

Project Name: Pythium Efficacy

New		Ongoing		Completed	X	Duration if ongoing or completed:	2006, 2007, 2010 – 2013, 2020 – 2021
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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):

Pythium aphanidermatum
Pythium irregulare
Pythium mamillatum

Pythium dissotocum
Pythium myriotylum

Pythium ultimum
Pythium vicia

Target Crops (list tested crops if ongoing or completed project)	
Cockscomb, Wool Flower (<i>Celosia sp.</i>) Fir, Douglas (<i>Pseudotsuga menziesii</i>) Garden Snapdragon (<i>Antirrhinum majus</i>) Geranium (<i>Geranium sp.</i>) Geranium (<i>Pelargonium sp.</i>) Geranium (<i>Pelargonium x domesticum</i>) Geranium (<i>Pelargonium x hortorum</i>)	Larkspur (<i>Delphinium sp.</i>) Madagascar Periwinkle (<i>Catharanthus roseus</i>) New Guinea Impatiens (<i>Impatiens hawkeri</i>) <i>Osteospermum ecklonis</i> <i>Osteospermum jucundum x barberiae</i> Petunia (<i>Petunia x violacea</i>) Poinsettia (<i>Euphorbia pulcherrima</i>)

Target Product(s)(list tested products or numbered compounds if ongoing or completed project)		
Actinovate Soluble Adorn 4F Agrifos Aliette WDG Alude Banol Calirus 150 Captan Cease Celero 16WVG CG100 Champ Formula 2F Daconil 54EC Daconil Ultrex Daconil Weather Stik (2787 Flowable Fungicide) Disarm 480SC Dithane 75DF Rainshield Fenstop Fluazinam Fore 80WP Gavel DF	Heritage Hymexazol 30L Insignia 20WDG Intrinsic Brand Fungicide K-Phite Magellan Maneb 75DF Medallion Micora MultiGuard Muscodor albus Orkestra Intrinsic Orvego (BAS 651F) Pageant Intrinsic Polyram Prestop Promax Proud 3 Regalia O5 (MOI-10605) Regalia SC (MOI 106) Remedier RootShield Plus WP (aka BW240)	SA 11210 Segovis Segway Serenade Prime (aka Rhapsody ASO) SP2770 10WP Stargus Stature DM Stature MZ Stature SC Subdue MAXX Taegro Tanos Terramec SP Terrazole 35%WP TM-459 Truban 25EC Truban 30WP V-10162 5.73FL Vital 4L ZeroTol

Products/Crops Registered through IR-4Research:					
	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.

Area	Characteristic	Pro	Con
Availability & effectiveness of alternative management tools	Pythium efficacy does not mirror Phytophthora efficacy	x	
	Some efficacious actives identified for further screening on identified Pythium species	x	
	Not enough effective tools	x	
	Root rot dominant disease	x	
	Individual Pythium species vary in response	x	x
	General labels could be refined by listing species – however, growers many not know which species they might have without detailed diagnostics	x	x
	Multiple years of data with successful registrations of products of different classes		x
	Many labels already list “Pythium diseases” on the label so further refinement of labels is not needed		x
Damage potential of target			
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	Awaiting data from 2020 and 2021 experiments; may not need additional data		x

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).



