commune</i>	<i>Fusarium oxysporum</i>	<i>Fusarium solani</i>	<i>Fusarium sp</i>	<i>Fusarium oxysporum f sp basilici</i>	<i>Fusarium oxysporum f sp chrysant</i>	<i>Fusarium oxysporum f sp cyclaminis</i>
FRAC 1	3336 F (Thiophanate-methyl)	3.5 (3 - 4) n2 Labeled	4.0 (3 - 5) n2 Labeled	5.0 (5 - 5) n1 Labeled	1.0 (1 - 1) n2 Labeled	5.0 (5 - 5) n1 Labeled		
	3336 WP (50%) (Thiophanate-methyl)				1.0 (1 - 1) n2			
FRAC 3	Avelyo (BAS 750 02F) (Mefentrifluconazole)		4.0 (4 - 4) n1				2.0 (2 - 2) n1	4.0 (4 - 4) n1
	Terraguard 50W (Triflumizole)		1.0 (1 - 1) n1					
	Torque 3.6SC (Tebuconazole)	3.0 (1 - 5) n2			1.0 (1 - 1) n2	1.0 (1 - 1) n1		
	Tourney 50WDG (Metconazole)	3.3 (1 - 5) n4 Labeled	2.0 (1 - 3) n2 Labeled	4.0 (4 - 4) n1 Labeled	1.4 (1 - 3) n5 Labeled	3.0 (3 - 3) n1 Labeled		
	Trinity 2SC (Triticonazole)	2.3 (1 - 4) n4 Labeled	2.5 (2 - 3) n2 Labeled	4.0 (4 - 4) n1 Labeled	1.7 (1 - 3) n3 Labeled	3.0 (3 - 3) n1 Labeled		
FRAC 7	Astun (isofetamid)		3.0 (3 - 3) n1					
FRAC 7 + FRAC 3	Postiva (pydiflumetofen + difenoconazole)		3.0 (3 - 3) n1				5.0 (5 - 5) n1	5.0 (5 - 5) n1
FRAC 7 + FRAC 11	Pageant Intrinsic (Boscalid + pyraclostrobin)	3.7 (3 - 4) n3 Labeled	3.0 (3 - 3) n1 Labeled					
FRAC 9 + FRAC 12	Palladium (Cyprodinil + fludioxonil)	1.0 (1 - 1) n3 Labeled	3.0 (3 - 3) n1 Labeled	5.0 (5 - 5) n1 Labeled	1.2 (1 - 2) n5 Labeled	3.0 (3 - 3) n1 Labeled		
FRAC 11	Compass 0 50WDG (Trifloxystrobin)	2.5 (2 - 3) n2		3.0 (3 - 3) n1				
	Disarm 480SC (Fluoxastrobin)				1.3 (1 - 2) n4 Labeled			
	Empress Intrinsic Brand Fungicide Insignia SC Intrinsic Brand Fungicide (Pyraclostrobin)	3.0 (3 - 3) n1	3.0 (3 - 3) n1					
	Heritage (Azoxystrobin)	1.3 (1 - 2) n4 Labeled		5.0 (5 - 5) n1 Labeled	2.0 (1 - 4) n3 Labeled			
FRAC 11 + FRAC 12	Tank Mix: Heritage + Medallion WDG (Azoxystrobin + fludioxonil)	3.0 (3 - 3) n1						
FRAC 12	Medallion (Fludioxonil)	1.3 (1 - 2) n3 Labeled	5.0 (5 - 5) n1 Labeled	3.0 (3 - 3) n1 Labeled	1.0 (1 - 1) n4 Labeled			
FRAC 12 + FRAC 4	Hurricane (Fludioxonil + mefonaxam)	1.0 (1 - 1) n2 Labeled	5.0 (5 - 5) n1 Labeled					

