

Project Name: Downy Mildew Efficacy

New		Ongoing		Completed	X	Duration if ongoing or completed:	2008-2009, 2013-2017, 2020
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Project Description:

This project arose out of the 2007 IR-4 Ornamental Horticulture Workshop due to a number of new downy mildews becoming common in ornamental horticulture production. Several new active ingredients were available for development and already registered products could be expanded. This project concluded after two seasons of testing, during which period several new products became available to growers including Adorn, Disarm, Pageant, and Segway.

Research Project Abstract (if available):

Abstract from 2017 Downy Mildew Efficacy Summary

In 2008, IR-4 initiated a high priority project to determine efficacy of several fungicides on downy mildew pathogens so data can be obtained to support current and future registrations. This research was conducted in 2008 and in 2009. Subsequently, Impatiens Downy Mildew (IDM) emerged, and studies on this disease sponsored in part by USDA-APHIS occurred from 2013 through to 2016. In addition to research collected from 12 studies through the IR-4 program from 2008 to 2016, this summary includes a review of 38 experiments conducted from 2000 to 2014 on ornamental horticulture crops. During this time period, numerous products representing 41 active ingredients were tested as foliar or drench applications against several species causing downy mildew on ornamentals. Most products are registered and commercially used. Most tests were conducted on *Plasmopara obducens* (impatiens downy mildew); other species tested included *Peronospora lamii* (lamium downy mildew), *Peronospora sp.* (coleus downy mildew), *Peronospora sparsa* (rose downy mildew), *Peronospora statives* (limonium downy mildew), *Peronospora antirrhini* (snapdragon downy mildew), and *Plasmopara viburni* (viburnum downy mildew). Although there were insufficient data for definitive conclusions, five relatively new products that are included in the Downy Mildew efficacy project: Adorn (V-10161) was effective for impatiens, lamium and snapdragon downy mildews; Orvego (BAS 651F) provided good to excellent control of coleus, impatiens, lamium and snapdragon downy mildews; Micora (NOA 446510) provided good to excellent control of coleus, impatiens, lamium and snapdragon downy mildews; Regalia exhibited excellent control of impatiens downy mildew, and good control of lamium, snapdragon and viburnum downy mildews at the higher rate; and Segovis applied as drench provided excellent control of impatiens downy mildew.

Basil downy mildew, caused by *Peronospora belbahrii*, has become a major problem in the production of basil in the United States since it was first reported in south Florida in 2007. We reviewed 31 available trials published in Plant Disease Management Reports to check efficacy of experimental and registered fungicides on basil downy mildew. Generally, Revus (mandipropamid), Quadris/Amistar (azoxystrobin), and Reason (fenamidone) applied as sprays, and Ridomil Gold (mefenoxam) drench or spray provided good to excellent efficacy. Efficacy of Ranman (cyazofamid) spray was variable. Two new products Zorvec/QGU42 (oxathiopiprolin) and Zampro/BAS 651 (ametoctradin + dimethomorph also provided excellent efficacy. The phosphorus acid fungicides (including Agri-Fos, K-Phite, Nutri-Phyte, Phostrol, Prophyt) and the products for organic production, including biofungicides (Actinovate, Companion, Double Nickel, Regalia, Serenade, Sonata), and copper fungicides (Badge X2, Cueva, Kocide, Nordox, Nu-Cop) generally provided poor efficacy.

