



Ornamental Horticulture Program Research Project Sheet

<http://ir4.rutgers.edu/Ornamental/ornamentalProjectInformationSheets.cfm>

Project Name: Pythium Efficacy

New		Ongoing		Completed	X	Duration if ongoing or completed:	2006, 2007, 2010 - 2013
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Project Description:

Development of Pythium efficacy to screen active ingredients and expand current labels arose jointly with Phytophthora Efficacy at the 2005 IR-4 Ornamental Horticulture Program Workshop. Pythium root rots often occur on young seedlings as damping off and on other plants under stress. Pythium is part of a group of organisms known as water molds or close cousins of fungi. Banol, Subdue and Truban have been the standard management tools, however pockets of resistant populations to each have developed. Aliette has also been an effective tool. Additional products of different mode of actions are needed. Pythium diseases typically have been put on labels along with Phytophthora diseases, but the activity spectra are different. And as Pythium species are described and growers get more details diagnoses, it is becoming apparent that not all Pythium species respond to management tools similarly. Understanding which tool is the best to use for each is important for a better implementation of IPM and judicious use of products, especially when growers face economic difficulties where every dollar spent must positively impact the bottom line.

Research Project Abstract (if available):

Abstract from 2015 Pythium Efficacy Summary

At the IR-4 Ornamental Horticulture Program Workshop in 2009, Pythium Efficacy was selected as a high priority project to expand the knowledge and list of fungicides available to growers for these diseases. In addition to research collected through the IR-4 program, this summary includes a review of experiments conducted from 1999 to 2013 on ornamental horticulture and vegetable crops. During this time period, numerous products representing 40 active ingredients were tested as drench, foliar or soil applications against several *Pythium* species causing root rot and damping-off on ornamentals, and root rot, cottony leak, damping-off and cavity spot on vegetables. *Pythium* species tested included: *P. aphanidermatum*, *P. irregulare*, *P. mamillatum*, *P. dissotocum*, *P. myriotylum*, *P. ultimum* and *P. vicia*. Most trials were conducted on *P. aphanidermatum* and *P. ultimum*. Although there were insufficient data for definitive conclusions, several relatively new products that are included in the Pythium efficacy project looked promising. These were Adorn, Disarm, Fenstop, Heritage and Pageant. V-10208 also looked promising. The phosphorus acids/phosphorus acid generators (Agri-Fos, Alude, K-Phite, Magellan, Phostrol or Vital) provided mix results. Acibenzolar, BW240/Rootshield Plus and CG100 were generally ineffective. The established standards Subdue Maxx and Terrazole/Truban generally performed well. Conversely, the registered biological products Companion/QRD 713, PlantShield/RootShield and SoilGard generally looked ineffective. The data from these trials suggest that the effectiveness of some fungicides in controlling Pythium root rot may vary, depending on the species of *Pythium* or crop.

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

<i>Pythium aphanidermatum</i>	<i>Pythium dissotocum</i>	<i>Pythium ultimum</i>
<i>Pythium irregulare</i>	<i>Pythium myriotylum</i>	<i>Pythium vicia</i>
<i>Pythium mamillatum</i>		

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

Caladium (<i>Caladium x hortulanum</i>)	New Guinea Impatiens
Cockscomb (<i>Celosia</i> sp.)	Petunia (<i>Petunia x violacea</i>)
Douglas Fir (<i>Pseudotsuga menziesii</i>)	Poinsettia (<i>Euphorbia pulcherrima</i> .)
Geranium (<i>Pelargonium x hortorum</i>)	Snapdragon (<i>Antirrhinum majus</i>)
Larkspur (<i>Delphinium</i> sp.)	

