

Project Name: **Non-Oomycete Root and Crown Rot Efficacy – Fusarium**

New	Ongoing	X	Completed		Duration if ongoing or completed:	2012-2013, 2018-2023
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Project Description:

This project arose out of the 2011 IR-4 Environmental 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. Subsequently, nonoomycete root and crown rot diseases became a high priority project starting in 2018.

Research Project Abstract (if available):

Abstract from 2021 Fusarium Efficacy Summary & Literature Review

From 2001 to 2020, 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 environmental horticulture crops, 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, lirioppe, 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 Astun (isofetamid), BAS 750 (mefentriconazole), Picatina (pydiflumetofen), Heritage (azoxystrobin), Compass (trifloxystrobin), Hurricane (fludioxonil+mefenoxam), Insignia (pyraclostrobin), Insimmo (acibenzolar), MBI-121, Orkestra (fluxapyroxad + pyraclostrobin), SP2169, Tourney (metconazole) and Trinity (triticonazole), Broadform (fluopyram + trifloxystrobin), BW240/RootShield Plus (*Trichoderma harzianum* & *T. virens*), (BWI161N), CG100 (caprylic acid), Mural, Pageant (boscalid+pyraclostrobin), Palladium (cyprodinil+fludioxonil), SP2550, SP2770 and TCX2020 provided no to mediocre efficacy. Postiva (pydiflumetofen + difenoconazole) provided excellent efficacy on *F. oxysporum* on various environmental horticultural crops in greenhouse experiments. Proline (prothioconazole) provided consistently good control of *F. oxysporum* in watermelon trials. The established standards 3336, Medallion and Terraguard generally provided inconsistent efficacy.

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

Fusarium commune (Fusarium commune)
Fusarium oxysporum (Fusarium oxysporum)
Fusarium solani (Fusarium solani)
Fusarium sp. (Fusarium sp.)
Fusarium Wilt of Basil (Fusarium oxysporum f sp basilici)
Fusarium Wilt of Chrysanthemum (Fusarium oxysporum f sp chrysanthemi)
Fusarium Wilt of Cyclamen (Fusarium oxysporum f sp cyclaminis)

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

Chrysanthemum/Dendranthema sp.
Cyclamen persicum
Delphinium sp.
Dracaena deremensis
Gladiolus sp.
Hydrangea quercifolia
Iris x hollandica
Lisianthus sp.
Ocimum basilicum
Pseudotsuga menziesii



Environmental Horticulture Program Research Project Sheet

<https://www.ir4project.org/ehc/ehc-registration-support-research/env-hort-extension-resources/>

Target Product(s)(list tested products or numbered compounds if ongoing or completed project)	
3336 F (Thiophanate-methyl) Astun (isofetamid) Avelyo Fungicide (Mefentrifluconazole) BAS 673 05F (BAS 673 05F) Broadform SC500 (Fluopyram + Trifloxystrobin) BW161N (BW161N) CG100 (Caprylic acid) Compass O 50WDG (Trifloxystrobin) Disarm 480SC (Fluoxastrobin) Empress Intrinsic Brand Fungicide (Pyraclostrobin) Heritage (Azoxyastrobin) Hurricane (Fludioxonil + mefenoxam) Insignia SC Intrinsic Brand Fungicide (Pyraclostrobin) Insimmo (Acibenzolar-S-methyl) MBI 121 (MBI 121) Medallion (Fludioxonil) Pageant Intrinsic (Boscalid + pyraclostrobin)	Palladium (Cyprodinil + fludioxonil) Postiva (pydiflumetofen + difenoconazole) Promax (Thyme oil) RD00AS-1 (BW159) (BW159) RootShield Plus WP (aka BW240) (Trichoderma harzianum) T-22 + Trichoderma virens G-41) SP2169 (SP2169) SP2478 (SP2478) SP2480 (SP2480) SP2550 (SP2550) SP2700 WP (SP2700) SP2770 10WP (SP2770) Stargus (Bacillus nakamurai strain F727) Terraguard 50W (Triflumizole) Torque 3.6SC (Tebuconazole) Tourney 50WDG (Metconazole) Tril-21 (Thyme oil) Trinity 2SC (Triticonazole) TXC2020 (Thyme oil) Zio (Pseudomonas chlororaphis strain AFS009)

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	Orkestra Postiva Tourney Trinity *	Disarm Pageant Intrinsic Hurricane Palladium PlantShield, RootShield RootShield Plus *
Labeled Generally But NOT Commercialized			
Labeled for Specific Diseases & Commercialized	Terraguard	Astun Avelyo Broadform Heritage	26/36 Chipco 26019 Empress Intrinsic MycoStop Trinity SC
Labeled for Specific Diseases but NOT Commercialized			Picatina
Not yet registered or Labeled		BAS 753 MBI-121 RD-00AS-1 SP2478 SP2550 SP2700 SP2770 Tril-21	BAS 750 Compass O Insimmo MBI 601 Promax 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			



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PROS	CONS
New unregistered active ingredients	Fusarium diseases impact different portions of plant tissues necessitating different application patterns and protocol refinements
Wide range of FRAC mode of actions to test, including biologicals	Many labels already list Fusarium diseases generally without detailing species
New unregistered active ingredients	Biopesticides better as preventative
Alternative application methods	Multiple applications considerations required
Loss of methyl bromide – need alternatives	May be limited researchers for Fusarium
Fusarium root and crown diseases remain major issues	
Additional research needed across species for registration with current A level treatments	