MOA Class	Product (Active Ingredients)	<i>Fusarium commune</i>	<i>Fusarium oxysporum</i>	<i>Fusarium solani</i>	<i>Fusarium sp</i>	<i>Fusarium oxysporum f sp basilici</i>	<i>Fusarium oxysporum f sp chrysant</i>	<i>Fusarium oxysporum f sp cyclaminis</i>
FRAC BM01	TXC2020 (Thyme oil)		3.0 (3 - 3) n1				<i>1.0 (1 - 1) n1</i>	<i>1.0 (1 - 1) n1</i>
FRAC BM02	RootShield Plus WP (aka BW240) (Trichoderma harzianum T-22 + Trichoderma virens G-41)	<i>1.5 (1 - 3) n4 Labeled</i>	<i>2.0 (1 - 3) n2 Labeled</i>	5.0 (5 - 5) n1 Labeled	<i>1.0 (1 - 1) n5 Labeled</i>	<i>1.0 (1 - 1) n1 Labeled</i>		
FRAC NC	CG100 (Caprylic acid)	<i>1.7 (1 - 3) n3</i>	<i>2.0 (2 - 2) n2</i>	3.0 (3 - 3) n1	<i>1.0 (1 - 1) n3</i>			
FRAC P01	Insimmo (Acibenzolar-S-methyl)	<i>1.3 (1 - 2) n3</i>	4.5 (4 - 5) n2	3.0 (3 - 3) n1	<i>1.8 (1 - 4) n4</i>			
FRAC P01 + FRAC 11	Tank Mix: Acibenzolar + Heritage (Acibenzolar + Azoxystrobin)	<i>1.0 (1 - 1) n1</i>			<i>1.8 (1 - 3) n5</i>			
IRAC 4A	Flagship 0.22G (Thiamethoxam)	<i>1.0 (1 - 1) n1</i>			<i>2.0 (2 - 2) n1</i>			
	Flagship 25WG (Thiamethoxam)	<i>1.0 (1 - 1) n1</i>						
IRAC 4A + FRAC 11	Tank Mix: Flagship 0.22G + Heritage (Thiamethoxam + azoxystrobin)	<i>1.0 (1 - 1) n1</i>			3.0 (3 - 3) n1			
IRAC 4A + FRAC 11	Tank Mix: Flagship 25WG + Heritage (Thiamethoxam + azoxystrobin)	<i>2.5 (2 - 3) n2</i>			<i>2.0 (2 - 2) n1</i>			
unknown	BW161N (BW161N)		<i>2.0 (2 - 2) n1</i>				<i>2.0 (2 - 2) n1</i>	<i>1.0 (1 - 1) n1</i>
	Kleengrow (Didecyl dimethyl ammonium chloride)		3.0 (3 - 3) n1					
	MBI 121 (MBI 121)		3.0 (3 - 3) n1				<i>2.0 (2 - 2) n1</i>	<i>1.0 (1 - 1) n1</i>
	SP2169 (SP2169)	<i>1.5 (1 - 2) n2</i>	5.0 (5 - 5) n1		<i>1.0 (1 - 1) n3</i>			
	SP2480 (SP2480)		<i>1.0 (1 - 1) n1</i>					<i>1.0 (1 - 1) n1</i>
	SP2550 (SP2550)				<i>1.0 (1 - 1) n2</i>	<i>1.0 (1 - 1) n1</i>		
	SP2700 WP (SP2700)		3.0 (3 - 3) n1				<i>1.0 (1 - 1) n1</i>	<i>1.0 (1 - 1) n1</i>

MOA Class	Product (Active Ingredients)	<i>Cylindrocladium sp</i>	<i>Rhizoctonia solani</i>	<i>Sclerotium rolfsii</i> var_ <i>delphinii</i>	<i>Chalara elegans</i> (aka <i>Thielaviopsis</i>)
FRAC 1	3336 F (Thiophanate-methyl)		3.0 (3 - 3) n1		3.0 (3 - 3) n1
	3336 WP (50%) (Thiophanate-methyl)		3.1 (3 - 4) n11 Labeled		3.0 (3 - 3) n1
	3336 WP 70% (Pennwalt) (Thiophanate-methyl)		3.5 (3 - 4) n2 Labeled		
	Benlate 50WP (Benomyl)		5.0 (5 - 5) n1		
	OHP 6672 4.5L (Thiophanate-methyl)				4.0 (4 - 4) n1
FRAC 3	Avelyo (BAS 750 02F) (Mefentrifluconazole)		4.0 (3 - 5) n2		2.7 (1 - 5) n3
FRAC 7	Astun (isofetamid)	2.0 (2 - 2) n1	1.0 (1 - 1) n2		1.0 (1 - 1) n2
	Contrast 70WSP (Flutalonil)			5.0 (5 - 5) n1	
FRAC 7	Picatina (Pydiflumetofen)		3.0 (3 - 3) n1		
FRAC 7	ProStar 70WP/WG (Flutalonil)		5.0 (5 - 5) n1		
FRAC 7 + FRAC 3	Postiva (pydiflumetofen + difenoconazole)	2.0 (2 - 2) n1	2.0 (2 - 2) n1		1.0 (1 - 1) n1
FRAC 7 + FRAC 11	Broadform SC500 (Fluopyram + Trifloxystrobin)		5.0 (5 - 5) n2 Labeled		1.0 (1 - 1) n2 <i>Labeled</i>
	Orkestra Intrinsic (Fluxapyroxad + pyraclostrobin)	2.0 (2 - 2) n1	5.0 (5 - 5) n1		1.0 (1 - 1) n2
FRAC 9 + FRAC 12	Switch 62.5WG (Cyprodinil + Fludioxonil)				3.0 (3 - 3) n1
FRAC 11	Compass 0 50WDG (Trifloxystrobin)			3.0 (3 - 3) n1	
	Disarm 480SC (Fluoxastrobin)		2.0 (2 - 2) n1 <i>Labeled</i>		
	Fenstop (Fenamidone)		1.0 (1 - 1) n1 <i>Labeled</i>		
	Heritage (Azoxystrobin)			4.0 (4 - 4) n1 Labeled	
FRAC 12	Medallion (Fludioxonil)	2.0 (2 - 2) n1		2.0 (2 - 2) n1 <i>Labeled</i>	
FRAC 12 + FRAC 4	Hurricane (Fludioxonil + mefonaxam)				