Target Product(s) (list tested products or numbered compounds if ongoing or completed project)	
A13839B A14658C Acibenzolar-methyl Adorn (fluopicolide) Agri-Fos (dipotassium phosphonate + dipotassium phosphate) Aliette (fosetyl-Al) Alude (mono and dipotassium salts of phosphorous acid) Banol (propamocarb hydrochloride) Banrot (etr Diazole + thiophanate-methyl) BSEF-11 CG100 Disarm (fluoxastrobin) Fenstop (fenamidone) Heritage (azoxystrobin) Hymexazol	Insignia/Empress (pyraclostrobin) Magellan (Mono- and dibasic sodium, potassium and ammonium phosphites) Micora (mandipropamid) Pageant Intrinsic (boscalid + pyraclostrobin) QRD 713 (<i>Bacillus subtilis</i>) Remedier (<i>Trichoderma asperellum</i> and <i>T. gamsii</i>) RootShield (<i>Trichoderma harzianum</i> T-22) RootShield Plus (<i>Trichoderma harzianum</i> and <i>T. virens</i>) Segway (cyazofamid) SoilGard (<i>Gliocladium virens</i>) Subdue Maxx (mefenoxam) Terrazole (etr Diazole) Truban (etr Diazole) V-10208 Vital (potassium phosphite) ZeroTol (hydrogen dioxide)

Products/Crops Registered through IR-4 Research:					
	Fully Screened (also includes standards)		Partially Screened through IR-4 ¹		Need Data Across Species ?
Labeled Generally & Commercialized	Adorn *	RootShield Plus *	Banol	Hurricane	Actinovate
	Aliette		Banrot	PlantShield	Captan
	DisArm	Segway *	Cease	RootShield	Mycostop
	FenStop	Subdue	Companion	Phosphorus	Taegro
	Pageant *	Maxx *	Empress *	Acid Salts ¹	
		Terrazole	Heritage	SoilGard	
Labeled Generally But NOT Commercialized					
Labeled for Specific Pythium & Commercialized					
Labeled for Specific Pythium but NOT Commercialized					
Not yet registered or labeled for Pythium			Bas 703 06F		
			Bio-Tam		
			CG100		
			SP 2770 10WP		
			SP 2771		
No longer available for development for Pythium			A13839B		
			Micora (NOA 446510) *		
			Remedier		
			SP20155		
* IR-4 Data contributed to registration decision – either adding pest to label or not pursuing further research					
¹ Agri-Fos, Alude Magellan, Vital etc.					

Other:
 This project also tested tank mix and rotations to foster IPM strategies for managing resistance.

Project Pros	Project Cons
<ol style="list-style-type: none"> 1 Pythium efficacy does not mirror Phytophthora efficacy 2 Many products to continue to screen on identified Pythium species 3 Individual Pythium species vary in response 4 General labels could be refined by listing species – however, growers many not know which species they might have without detailed diagnostics 5 Dominate root rot 6 Not enough effective tools 	<ol style="list-style-type: none"> 1 Multiple years of data with successful registrations of products of different classes 2 Individual Pythium species vary in response 3 Many labels already list “Pythium diseases” on the label so further refinement of labels is not needed 4 Growers many not know which species they might have without detailed diagnostics

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).

‘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.

