

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

New		Ongoing	X	Completed		Duration if ongoing or completed:	2012-2013
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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):

Abbreviated Abstract from 2013 Fusarium Efficacy Summary

From 2001 to 2012, numerous products representing 17 active ingredients were evaluated in greenhouse and field trials as soil drench, soil incorporation, tuber soaks, and foliar applications against several *Fusarium* species causing rots (crown, stem and tuber rots) and wilt on ornamentals. *Fusarium* species tested included: *F. avenaceum*, *F. commune*, *F. oxysporum* and *F. solani*. Most trials were conducted on *F. oxysporum* on larkspur, 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 acibenzolar, Heritage (azoxystrobin), Compass (trifloxystrobin), Hurricane (fludioxonil + mefenoxam), Insignia (pyraclostrobin), SP2169, Tourney (metconazole) and Trinity (triticonazole). BW240/RootShield Plus (*Trichoderma harzianum* & *T. virens*), CG100 (caprylic acid), Pageant (boscalid + pyraclostrobin) and Palladium (cyprodinil + fludioxonil) provided no to mediocre efficacy. Proline (prothioconazole) provided consistently good control of *F. oxysporum* in watermelon trials. The established standards 3336 and Medallion generally provided inconsistent efficacy while Terraguard was effective in one trial.

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

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

Target Crops (list tested crops if ongoing or completed project)

<i>Eustoma grandiflora</i>	Iris, Dutch (<i>Iris x hollandica</i>)
Fir, Douglas (<i>Pseudotsuga menziesii</i>)	Lisianthus (<i>Lisianthus</i> sp.)
Larkspur (<i>Delphinium</i> sp.)	Lily (<i>Lilium</i> sp.)
<i>Dracaena deremensis</i>	Pansy (<i>Viola</i> sp.)
<i>Gladiolus</i> sp.	

Target Product(s) (list tested products or numbered compounds if ongoing or completed project)

3336 F (thiophanate-methyl)	Medallion (fludioxonil)
Acibenzolar-S-methyl	Pageant Intrinsic 38WG (boscalid + pyraclostrobin)
CG100 (caprylic acid)	Palladium (cyprodinil + fludioxonil)
Compass O 50WDG (trifloxystrobin)	RootShield Plus (<i>Trichoderma harzianum</i> T-22 + <i>Trichoderma virens</i> G-41)
Contrast 70WSP (flutaloniol)	SP2169
Disarm 480SC (fluoxastrobin)	Switch 62.5WG (cyprodinil + fludioxonil)
Flagship 0.22G (thiamethoxam)	Terraclor 75WSP (PCNB)
Flagship 25WG (thiamethoxam)	Torque 3.6SC (tebuconazole)
Heritage (azoxystrobin)	Tourney (metconazole)
Hurricane (fludioxonil + mefenoxam)	Trinity (triticonazole)
Insignia/Empress Intrinsic (pyraclostrobin)	

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	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			
Not yet registered or Labeled			BAS703 06F Compass O Flagship 0.22G Insimmo Promax SP2015 SP2550 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			

Project Pros	Project Cons
<ol style="list-style-type: none"> 1 Fusarium root and crown diseases remain major issues 2 Wide range of FRAC mode of actions to test, including biologicals 3 New unregistered active ingredients 4 Alternative application methods 5 Loss of methyl bromide – need alternatives 	<ol style="list-style-type: none"> 1 Fusarium diseases impact different portions of plant tissues necessitating different application patterns and protocol refinements 2 Many labels already list Fusarium diseases generally without detailing species 3 Biopesticides better as preventative 4 Multiple applications considerations required

IR-4 Efficacy Trials to Date
<p>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.</p> <p>'Labeled' indicates that this disease species or genera is listed on the label. A rating of 2 or lower is considered unacceptable efficacy (<i>red text</i>). 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 <i>green text</i>. For disease/product combinations that are blank, IR-4 has not screened this combination.</p>