MOA Class	Product (Active Ingredients)	<i>Cylindrocladium</i> <i>sp</i>	<i>Rhizoctonia</i> <i>solani</i>	<i>Sclerotium</i> <i>rolfsii</i> var_ <i>delphinii</i>	<i>Chalara</i> <i>elegans</i> (aka <i>Thielaviopsis</i>)
FRAC 14	Terraclor 75WP (PCNB)			5.0 (5 - 5) n1	
FRAC 19	Endorse (Polyoxin D)		1.0 (1 - 1) n1 Labeled		
FRAC 21	Segway (Cyazofamid)		2.0 (2 - 2) n1		
FRAC 32	Hymexazol 30L (Hymexazol)		1.0 (1 - 1) n1		
FRAC 40	Micora (Mandipropamid)		2.0 (2 - 2) n1		
FRAC 43	Adorn 4F (Fluopicolide)		2.0 (2 - 2) n1		
FRAC BM01	Promax (Thyme Oil (3%))		1.0 (1 - 1) n1		
	TXC2020 (Thyme oil)		1.0 (1 - 1) n1		1.0 (1 - 1) n1
FRAC BM02	Actinovate Soluble (Streptomyces lydicus WYEC 108)		1.0 (1 - 1) n1 Labeled		
	Pvent (Gliocladium catenulatum Strain J1446)		3.0 (3 - 3) n1		2.0 (1 - 3) n2
	Zio (Pseudomonas chlororaphis strain AFS009)	2.0 (2 - 2) n1	1.0 (1 - 1) n1		1.0 (1 - 1) n2
FRAC NC	MBI 601 (Muscodor albus)		3.0 (3 - 3) n2		1.0 (1 - 1) n2
	ZeroTol (Hydrogen dioxide)		1.0 (1 - 1) n1		
FRAC P07	Agrifos (Dipotassium phosphonate + Dipotassium phosphate)		3.0 (3 - 3) n1		
FRAC P07	Vital 4L (Potassium phosphite)		3.0 (3 - 3) n1		
IRAC UNF & FRAC BM02	Stargus (Bacillus nakamurai strain F727)	2.0 (2 - 2) n1	1.0 (1 - 1) n1 Labeled		2.0 (1 - 3) n2
unknown	BW161N (BW161N)		5.0 (5 - 5) n1		1.0 (1 - 1) n1
	Kleengrow (Didecyl dimethyl ammonium chloride)				
	MBI 121 (MBI 121)		5.0 (5 - 5) n1		1.0 (1 - 1) n1
	MultiGuard (Furfural)		2.0 (2 - 2) n1 Labeled		
	SP2480 (SP2480)		2.0 (2 - 2) n1		
	SP2700 AS (SP2700)	3.0 (3 - 3) n1	1.0 (1 - 1) n2		
	SP2700 WP (SP2700)		5.0 (5 - 5) n1		1.0 (1 - 1) n2