Environmental Horticulture Program Research Project Sheet

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

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'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	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 vicia</i>
FRAC 4	Subdue MAXX (Mefenoxam)	3.5 (1 - 5) n6 Labeled	2.5 (2 - 3) n2 Labeled	3.3 (2 - 5) n4 Labeled	5.0 (5 - 5) n1 Labeled	2.3 (1 - 5) n3 Labeled	2.5 (2 - 3) n2 Labeled
FRAC 7 + FRAC 11	Pageant Intrinsic (Boscalid + pyraclostrobin)	2.7 (1 - 5) n7 Labeled	1.0 (1 - 1) n2 Labeled	1.5 (1 - 3) n4 Labeled	2.0 (2 - 2) n1 Labeled	1.0 (1 - 1) n4 Labeled	1.0 (1 - 1) n2 Labeled
FRAC 11	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
FRAC 11	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
FRAC 11	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
FRAC 11	Insignia 20WDG Intrinsic Brand Fungicide (Pyraclostrobin)			2.0 (2 - 2) n2 Labeled		1.0 (1 - 1) n1 Labeled	
FRAC 11 + FRAC 4	Plentrix (Azoxystrobin + mefenoxam)			3.0 (3 - 3) n1 Labeled			
FRAC 11 + FRAC 4	Tank Mix: Heritage + Subdue MAXX (Azoxystrobin + mefenoxam)	3.0 (3 - 3) n1 Labeled		5.0 (5 - 5) n1 Labeled			
FRAC 14	Terrazole 35%WP (Etridiazole)	5.0 (5 - 5) n1 Labeled		2.3 (1 - 5) n3 Labeled		5.0 (5 - 5) n2 Labeled	
FRAC 14	Terrazole EC (Etridiazole)	3.5 (1 - 5) n4 Labeled		1.0 (1 - 1) n1 Labeled	5.0 (5 - 5) n1 Labeled	1.0 (1 - 1) n1 Labeled	
FRAC 21	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	
FRAC 32	Hymexazol 30L (Hymexazol)	2.5 (1 - 4) n2		1.7 (1 - 3) n3	3.0 (3 - 3) n1	1.0 (1 - 1) n1	
FRAC 40	Micora (Mandipropamid)	2.0 (1 - 3) n2		1.0 (1 - 1) n1	3.0 (3 - 3) n1		
FRAC 43	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
FRAC 43 + FRAC 4	Tank Mix: Adorn + Subdue MAXX (Fluopicolide + mefenoxam)	3.5 (3 - 4) n2 Labeled		1.0 (1 - 1) n1 Labeled		3.0 (3 - 3) n1 Labeled	
FRAC BM01	Tril-21 (Thyme oil)	1.0 (1 - 1) n1					
FRAC BM02	Actinovate Soluble (Streptomyces lydicus WYEC 108)				2.0 (2 - 2) n1 Labeled	1.0 (1 - 1) n1 Labeled	
FRAC BM02	Remedier (Trichoderma asperellum + Trichoderma gamsii)				1.0 (1 - 1) n1 Labeled		
FRAC BM02	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	1.8 (1 - 3) n4 Labeled	1.0 (1 - 1) n1 Labeled	1.0 (1 - 1) n3 Labeled	1.5 (1 - 2) n2 Labeled
FRAC M4	Captan (Captan)			2.0 (2 - 2) n2 Labeled		1.0 (1 - 1) n1 Labeled	
FRAC M5	Daconil ZN (Chlorothalonil)	5.0 (5 - 5) n1					