Table 1 of 2

Product (Active Ingredients)	<i>Fusarium commune</i>	<i>Fusarium oxysporum</i>	<i>Fusarium solani</i>	<i>Fusarium sp.</i>
3336 F (Thiophanate-methyl)	4.0 (4 - 4) n1 Labeled	4.0 (3 - 5) n2 Labeled	5.0 (5 - 5) n1 Labeled	1.0 (1 - 1) n2 Labeled
CG100 (Caprylic acid)	1.7 (1 - 3) n3	2.0 (2 - 2) n2	3.0 (3 - 3) n1	1.0 (1 - 1) n3
Compass 0 50WDG (Trifloxystrobin)	2.5 (2 - 3) n2		3.0 (3 - 3) n1	
Disarm 480SC (Fluoxastrobin)				1.3 (1 - 2) n4 Labeled
Flagship 0.22G (Thiamethoxam)	1.0 (1 - 1) n1			2.0 (2 - 2) n1
Flagship 25WG (Thiamethoxam)	1.0 (1 - 1) n1			
Heritage (Azoxystrobin)	1.0 (1 - 1) n3 Labeled		5.0 (5 - 5) n1 Labeled	2.0 (1 - 4) n3 Labeled
Hurricane (Fludioxonil + mefenoxydempronil)	1.0 (1 - 1) n2 Labeled	5.0 (5 - 5) n1 Labeled		
Insignia SC / Empress Intrinsic (Pyraclostrobin)	3.0 (3 - 3) n1 Labeled			
Insimmo (Acibenzolar-S-methyl)	1.0 (1 - 1) n2	4.5 (4 - 5) n2	3.0 (3 - 3) n1	1.8 (1 - 4) n4
Medallion (Fludioxonil)		5.0 (5 - 5) n1 Labeled	3.0 (3 - 3) n1 Labeled	1.0 (1 - 1) n4 Labeled
Pageant Intrinsic 38WG (Boscalid + Pyraclostrobin) *	3.7 (3 - 4) n3 Labeled	3.0 (3 - 3) n1 Labeled		
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
RootShield Plus WP (aka BW240) (Trichoderma harzianum T-22 + Trichoderma virens G-41)	1.0 (1 - 1) n3 Labeled	2.0 (1 - 3) n2 Labeled	5.0 (5 - 5) n1 Labeled	1.0 (1 - 1) n5 Labeled
SP2169 (SP2169)	1.5 (1 - 2) n2	5.0 (5 - 5) n1		1.0 (1 - 1) n3
SP2550 (SP2550)				1.0 (1 - 1) n2
Tank Mix: 3336 50WP + Insimmo (Thiophanate-methyl + acibenzolar-S-methyl)				1.0 (1 - 1) n2
Tank Mix: Acibenzolar + Heritage (Acibenzolar + Azoxystrobin)	1.0 (1 - 1) n1			1.8 (1 - 3) n5
Tank Mix: Flagship 0.22G + Heritage (thiamethoxam + azoxystrobin)	1.0 (1 - 1) n1			3.0 (3 - 3) n1
Tank Mix: Flagship 25WG + Heritage (Thiamethoxam + azoxystrobin)	3.0 (3 - 3) n1			2.0 (2 - 2) n1
Torque 3.6SC (Tebuconazole)	1.0 (1 - 1) n1			1.0 (1 - 1) n2
Tourney 50WDG (Metconazole)	3.7 (1 - 5) n3 Labeled	2.0 (1 - 3) n2 Labeled	4.0 (4 - 4) n1 Labeled	1.4 (1 - 3) n5 Labeled
Trinity 2SC (Triticonazole)	2.0 (1 - 4) n3 Labeled	2.5 (2 - 3) n2 Labeled	4.0 (4 - 4) n1 Labeled	1.7 (1 - 3) n3 Labeled

Table 2 of 2

Product (Active Ingredients)	<i>Rhizoctonia solani</i>	<i>Sclerotium rolfsii</i> var <i>delphinii</i>	<i>Chalara elegans</i>
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		
Actinovate Soluble (Streptomyces lydicus WYEC 108)	1.0 (1 - 1) n1 <i>Labeled</i>		
Adorn 4F (Fluopicolide)	2.0 (2 - 2) n1		
Agrifos (Dipotassium phosphonate + Dipotassium phosphate)	3.0 (3 - 3) n1 Labeled		
Compass (Trifloxystrobin)		3.0 (3 - 3) n1	
Contrast 70WSP (Flutalonil)		5.0 (5 - 5) n1	
Disarm 480SC (Fluoxastrobin)	2.0 (2 - 2) n1 <i>Labeled</i>		
Endorse (Polyoxin D)	1.0 (1 - 1) n1 <i>Labeled</i>		
Fenstop (Fenamidone)	1.0 (1 - 1) n1 <i>Labeled</i>		
Heritage (Azoxystrobin)		4.0 (4 - 4) n1 Labeled	
Hymexazol 30L (Hymexazol)	1.0 (1 - 1) n1		
Medallion (Fludioxonil)		2.0 (2 - 2) n1 <i>Labeled</i>	
Micora (NOA 446510) (Mandipropamid)	2.0 (2 - 2) n1		
MultiGuard (Furfural)	2.0 (2 - 2) n1 <i>Labeled</i>		
Segway (Cyazofamid)	2.0 (2 - 2) n1		
Switch 62.5WG (Cyprodinil + Fludioxonil)			3.0 (3 - 3) n1 Labeled
Terraclor 75WP (PCNB)		5.0 (5 - 5) n1	
Vital 4L (Potassium phosphite)	3.0 (3 - 3) n1		