FRAC Class	Products (Active Ingredients)	Registered Use Site(s)	REI	Application Method	Crown, Stem & Root Rot Efficacy				
					Fusarium	Rhizoctonia	Sclerotinia	Sclerotium	Thielaviopsis
Registered Products									
1	3336, OHP 6672, etc. (thiophanate methyl)	G, I, L, N, S	12 h	D	P-E	P-E	-	-	E
				S	-	-	E	-	-
				Sp	E	-	-	-	-
2	Chipco 26019, etc. (iprodione)	G, N	12 h	D	-	F	-	-	-
2 + 1	26/36 (iprodione+thiophanate methyl	G, N	12 h	D	-	-	-	-	-
3	Avelyo, BAS 750 (mefentrifluconazole)	G, I, L, N, S	12 h	D	F-G	G-E	-	-	F-E
				Sp	-	E	-	-	-
	Terraguard (triflumizole)	G, I, N, S	12 h	D	G	P-G	-	P-E	G
				Torque, Tebuconazole SC T&O Fungicide (tebuconazole)	N	12 h	Di	P	-
	S	P	-				-	-	-
	Tourney (metconazole)	N	12 h	D	P-E	G	-	-	G
				Di	P	-	-	-	-
				Sp	E	-	-	-	-
	Trinity (triticonazole)	G, I, L, N, S	12 h	D	G-E	-	-	-	-
				S	P	G	-	G	P
				Sp	E	-	-	-	-
7	Astun (isofetamid)	G, N	12 h	D	G	P-G	-	P	P
				S	-	P	-	-	-
				Sp	P-G	P	-	-	-
	Contrast, Prostar (flutolanil)	G, N, S	12 h	Di	-	-	-	-	-
	Picatina, A19649B (pydiflumetofen)	TBD	-	D	G-E	G	-	-	-
Prostar 70WP (flutolanil)	G, N, S	12 h	D	-	E	-	-	-	
7 + 11	Broadform (fluopyram + trifloxystrobin)	G, I, L, N, S	12 h	D	P	E	-	-	P-F
	Orchestra, BAS703 (fluxapyroxad + pyraclostrobin)	G, L, N,S	12 h	D	-	G-E	-	-	P-E
				S	P	-	-	-	-
				Sp	F-E	-	-	-	-
9 + 12	Palladium (cyprodinil+fludioxonil)	G, L, N, S	12 h	D	P	-	-	-	-
				Di	P	-	-	-	-
				S	P	-	-	-	-
				Sp	E	-	-	-	-
11	Compass O (trifloxystrobin)	G, I, L, N, S	12 h	D	-	G-E	-	-	-
				Sp	G	-	-	-	-
	Disarm (fluoxastrobin)	G, I, N, S	12 h	Di	P	-	-	-	-
				S	P	-	-	-	-
	Empress Intrinsic, Insignia (pyraclostrobin) ^a	G, I, L, N, S	12 h	D	P-G	E	-	E	-
				D	P	E	G	E	P
	Heritage (azoxystrobin)	G, L, N, S	4 h	Di	G	-	-	-	-
				S	P	-	-	G	-
Sp				E	-	-	-	-	
11 + 3	Alibi Flora (azoxystrobin + difenoconazole)	G, L, N, S	12 h	S	-	-	E	-	-
11 + 7	Mural (azoxystrobin + benzovindiflupyr)	G, L, N, S	12 h	D	P	E	-	-	-