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

<i>Peronospora lamii</i>	<i>Plasmopara obducens</i>
<i>Peronospora sparsa</i>	<i>Plasmopara viburni</i>
<i>Peronospora sp.</i>	



Environmental Horticulture Program Research Project Sheet

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

Target Crops (list tested crops if ongoing or completed project)	
Coleus (<i>Solenostemonscutellarioides</i>)	Rose (<i>Rosa sp.</i>)
Dead Nettle (<i>Lamiummaculatum</i>)	Snapdragon (<i>Antirrhinum majus</i>)
Impatiens (<i>Impatiens walleriana</i>)	<i>Viburnum odoratissimum</i>

Target Product(s)(list tested products or numbered compounds if ongoing or completed project)	
Adorn 4F (Fluopicolide)	Orkestra Intrinsic (fluxapyroxad + pyraclostrobin)
Aliette WDG (Fosetyl Al)	Orvego (Ametoctradin + dimethomorph)
Alude (Potassium phosphite)	Pageant Intrinsic (Boscalid + Pyraclostrobin)
Disarm 480SC (Fluoxastrobin)	Regalia 50 (Extract of <i>Reynoutriasachalinensis</i>)
Fenstop (Fenamidone)	Regalia SC (Extract of <i>Reynoutriasachalinensis</i>)
Heritage (Azoxystrobin)	Segovis SC (oxathiapiprolin)
Inosco (phosphorous acid generator)	SP2015 (SP2015)
Insignia Intrinsic (Pyraclostrobin)	SP2770 10WP
Micora (Mandipropamid)	Stature SC (Dimethomorph)
	Subdue MAXX (Mefenoxam)

Product Registration and Research Status				
	Fully Screened (also includes standards)	Partially Screened through IR-4 ¹	Need Data Across Species ?	
Labeled Generally & Commercialized	Affirm Dithane 75DF Protect DF Segway Stature SC Subdue MAXX *	Adorn 4F * Heritage * Inosco * Micora * Orkestra * Orvego * Regalia 50 * Regalia SC * Segovis *	Aliette WDG Alude Compass O 50WDG Disarm 480SC	Fenstop Insignia Pageant 38WG Triact 70
Labeled Generally But NOT Commercialized				
Labeled for Specific Diseases & Commercialized				
Labeled for Specific Diseases but NOT Commercialized				
Not yet registered or Labeled				
No longer available for development	Cygnus SP2015 SP2770 10WP			
* 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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Area	Characteristic	Pro	Con
Availability & effectiveness of alternative management tools	New downy mildew disease are becoming more prevalent with little known about how products will perform		
	IDM Efficacy unknown resistance	x	
	Efficacy different on different species	x	
	Rose DM	x	
	Viburnum DM	x	
	Labels are already generally labeled for growers to apply for downy mildew diseases		x
	Many available products		x
	Some growers can manage disease with existing tools		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	Some MFG prefer to label by species	x	
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	Product (Active Ingredients)	Downy Mildew (<i>Peronospora sp.</i>)	Downy Mildew of Mint, Coleus (<i>Peronospora lamii</i>)	Downy mildew of rose (<i>Peronospora sparsa</i>)	Impatiens Downy Mildew (<i>Plasmopara obduscens</i>)	Viburnum Downy Mildew (<i>Plasmopara viburni</i>)
FRAC 4	Subdue MAXX (Mefenoxam)	5.0 (5 - 5) n1	2.3 (1 - 5) n15	3.0 (3 - 3) n1		
FRAC 7 + FRAC 11	Orkestra Intrinsic (Fluxapyroxad + pyraclostrobin)		1.0 (1 - 1) n2 Labeled			
FRAC 7 + FRAC 11	Pageant Intrinsic (Boscalid + pyraclostrobin)			3.0 (3 - 3) n1 Labeled		
FRAC 11	Disarm 480SC (Fluoxastrobin) *	3.3 (2 - 5) n3 Labeled		3.0 (3 - 3) n1 Labeled	4.0 (4 - 4) n1 Labeled	5.0 (5 - 5) n1 Labeled
FRAC 11	Fenstop (Fenamidone)	4.0 (3 - 5) n2 Labeled				
FRAC 11	Heritage (Azoxystrobin)	3.7 (3 - 5) n3 Labeled		3.5 (3 - 4) n2 Labeled	1.0 (1 - 1) n1 Labeled	5.0 (5 - 5) n1 Labeled
FRAC 11	Insignia 20WDG Intrinsic Brand Fungicide (Pyraclostrobin)			4.0 (4 - 4) n1 Labeled		
FRAC 11 + FRAC 27	SP2015 (SP2015)	4.0 (4 - 4) n1				
FRAC 22	Zoxamide (Zoxamide)		1.0 (1 - 1) n1			
FRAC 40	Micora (Mandipropamid)	3.7 (3 - 5) n3 Labeled		4.0 (3 - 5) n2 Labeled	4.0 (4 - 4) n1 Labeled	2.0 (2 - 2) n1 Labeled
FRAC 40	Stature SC (Dimethomorph)	4.0 (3 - 5) n2 Labeled	1.0 (1 - 1) n1 Labeled	3.0 (3 - 3) n1 Labeled		3.0 (3 - 3) n1 Labeled
FRAC 40 + FRAC 7 + FRAC 11 / FRAC P07	Rotation: Stature + Pageant / Alude (Dimethomorph + Boscalid + Pyraclostrobin / Potassium phosphite)		3.0 (3 - 3) n1			
FRAC 40 + FRAC 7 + FRAC 11	Tank Mix: Stature + Pageant (Dimethomorph + Boscalid + Pyraclostrobin)		1.0 (1 - 1) n1			
FRAC 43	Adorn 4F (Fluopicolide)	3.0 (1 - 5) n3 Labeled	2.0 (1 - 5) n15 Labeled	4.0 (3 - 5) n2 Labeled	1.0 (1 - 1) n1 Labeled	1.0 (1 - 1) n1 Labeled
FRAC 43 + FRAC P07	Tank Mix: Adorn + Alude (Fluopicolide + phosphorous acid)		5.0 (5 - 5) n3			
FRAC 45 + FRAC 40	Orvego (BAS 651F) (Ametoctradin + dimethomorph (BAS 651))	4.3 (3 - 5) n3 Labeled	1.0 (1 - 1) n1 Labeled	5.0 (5 - 5) n1 Labeled	1.0 (1 - 1) n1 Labeled	4.0 (4 - 4) n1 Labeled