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 chrysanthi</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		
FRAC 1 + FRAC P1	Tank Mix: 3336 50WP + Insimmo (Thiophanate-methyl + acibenzolar-S-methyl)				1.0 (1 - 1) n2			
FRAC 11	Compass 0 50WDG (Trifloxystrobin)	2.5 (2 - 3) n2		3.0 (3 - 3) n1				
FRAC 11	Disarm 480SC (Fluoxastrobin)				1.3 (1 - 2) n4 Labeled			
FRAC 11	Empress Intrinsic Brand Fungicide (Pyraclostrobin)		3.0 (3 - 3) n1 Labeled					
FRAC 11	Heritage (Azoxystrobin)	1.3 (1 - 2) n4 Labeled		5.0 (5 - 5) n1 Labeled	2.0 (1 - 4) n3 Labeled			
FRAC 11	Insignia SC Intrinsic Brand Fungicide (Pyraclostrobin)	3.0 (3 - 3) n1						
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					
FRAC 3	Avelyo Fungicide (Mefentrifluconazole)		4.0 (4 - 4) n1				2.0 (2 - 2) n1	4.0 (4 - 4) n1
FRAC 3	Terraguard 50W (Triflumizole)		1.0 (1 - 1) n1					
FRAC 3	Torque 3.6SC (Tebuconazole)	3.0 (1 - 5) n2			1.0 (1 - 1) n3	1.0 (1 - 1) n1		
FRAC 3	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		
FRAC 3	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 11	Pageant Intrinsic (Boscalid + pyraclostrobin)	3.7 (3 - 4) n3 Labeled	3.0 (3 - 3) n1 Labeled					
FRAC 7 + FRAC 3	Postiva (pydiflumetofen + difenoconazole)		3.0 (3 - 3) n1 Labeled				5.0 (5 - 5) n1 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 chrysanthi</i>	<i>Fusarium oxysporum f sp cyclaminis</i>
FRAC 9 + FRAC 12	Palladium (Cyprodinil + fludioxanil)	1.0 (1 - 1) n3 <i>Labeled</i>	3.0 (3 - 3) n1 <i>Labeled</i>	5.0 (5 - 5) n1 <i>Labeled</i>	1.2 (1 - 2) n5 <i>Labeled</i>	3.0 (3 - 3) n1 <i>Labeled</i>		
FRAC BM01	TXC2020 (Thyme oil)		3.0 (3 - 3) n1				1.0 (1 - 1) n1	1.0 (1 - 1) n1
FRAC BM02	RootShield Plus WP (aka BW240) (Trichoderma harzianum T-22 + Trichoderma virens G-41)	1.5 (1 - 3) n4 <i>Labeled</i>	2.0 (1 - 3) n2 <i>Labeled</i>	5.0 (5 - 5) n1 <i>Labeled</i>	1.0 (1 - 1) n5 <i>Labeled</i>	1.0 (1 - 1) n1 <i>Labeled</i>		
FRAC NC	CG100 (Caprylic acid)	1.7 (1 - 3) n3	2.0 (2 - 2) n2	3.0 (3 - 3) n1	1.0 (1 - 1) n3			
FRAC P01	Insimmo (Acibenzolar-S-methyl)	1.3 (1 - 2) n3	4.5 (4 - 5) n2	3.0 (3 - 3) n1	1.8 (1 - 4) n4			
FRAC P01 + FRAC 11	Tank Mix: Acibenzolar + Heritage (Acibenzolar + Azoxystrobin)	1.0 (1 - 1) n1			1.8 (1 - 3) n5			
IRAC 4A	Flagship 0.22G (Thiamethoxam)	1.0 (1 - 1) n1			2.0 (2 - 2) n1			
IRAC 4A	Flagship 25WG (Thiamethoxam)	1.0 (1 - 1) n1			1.0 (1 - 1) n1			
IRAC 4A + FRAC 11	Tank Mix: Flagship 0.22G + Heritage (Thiamethoxam + azoxystrobin)	1.0 (1 - 1) n1			3.0 (3 - 3) n1			
IRAC 4A + FRAC 11	Tank Mix: Flagship 25WG + Heritage (Thiamethoxam + azoxystrobin)	2.5 (2 - 3) n2			2.0 (2 - 2) n1			
unknown	BW161N (BW161N)		2.0 (2 - 2) n1				2.0 (2 - 2) n1	1.0 (1 - 1) n1
unknown	Kleengrow (Didecyl dimethyl ammonium chloride)		3.0 (3 - 3) n1					
unknown	MBI 121 (MBI 121)		3.0 (3 - 3) n1				2.0 (2 - 2) n1	1.0 (1 - 1) n1
unknown	SP2169 (SP2169)	1.5 (1 - 2) n2	5.0 (5 - 5) n1		1.0 (1 - 1) n3			
unknown	SP2480 (SP2480)		1.0 (1 - 1) n1					1.0 (1 - 1) n1
unknown	SP2550 (SP2550)				1.0 (1 - 1) n2	1.0 (1 - 1) n1		
unknown	SP2700 WP (SP2700)		3.0 (3 - 3) n1				1.0 (1 - 1) n1	1.0 (1 - 1) n1