FRAC Class	Products (Active Ingredients)	Registered Use Site(s)	REI	Application Method	Crown, Stem & Root Rot Efficacy				
					<i>Fusarium</i>	<i>Rhizoctonia</i>	<i>Sclerotinia</i>	<i>Sclerotium</i>	<i>Thielaviopsis</i>
11 + 7	Pageant Intrinsic (pyraclostrobin+boscalid)	G, I, L, N, S	12 h	D	G	G-E	-	E	-
				S	G	E	E	E	-
12	Medallion (fludioxonil)	G, I, L, N, S	12 h	D	P-E	E	-	P-E	P-E
				Di	P	-	-	-	-
				S	P	-	-	-	-
				Sp	G	-	-	-	-
12 + 4	Hurricane (fludioxonil+mefenoxam)	G	48 h	D	P-E	E	-	-	F
14	Terraclor (PCNB)	G, I, N, S	12 h	D	-	E	-	G	P
	Terrazole, Truban (etridiazole)	G, N	12 h	D	-	-	-	-	-
14 + 1	Banrot (etridiazole+thiophanate methyl)	G	12 h	D	-	G	-	-	G-E
19	Affirm, Veranda (polyoxin D zinc salt)	G, L, N, S	4 h	D	-	E	-	-	G-E
44	Cease, Companion, Serenade Optimum, etc. (<i>Bacillus subtilis</i>)	G, I, N, S	4 h	D	-	P	-	-	P
	Stargus, MBI 110 (<i>Bacillus amyloliquifaciens</i> strain F727)	G, N, S	4 h	D	-	P-E	E	-	-
				Di	P	-	?	-	-
				S	-	-	-	-	-
M4	Captan (captan)	G	48 h	D	-	G	-	-	-
M5 + 1	Spectro (chlorothalonil+thiophanate methyl)	G, I, N	12 h	S	-	-	-	-	-
BM02	Zio (<i>Pseudomonas chlororaphis</i> strain AFS009)	G, I, L, N, S	4 h	D	-	-	-	-	P
NC	Actinovate (<i>Streptomyces lydicus</i>)	G, I, L, N, S	1 h	D, S	-	E,G,F	-	G,F	G,F
	Mycostop (<i>Streptomyces griseoviridis</i>)	G, N	4 h	D	-	-	-	-	P-E
	Kleengrow (Didecyl dimethyl ammonium chloride)	G	48 h	D	G	-	-	-	-
	PlantShield ^b , RootShield (<i>Trichoderma harzianum</i>)	G, I, N, S	0 h	D	-	P	-	-	-
	Prestop (<i>Gliricium catelunatum</i> strain J446)	G, I, N, S	0 h	D	-	-	-	-	-
	RootShield Plus (<i>Trichoderma harzianum</i> and <i>Trichoderma virens</i>)	G, I, N, S	0, 4 h	D	G	-	-	-	-
				Di	P	-	-	-	-
				S	P	-	-	-	-
				Sp	E	-	-	-	-
	SoilGard (<i>Gliricium virens</i>)	G, I, N	0 h	D	-	P-E	-	-	-
	ZeroTol (hydrogen dioxide + peroxyacetic acid)	G, I, N	0 h	D	-	P	-	-	-
Experimental Actives									
7 + 3	Postiva (pydiflumetofen + difenoconazole)	TBD	-	D	G-E	-	-	-	P-F
P1	Insimmo (acibenzolar)	TBD	12 h	D	P-G	-	-	-	-
				S	P	-	-	-	-
				Sp	G	-	-	-	-
NC	IT 5103 (<i>Trichoderma</i> spp.)	TBD	-	D	-	F-E	-	-	-
	Pvent (<i>Gliricium catelunatum</i> strain J446)	TBD	0 h	D	-	G	-	-	P
-	BW116IN (BW116IN)	TBD	-	D	P-G	-	-	-	P-F
-	BW159	TBD	-						
-	GWN 10320	TBD	-	S	-	-	E	-	-
-	MBI 121	TBD	-	D	P-G	-	-	-	-
			-	S	-	-	-	-	P-F

FRAC Class	Products (Active Ingredients)	Registered Use Site(s)	REI	Application Method	Crown, Stem & Root Rot Efficacy				
					<i>Fusarium</i>	<i>Rhizoctonia</i>	<i>Sclerotinia</i>	<i>Sclerotium</i>	<i>Thielaviopsis</i>
-	MBI 601	TBD	-	S	-	P-E	-	-	P-F
-	CG100 (caprylic acid)	TBD	-	D	G	-	-	-	-
				Sp	G	-	-	-	-
-	SP2480 (SP2480)	TBD	-	D	P-G	-	-	-	-
-	SP2550 (SP2550)	TBD	-	D	P	-	-	-	-
-	SP2700 (SP2700)	TBD	-	D	P-G	P-G	-	-	P
-	SP2770 (SP2770)	TBD	-	D	-	Ps	-	-	-
-	TCX2020 (TCX2020)	TBD	-	D	P-G	-	-	-	P-F

Registered Use Sites: G = Greenhouse; L = Lath House; I = Indoors; N = Nursery; S = Shade House; TBD = To Be Determined

Application Method: D = Drench; S = Spray, Di = Dip, Sp = Sprenc

Efficacy: E = clearly statistically equivalent or better than untreated non-inoculated and/or clearly statistically different than untreated inoculated; G = statistically different from untreated inoculated and untreated non-inoculated; F = statistically equivalent to both untreated inoculated and untreated non-inoculated; P = statistically equivalent to untreated inoculated. For trials without non-inoculated check, efficacy determined on author's conclusions, % control or comparisons to standard product(s).

Efficacy ratings taken from 2020 IR-4 *Fusarium* efficacy summary, 2021 IR-4 *Rhizoctonia* efficacy summary, 2021 IR-4 *Thielaviopsis* efficacy summary, 3 2020 IR-4 reports and 7 2017-2018 PDMR reports.

* Crown and root rots caused by fungi other than *Phytophthora* and *Pythium* (*Armillaria*, *Cylindrocladium*, *Cylindrocarpon*, *Fusarium*, *Myrothecium*, *Rhizoctonia*, *Sclerotinia*, *Sclerotium*, *Thielaviopsis*)

^a Empress Intrinsic has replaced Insignia for use in production environmental horticulture crops applied as drench to control soil-borne diseases caused by *Fusarium*, *Phytophthora*, *Pythium* and *Rhizoctonia* spp.

^b PlantShield is only registered in a few states.

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