MOA	Product (Active Ingredients)	Downy Mildew (<i>Peronospora sp.</i>)	Downy Mildew of Mint, Coleus (<i>Peronospora lamii</i>)	Downy mildew of rose (<i>Peronospora sparsa</i>)	Impatiens Downy Mildew (<i>Plasmopara obduscens</i>)	Viburnum Downy Mildew (<i>Plasmopara viburni</i>)
FRAC 49	Segovis (Oxathiapiprolin)		4.8 (4 - 5) n8 Labeled			
FRAC 49 / FRAC P07	Rotation: Segovis / Inosco (Oxathiapiprolin / Potassium phosphite)		5.0 (5 - 5) n2			
FRAC BM01	Regalia O5 (MOI-10605) (Extract of Reynoutria sachalinensis)	3.0 (3 - 3) n1 Labeled		3.0 (3 - 3) n1 Labeled		
FRAC BM01	Regalia SC (MOI 106) (Extract of Reynoutria sachalinensis)	2.5 (1 - 4) n2			4.0 (4 - 4) n1	3.0 (3 - 3) n1
FRAC P07	Aliette WDG (Fosetyl Al)	3.0 (3 - 3) n1				
FRAC P07	Alude (Potassium phosphite)		2.8 (1 - 5) n14 Labeled	3.0 (3 - 3) n1 Labeled		
FRAC P07	Inosco (Potassium phosphite)		2.6 (1 - 4) n10 Labeled			
FRAC P07 / FRAC 7 + FRAC 11	Rotation: Alude/Orkestra (Potassium phosphite / fluxapyroxad + pyraclostrobin)		4.0 (4 - 4) n2			
FRAC P07 + FRAC 49	Tank Mix: Alude + Segovis (Potassium phosphite + oxathiapiprolin)		5.0 (5 - 5) n3			
FRAC P07 + FRAC 4	Tank Mix: Alude + Subdue (Potassium phosphite + mefonaxom)		5.0 (5 - 5) n3			
unknown	MBI 121 (MBI 121)		1.0 (1 - 1) n1			
unknown	SP2770 10WP (SP2770)		1.0 (1 - 1) n3			
unknown	TDA-NC-1 (TDA)		1.0 (1 - 1) n1			