Product (Active Ingredients)	<i>Pythium aphanidermatum</i>	<i>Pythium dissotocum</i>	<i>Pythium irregulare</i>	<i>Pythium sp.</i>	<i>Pythium ultimum</i>	<i>Pythium vipa</i>
A13836B (A13836B)	3.5 (3 - 4) n2				1.0 (1 - 1) n1	
A14658C (A14658C)			3.0 (3 - 3) n1			
Actinovate Soluble (Streptomyces lydicus WYEC 108)				2.0 (2 - 2) n1 Labeled	1.0 (1 - 1) n1 Labeled	
Adorn 4F (Fluopicolide)	3.1 (1 - 5) n8 Labeled	1.0 (1 - 1) n2 Labeled	1.0 (1 - 1) n6 Labeled	3.0 (3 - 3) n1 Labeled	2.6 (1 - 5) n5 Labeled	2.5 (2 - 3) n2 Labeled
Agrifos (Dipotassium phosphonate + Dipotassium phosphate)	1.0 (1 - 1) n1 Labeled			3.0 (3 - 3) n1 Labeled	1.0 (1 - 1) n2 Labeled	
Aliette WDG (Fosetyl AI)	2.0 (1 - 3) n2 Labeled	3.0 (3 - 3) n1 Labeled	3.3 (3 - 4) n3 Labeled	1.0 (1 - 1) n1 Labeled	1.0 (1 - 1) n2 Labeled	3.0 (3 - 3) n1 Labeled
Alude (Potassium phosphite)	1.0 (1 - 1) n1 Labeled	3.0 (3 - 3) n1 Labeled	1.7 (1 - 3) n3 Labeled		1.8 (1 - 3) n4 Labeled	4.0 (4 - 4) n1 Labeled
BSEF-11 (Unknown)	1.0 (1 - 1) n2					
Captan (Captan)			2.0 (2 - 2) n2 Labeled		1.0 (1 - 1) n1 Labeled	
CG100 (Caprylic acid)	1.8 (1 - 5) n5	1.0 (1 - 1) n1	1.0 (1 - 1) n3	1.0 (1 - 1) n1	1.0 (1 - 1) n3	1.0 (1 - 1) n1
Disarm 480SC (Fluoxastrobin)	2.3 (1 - 5) n6	1.0 (1 - 1) n1	1.0 (1 - 1) n4	3.0 (3 - 3) n2	1.6 (1 - 3) n5	1.0 (1 - 1) n1
Fenstop (Fenamidone)	3.7 (3 - 5) n6 Labeled	1.0 (1 - 1) n1 Labeled	1.0 (1 - 1) n2 Labeled	3.5 (2 - 5) n2 Labeled	3.5 (2 - 5) n4 Labeled	1.0 (1 - 1) n1 Labeled
Heritage (Azoxystrobin)	2.1 (1 - 5) n9	1.0 (1 - 1) n2	2.2 (1 - 5) n5	1.0 (1 - 1) n1	1.2 (1 - 2) n5	1.5 (1 - 2) n2
Hymexazol 30L (Hymexazol)	2.5 (1 - 4) n2		1.7 (1 - 3) n3	3.0 (3 - 3) n1	1.0 (1 - 1) n1	
Insignia 20WDG Intrinsic Brand Fungicide (Pyraclostrobin)			2.0 (2 - 2) n2 Labeled		1.0 (1 - 1) n1 Labeled	
Insimmo (Acibenzolar-S-methyl)	1.0 (1 - 1) n2		3.0 (3 - 3) n1	1.0 (1 - 1) n1	1.5 (1 - 2) n2	
Magellan (Mono- and Dibasic Sodium, Potassium and Ammonium Phosphites)			1.0 (1 - 1) n2 Labeled	1.0 (1 - 1) n1 Labeled		
Micora (NOA 446510) (Mandipropamid)	2.0 (1 - 3) n2		1.0 (1 - 1) n1	3.0 (3 - 3) n1		
MultiGuard (Furfural)			1.0 (1 - 1) n2 Labeled	2.0 (2 - 2) n1 Labeled	1.0 (1 - 1) n1 Labeled	
Pageant 38WG (Boscalid + Pyraclostrobin)	2.7 (1 - 5) n7 Labeled	1.0 (1 - 1) n2 Labeled	3.0 (3 - 3) n1	2.0 (2 - 2) n1 Labeled	1.0 (1 - 1) n4 Labeled	1.0 (1 - 1) n2 Labeled
Remedier (Trichoderma asperellum + Trichoderma gamsii)				1.0 (1 - 1) n1		
RootShield Plus WP (aka BW240) (Trichoderma harzianum T-22 + Trichoderma virens G-41)	1.1 (1 - 2) n7 Labeled	1.0 (1 - 1) n2 Labeled	2.0 (2 - 2) n1	1.0 (1 - 1) n1 Labeled	1.0 (1 - 1) n3 Labeled	1.5 (1 - 2) n2 Labeled
Rotation: BW240 / Aliette (BW240 / Aluminum tris-phosphate)			1.0 (1 - 1) n1		1.0 (1 - 1) n1	