Fungicides (active ingredients)	FRAC Class	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>
26/36 (iprodione+thiophanate methyl)	2 + 1	G, N	12 h	D	?	?	?	?	?
3336, OHP 6672, etc. (thiophanate methyl)	1	G, I, L, N, S	12 h	D	E	E	?	?	E
				Sp	E	?	?	?	?
Actinovate (<i>Streptomyces lydicus</i>)	NC	G, I, L, N, S	1 h	D, S	?	E,G,F	?	G,F	G,F
Affirm, Veranda (polyoxin D zinc salt)	19	G, L, N, S	4 h	D	?	E	?	?	G-E
Alibi Flora (azoxystrobin + difenoconazole)	11 + 3	G, L, N, S	12 h	S	?	?	E	?	?
Banrot (etridiazole+thiophanate methyl)	14 + 1	G	12 h	D	?	G	?	?	G-E
Captan (captan)	M4	G	48 h	D	?	G	?	?	?
Cease, Companion, Serenade Optimum, etc. (<i>Bacillus subtilis</i>)	44	G, I, N, S	4 h	D	?	P	?	?	P
Chipco 26019, etc. (iprodione)	2	G, N	12 h	D	?	F	?	?	?
Compass O (trifloxystrobin)	11	G, I, L, N, S	12 h	D	?	G-E	?	?	?
				Sp	G	?	?	?	?
Contrast, Prostar (flutolanil)	7	G, N, S	12 h	Di	?	?	?	?	?
Disarm, Fame (fluoaxastrobin) ^c	11	G, I, N, S	12 h	Di	P	?	?	?	?
				S	P	?	?	?	?
Insignia, Empress Intrinsic (pyraclostrobin) ^a	11	G, I, L, N, S	12 h	D	?	E	?	E	?
Heritage (azoxystrobin)	11	G, L, N, S	4 h	D	P	E	G	E	P
				Di	G	?	?	?	?
				S	P	?	?	?	?
				Sp	E	?	?	?	?
Hurricane (fludioxonil+mefenoxam)	12 + 4	G	48 h	D	P-E	E	?	?	F
Kleengrow (Didecyl dimethyl ammonium chloride)	-	G	48 h	D	?	?	?	?	?
Medallion (fludioxonil)	12	G, I, L, N, S	12 h	D	P-E	E	?	P-E	P-E
				Di	P	?	?	?	?
				S	P	?	?	?	?
				Sp	G	?	?	?	?
Mycostop (<i>Streptomyces griseoviridis</i>)	NC	G, N	4 h	D	?	?	?	?	P-E
Pageant Intrinsic (pyraclostrobin+boscalid)	11+7	G, I, L, N, S	12 h	D	G	?	?	E	?
				S	G	E	E	E	?
Palladium (cyprodinil+fludioxonil)	9+12	G, L, N, S	12 h	D	P	?	?	?	?
				Di	P	?	?	?	?
				S	P	?	?	?	?
				Sp	E	?	?	?	?
PlantShield ^b , RootShield (<i>Trichoderma harzianum</i>)	NC	G, I, N, S	0 h	D	?	P	?	?	?
Prestop (<i>Gliocladium catelunatum</i> strain J446)	NC	G, I, N, S	0 h	D	?	?	?	?	?
RootShield Plus (<i>Trichoderma harzianum</i> and <i>Trichoderma virens</i>)	NC	G, I, N, S	0, 4 h	D	G	?	?	?	?
				Di	P	?	?	?	?
				S	P	?	?	?	?
				Sp	E	?	?	?	?
SoilGard (<i>Gliocladium virens</i>)	NC	G, I, N	0 h	D	?	P-E	?	?	?
Spectro (chlorothalonil+thiophanate methyl)	M5+1	G, I, N	12 h	S	?	?	?	?	?

Fungicides (active ingredients)	FRAC Class	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>
Terraclor (PCNB)	14	G, I, N, S	12 h	D	?	E	?	G	P
Terraguard (triflumizole)	3	G, I, N, S	12 h	D	?	G	?	P-E	G
Terrazole, Truban (etridiazole)	14	G, N	12 h	D	?	?	?	?	?
Tourney (metconazole)	3	N	12 h	D	P-E	G	?	?	?
				Di	P	?	?	?	?
				Sp	E	?	?	?	?
Trinity (triticonazole)	3	G, I, L, N, S	12 h	D	G-E	?	?	?	?
				S	P	G	?	G	P
				Sp	E	?	?	?	?
Experimental Products									
BAS703 06F	-	TBD	?	?	?	?	?	?	?
CG100 (caprylic acid) **	-	TBD	-	D	G	?	?	?	?
				Sp	G	?	?	?	?
Insimmo (acibenzolar)	P1	TBD	12 h	D	P-G	?	?	?	?
				S	P	?	?	?	?
				Sp	G	?	?	?	?
MBI-110 (<i>Bacillus amyloliquifaciens</i> strain F727)	44	TBD	?	Di	P	?	?	?	?
SP2550 (SP2550)	-	TBD	-	S	P	?	?	?	?
SP2770 (SP2770) **	-	TBD	-	?	?	?	?	?	?
Torque, Tebuconazole SC T&O Fungicide (tebuconazole)	3	N	12 h	Di	P	?	?	?	?
				S	P	?	?	?	?

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 = Sprench

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 24 PDMR efficacy reports (1 *Fusarium*, 12 *Rhizoctonia solani*, 1 *Sclerotinia*, 4 *Sclerotium rolfsii* and 6 *Thielaviopsis basicola*) and 5 IR-4 efficacy reports (*Fusarium*).

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

** No longer available for development in ornamental horticulture crops

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

^bPlantShield is only registered in a few states.

^cFame will be replacing DisArm