* Disarm 480SC is now known as Fame SC

FRAC Class	Fungicides (active ingredients)	Registered Use Site(s)	REI	Application Method	Downy Mildew Efficacy							
					<i>Peronospora antrrhini</i>	<i>Peronospora lamii</i>	<i>Peronospora sp.</i>	<i>Peronospora sparsa</i>	<i>Plasmopara obducens</i>	<i>Plasmopara viburni</i>	<i>Basil Downy Mildew</i>	
Registered Products												
4	Subdue MAXX, Fenox, Ridomil Gold (mefenoxam)	G, L, N, S	48 h	D	-	-	E	G	E	-	E	
				S	-	P-G	E	P-G	P-E	-	E	
7 + 11	Broadform (fluopyram + trifloxystrobin)	G, I, L, N, S	12 h	S	-	-	-	-	G	-	-	
	Orkestra, BAS703 (fluxapyroxad + pyraclostrobin)	G, L, N, S	12 h	S	-	-	-	-	P	-	-	
11	Compass (trifloxystrobin)	G, I, L, N, S	12 h	S	P	-	-	-	-	-	-	
	Cygnus (kresoxym-methyl)	G, L, N, S	12 h	S	-	-	-	-	-	-	-	
	Disarm (fluoxastrobin)	G, I, N, S	12 h	S	-	P	P-E	P	E	P	-	
	Fenstop, Reason (fenamidone)	G	12 h	S	G	-	P-E	E	-	-	G-E	
	Heritage, Quadris, Amistar (azoxystrobin)	F, G, N, S	4h	D	-	-	-	-	-	-	-	?
				S	P	F-G	P-E	P	G-E	P	P-E	
Insignia (pyraclostrobin)	G, I, L, N, S	12 h	S	G	G	-	P	-	-	-		
11 + 3	Strike Plus (trifloxystrobin + triadimefon)	G, N	12 h	S	-	-	-	-	-	-	-	
11 + 7	Pageant (pyraclostrobin + boscalid)	G, I, L, N, S	12 h	S	-	G	-	G	G-E	-	F-E -	
19	Affirm, Veranda (polyoxin D zinc salt)	G, L, N, S	4 h	S	-	-	-	-	-	-	-	
21	Segway, Ranman (cyazofamid)	G, N	12 h	S	-	-	-	-	E	-	P-E	
40	Micora, Revus (mandipropamid)	F, G, L, N, S	4 h	S	-	G	P-E	P	E	P	P-E	
	Stature (dimethomorph)	G, L, N	12 h	S	G	G	P-E	P	P-E	P	-	
43	Adorn (fluopicolide)	G, L, N, S	12 h	D	-	-	P-F	P	P-E	P	P	
				S	-	F-E	E	G	E	-	P-E	
45 + 40	Orvego (ametoctradin+dimethomorph)	G, I, L, N, S	12 h	S	-	-	E	-	P-E	-	P-E	
49	Segovis, A21008A, SYN546539 (oxathiapiprolin)	G, L, N, S	4 h	D	-	-	-	E	E	-	-	
				S	-	-	-	E	-	-	F-E -	
BM 01	Triact 70, Trilogy (neem oil extract)	G, I, L, N, S	4 h	S	-	-	-	-	-	-	-	
BM 02	Actinovate (<i>Streptomyces lydicus</i>)	F, G, I, L, N, S	1 h	D	-	-	-	-	-	-	P-F	
				S	-	-	-	-	-	-	-	
	Cease, Rhapsody, Serenade, etc. (<i>Bacillus subtilis</i>)	G, I, N, S	4 h	S	-	-	-	-	P	-	P	
	Double Nickel (<i>Bacillus amyloquefaciens</i> strain D747)	F, G, I, L, N, S	4 h	S	-	-	-	-	-	-	P	
	Stargus, MBI 110 (<i>Bacillus amyloliquifaciens</i> strain F727)	G, N, S	4 h	-	-	-	-	-	-	-	-	
Zonix (<i>Pseudomonas aeruginosa</i>)	G, N	4 h	S	-	-	-	-	P	-	-		
P 05	Regalia (extract of <i>Reynoutria sachalinensis</i>)	G, L, I, N, S	4 h	S	-	F	P-G	P	G	P	P-F	
P 07	Aliette (fosetyl Al)	G, N	12 h	D	-	-	P	-	P	-	-	
				S	G	-	P	G	P	-	-	