Product (Active Ingredients)	<i>Pythium aphanidermatum</i>	<i>Pythium dissotocum</i>	<i>Pythium irregulare</i>	<i>Pythium sp.</i>	<i>Pythium ultimum</i>	<i>Pythium vipa</i>
Rotation: BW240 / Phosphorus Acid (BW240 / Phosphorus Acid)	2.0 (2 - 2) n1					
Segway (Cyazofamid)	2.0 (2 - 2) n1 Labeled		3.0 (3 - 3) n2 Labeled	4.0 (3 - 5) n2 Labeled	3.0 (1 - 5) n2 Labeled	
SP2770 10WP (SP2770)		1.0 (1 - 1) n1	1.0 (1 - 1) n1		1.0 (1 - 1) n1	1.0 (1 - 1) n1
SP2771 (SP2771)		1.0 (1 - 1) n1	1.0 (1 - 1) n1		1.0 (1 - 1) n1	
Subdue MAXX (Mefenoxam)	3.5 (1 - 5) n6 Labeled	2.5 (2 - 3) n2 Labeled	3.3 (2 - 5) n3 Labeled	5.0 (5 - 5) n1 Labeled	2.3 (1 - 5) n3 Labeled	2.5 (2 - 3) n2 Labeled
Tank Mix: A14658C + Heritage (A14658C + azoxystrobin)			3.0 (3 - 3) n1			
Tank Mix: Acibenzolar + Heritage (Acibenzolar + Azoxystrobin)	1.0 (1 - 1) n2		3.0 (3 - 3) n1		1.0 (1 - 1) n2	
Tank Mix: Adorn + Subdue MAXX (Fluopicolide + mefenoxam)	3.5 (3 - 4) n2		1.0 (1 - 1) n1		3.0 (3 - 3) n1	
Tank Mix: BW420 + Alude (BW420 + Potassium phosphite)		1.0 (1 - 1) n1	1.0 (1 - 1) n1			2.0 (2 - 2) n1
Tank Mix: Heritage + Subdue MAXX (Azoxystrobin + mefenoxam)	3.0 (3 - 3) n1		5.0 (5 - 5) n1			
Terrazole 35%WP (Etridiazole)	5.0 (5 - 5) n1 Labeled		2.3 (1 - 5) n3 Labeled		5.0 (5 - 5) n2 Labeled	
Terrazole EC (Etridiazole)	3.5 (1 - 5) n4 Labeled		1.0 (1 - 1) n1	5.0 (5 - 5) n1 Labeled	1.0 (1 - 1) n1 Labeled	
V-10208 SC (V-10208)					4.0 (4 - 4) n1	
Vital 4L (Potassium phosphite)	1.5 (1 - 2) n2			4.0 (4 - 4) n1 Labeled	1.0 (1 - 1) n2 Labeled	