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FRAC P01	Insimmo (Acibenzolar-S-methyl)	1.0 (1 - 1) n2		3.0 (3 - 3) n1	1.0 (1 - 1) n1	1.5 (1 - 2) n2	
FRAC P01 + FRAC 11	Tank Mix: Acibenzolar + Heritage (Acibenzolar + Azoxystrobin)	1.0 (1 - 1) n2		3.0 (3 - 3) n1		1.0 (1 - 1) n2	
FRAC P07	Agrifos (Dipotassium phosphonate + Dipotassium phosphate)	1.0 (1 - 1) n1 <i>Labeled</i>			3.0 (3 - 3) n1 <i>Labeled</i>	1.0 (1 - 1) n2 <i>Labeled</i>	
FRAC P07	Aliette WDG (Fosetyl Al)	2.0 (1 - 3) n2 <i>Labeled</i>	3.0 (3 - 3) n1 <i>Labeled</i>	2.8 (1 - 4) n4 <i>Labeled</i>	1.0 (1 - 1) n1 <i>Labeled</i>	1.0 (1 - 1) n2 <i>Labeled</i>	3.0 (3 - 3) n1 <i>Labeled</i>
FRAC P07	Alude (Potassium phosphite)	1.0 (1 - 1) n1 <i>Labeled</i>	3.0 (3 - 3) n1 <i>Labeled</i>	1.7 (1 - 3) n3 <i>Labeled</i>		1.8 (1 - 3) n4 <i>Labeled</i>	4.0 (4 - 4) n1 <i>Labeled</i>
FRAC P07	Inosco (Potassium phosphite)			3.0 (3 - 3) n1 <i>Labeled</i>			
FRAC P07	Magellan (Mono- and Dibasic Sodium, Potassium and Ammonium Phosphites)			1.0 (1 - 1) n2 <i>Labeled</i>	1.0 (1 - 1) n1 <i>Labeled</i>		
FRAC P07	Vital 4L (Potassium phosphite)	1.3 (1 - 2) n3 <i>Labeled</i>			4.0 (4 - 4) n1 <i>Labeled</i>	1.0 (1 - 1) n2 <i>Labeled</i>	
FRAC P07 + FRAC 11	Tank Mix: Inosco + Heritage (Potassium phosphite + azoxystrobin)			3.0 (3 - 3) n1			
FRAC NC	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
FRAC NC / FRAC P07	Rotation: BW240 / Agrifos (BW240 / potassium phosphite)	1.0 (1 - 1) n1					
FRAC NC / FRAC P07	Rotation: BW240 / Aliette (BW240 / Aluminum tris-phosphate)			1.0 (1 - 1) n1		1.0 (1 - 1) n1	
FRAC NC / FRAC P07	Rotation: BW240 / Alude (BW240 / potassium phosphite)	2.0 (1 - 3) n2					
FRAC NC / FRAC P07	Rotation: BW240 / Phosphorus Acid (BW240 / Phosphorus Acid)	2.0 (2 - 2) n1			1.0 (1 - 1) n1		
FRAC NC / FRAC P07	Rotation: BW240/Vital (BW240 / potassium phosphite)	1.0 (1 - 1) n1					
FRAC NC + FRAC P07	Tank Mix: BW420 + Alude (BW420 + potassium phosphite)		1.0 (1 - 1) n1	1.0 (1 - 1) n1			2.0 (2 - 2) n1
unknown	A13836B (A13836B)	3.5 (3 - 4) n2				1.0 (1 - 1) n1	
unknown	BSEF-11 (BSEF-11)	1.0 (1 - 1) n2					
unknown	BW161N (BW161N)	5.0 (5 - 5) n1					
unknown	MBI 121 (MBI 121)	5.0 (5 - 5) n1					
unknown	MultiGuard (Furfural)			1.0 (1 - 1) n2 <i>Labeled</i>	2.0 (2 - 2) n1 <i>Labeled</i>	1.0 (1 - 1) n1 <i>Labeled</i>	
unknown	Picarbutrazox 20WG (Picarbutrazox)	5.0 (5 - 5) n1					
unknown	Picarbutrazox SC (NF-171) (Picarbutrazox)	5.0 (5 - 5) n1					

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unknown	SP2770 10WP (SP2770)		1.0 (1 - 1) n1	1.0 (1 - 1) n1		1.0 (1 - 1) n1	1.0 (1 - 1) n1
unknown	SP2771 (SP2771)		1.0 (1 - 1) n1	1.0 (1 - 1) n1		1.0 (1 - 1) n1	
unknown	V-10208 SC (V-10208)					4.0 (4 - 4) n1	

** Disarm 480SC is now known as Fame SC

FRAC Class	Fungicides (active ingredients)	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>
Experimental Products												
11 + 4	A13836B, Plenitrix (azoxystrobin + metalaxyl)			D	-	-	G-E	-	-	-	-	-
P1	Insimmo (acibenzolar)	TBD	12 h	D	-	-	E	-	-	-	P	-
U17	Picarbutrazox (picarbutrazox)	TBD	-	D	E	-	-	-	-	-	-	-
BM02	Bio-Tam (<i>Trichoderma asperellum</i> & <i>gamsii</i>)	TBD	1 h	D	-	-	-	P	-	-	P	-
-	BW161N (BW161N)	TBD	-	D	E	-	-	-	-	-	-	-
-	BW159	TBD										
-	CG100 (caprylic acid)	TBD	-	D	P	P	P	F	-	-	P-F	P
-	MBI 121	TBD	-	D	E	-	-	-	-	-	-	-
-	SP2770 (SP2770)	TBD	-	D	-	P	P	-	-	-	E	P
-	SP2771 (SP2771)	TBD	-	D	-	P	P	-	-	-	G	P
-	Tril-21	TBD	-	Sp	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, 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).

* No longer available for development in ornamental horticulture crops for this use

Efficacy ratings taken from the 2015 IR-4 Pythium efficacy summary, 8 additional IR-4 efficacy reports and 5 2011-2020 PDMR reports. If mefenoxam-resistant Pythium isolate used in a trial, data were not included for mefenoxam efficacy

¹ 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.

² PlantShield is only registered in a few states.

Updated 9/17/2021