FRAC Class	Fungicides (active ingredients)	Registered Use Site(s)	REI	Application Method	Downy Mildew Efficacy						
					<i>Peronospora antrrhini</i>	<i>Peronospora lamii</i>	<i>Peronospora</i> sp.	<i>Peronospora sparsa</i>	<i>Plasmopara obducens</i>	<i>Plasmopara viburni</i>	<i>Basil Downy Mildew</i>
P 07	Alude, Magellan, Vital, K- Phyte, Prophyt, etc. (phosphorus acid salts)	F, G, N	4 h	D	-	-	-	-	P-E	-	-
				S	-	F	P-E	-	P-E	-	P-E
	OxiPhos (Mono- and di-potassium salts of phosphorus acid + hydrogen peroxide)	G	4 h	S	-	-	-	-	-	-	-
M1	Champion, Kentan, Kocide, etc. (copper hydroxide)	G, I, N, S	48 h	S	-	-	-	-	-	-	P
	Phyton (copper sulfate pentahydrate)	G, I, N	24 h	S	-	-	-	-	-	-	-
M3	Dithane, Protect, Pentathlon, etc. (mancozeb)	G, N	24 h	S	E	-	P	G	E	?	-
M1 + M3	Junction (copper hydroxide + mancozeb)	G, N	24 h	S	-	-	-	-	-	-	-
NC	Milstop (potassium bicarbonate)	F, G, I, L, N, S	1 h	S	-	-	-	-	-	-	-
	Kleengrow (Didecyl dimethyl ammonium chloride)	G	48 h	S	-	-	-	-	-	-	-
	Oxidate (hydrogen dioxide + peroxyacetic acid)	F, G	1 h	S	-	-	-	-	-	-	P
Experimental Products											
11 + 27	SP2015, Tanos (famoxadone +cymoxanil)*	TBD	12 h	S	-	G	-	P	-	-	-
P 07	Inosco, A14658C (potassium phosphite)	TBD	-	S	-	-	-	G	P-E	-	-
U17	Picarbutrazox (picarbutrazox)	TBD	-	S	-	-	-	-	E	-	-
-	A21591 SC (A21591)	TBD	-	S	-	-	-	-	-	-	E
-	MBI 121 (MBI 121)	TBD	-	S	-	-	-	-	P	-	-
-	SP2770 (SP2770)	TBD	?	D	-	-	-	-	P	-	-
-	TDA-NC-1	TBD	-	S	-	-	-	-	P	-	-

Registered Use Sites: G = Greenhouse; L = Lath House; I = Indoors; N = Nursery; S = Shade House; TBD = To Be Determined; F = Field (for basil)

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).

Efficacy ratings taken from the 2017 DM efficacy summary, 1 IR-4 efficacy report, and 3 2017-2021 PDMR reports. If mefenoxam resistant downy mildew isolate used in a trial, data were not included for mefenoxam efficacy.

* No longer available for development in environmental horticulture crops