Fungicides (active ingredients)	FRAC Class	Registered Use Site(s)	REI	Application Method	Pythium Efficacy								
					<i>P. aphanidermatum</i>	<i>P. dissotocum</i>	<i>P. irregulare</i>	<i>P. mamillatum</i>	<i>P. myriotylum</i>	<i>Pythium spp.</i>	<i>P. ultimum</i>	<i>P. vicia</i>	
Actinovate (<i>Streptomyces lydicus</i>)	NC	G, N	1 h	D	?	?	?	?	?	?	?	?	?
Adorn (fluopicolide)	43	G, L, N S	12 h	D	P-E	P	P	F	?	P-E	P-E	P-G	
Aliette (fosetyl Al)	33	G, N	12 h	D	P-G	P	P-G	F	?	E	P-G	G	
Alude, Magellan, Vital, etc. (phosphorus acid salts)	33	G, N	4 h	D	?	P	G	F	?	G-E	P-G	E	
				F	P	?	?	?	?	?	?	?	
Banol, Proplant (propamocarb)	28	G, N	24 h	D	?	?	F	?	?	P	G	?	
Banrot (etridiazole+thiophanate methyl)	14 + 1	G	12 h	D	?	?	?	?	?	P-E	?	?	
Captan (captan)	M4	G	48 h	D	?	?	?	?	?	?	?	?	
Cease, Companion (<i>Bacillus subtilis</i>)	44	G, I, N, S	4 h	D	P	?	?	?	?	?	P	?	
Fenstop (fenamidone)	11	G	12 h	D	P	?	P	F	?	P-E	P-E	P	
Heritage (azoxystrobin)	11	G, L, N, S	4 h	D	P-E	P	P-E	F	E	P-E	P-G	P-G	
				F	G	?	?	?	?	?	?	?	
Hurricane (fludioxonil+mefenoxam)	12 + 4	G, I, N, S	48 h	D	G-E	P	G	E	E	?	F-E	G	
Insignia, Empress Intrinsic (pyraclostrobin)*	11	G, I, L, N, S	12 h	F	F-E	?	F-G	?	G-E	?	?	?	
				F	P-E	?	P-G	?	?	?	?	?	
Kleengrow (Didecyl dimethyl ammonium chloride)	-	G	48 h	D	?	?	?	?	?	?	?	?	
Mycostop (<i>Streptomyces griseoviridis</i>)	NC	G, N	4 h	D	?	?	?	?	?	?	?	?	
Pageant Intrinsic (pyraclostrobin+boscalid) ²	11+7	G, I, L, N, S	12 h	D	P-E	P	P-E	F	?	?	P-G	P	
				F	P-E	P	P	F	?	?	P-G	P	
PlantShield ³ , RootShield (<i>Trichoderma harzianum</i>)	NC	G, I, N, S	0 h	D	P	?	?	?	P	?	P	?	
Prestop (<i>Gliocladium catelunatum</i> strain J446)	NC	G, I, N, S	0 h	D	?	?	?	?	?	?	?	?	
RootShield Plus (<i>Trichoderma harzianum</i> + <i>Trichoderma virens</i>)	NC	G, I, N, S	0.4 h	D	?	P	P	?	?	?	P-G	P	
				F	G	?	?	?	?	?	?	?	
SoilGard (<i>Gladiolium virens</i>)	NC	G, I, N	0 h	D	P	?	?	?	?	?	P	?	
Subdue, Fenox (mefenoxam) ¹	4	G, L, N, S	0 or 48 h	D	G-E	P	P-E	G-E	E	?	F-E	G	
Terrazole, Truban (etridiazole)	14	G, N	12 h	D	E	?	P-F	E	?	?	F-E	?	
ZeroTol (hydrogen dioxide)	NC	G, I, N	0 h	D	?	?	?	?	?	?	?	?	
Experimentals													
A13839B*	-	TBD	-	D	G	?	?	?	?	?	?	?	?
A14658C	-	TBD	-	D	?	?	E	?	?	?	?	?	?
Bio-Tam (<i>Trichoderma asperellum</i> & <i>gamsii</i>)	NC	TBD	1 h	D	?	?	?	P	?	?	P	?	
CG100 (caprylic acid) *	-	TBD	?	D	P	P	P	F	?	?	P-F	P	
Disarm, Fame (fluoxastrobin)	11	TBD	12 h	D	P-E	P	P	E	?	?	P-F	P	

Fungicides (active ingredients)	FRAC Class	Registered Use Site(s)	REI	Application Method	Pythium Efficacy							
					<i>P. aphanidermatum</i>	<i>P. dissotocum</i>	<i>P. irregulare</i>	<i>P. mamillatum</i>	<i>P. myriotylum</i>	<i>Pythium spp.</i>	<i>P. ultimum</i>	<i>P. vicia</i>
Insimmo (acibenzolar)	P1	TBD	12 h	D	?	?	E	?	?	?	P	?
Rootmate, BW 240 (<i>Trichoderma virens</i> strain G-41)	NC	TBD	?	D	P	P	G	F	?	?	?	G
SP2015, Tanos (famoxadone +cymoxanil)*	11+27	TBD	12 h	S	P	?	?	?	?	?	?	?
SP2770 (SP2770) *	-	TBD	-	D	?	P	P	?	?	?	E	P
SP2771 (SP2771) *	-	TBD	-	D	?	P	P	?	?	?	G	P
Taegro (<i>Bacillus subtilis</i> var. <i>amyloliquefaciens</i>)	44	TBD	24 h	D	?	?	?	?	?	?	?	?

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

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).

* No longer available for development in ornamental horticulture crops

1 Pythium Efficacy taken from latest IR-4 Pythium efficacy summary and 4 additional IR-4 efficacy reports. If mefenoxam-resistant Pythium isolate used in a trial, data were not included for mefenoxam efficacy

2 Empress 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.

3 PlantShield is only registered in a few states.