Project Name: Whitefly Efficacy

New		Ongoing		Completed	X	Duration if ongoing or completed:	2002 - 2009, 2012 - 2013

Project Description:

Whiteflies have plagued ornamental horticulture plant growers for generations. With the advent of the Bemisia Q Biotype (MED) whitefly entering the United States, examining available tools for use within an integrated pest management program became a priority. From data generated through IR-4 and other sources, a Whitefly Management Plan was created based on the best available information. This document was fluid and adjusted over time as new data were developed.

Research Project Abstract (if available):

Abstract from 2014 Whitefly Efficacy Summary

Whiteflies are significant pests of ornamental horticulture crops. Three whiteflies species and biotypes contribute to crop production losses in the United States: greenhouse whitefly (*Trialeurodes vaporariorum*), silverleaf whitefly B biotype (*Bemisia tabaci* B Biotype), and silverleaf whitefly Q biotype (*Bemisia tabaci* Q Biotype). From 2002 through 2013, 87 products or rotational/tank mix treatments comprised of 49 different active ingredients were tested through this screening program. In addition to research collected through the IR-4 program, this summary includes a review of experiments conducted from 2004 to 2013 on ornamental horticulture crops. The best products for Q biotype eradication, and those that should be reserved for critical situations, were Judo and Safari. However, Avid, Sanmite, and TriStar also demonstrated effective control and should be utilized routinely as part of the overall management program for Bemisia whiteflies.

Mycoinsecticides under these testing conditions did not perform as well as anticipated for Q biotype whitefly management. Several new products that are included in the IR-4 Whitefly efficacy project looked promising based on their efficacy relative to standards. These include A20520A, GF-2626, GF-2860 and NNI-0101. Further research is needed to obtain additional efficacy data to recommend actions to register or amend labels for these pests. Studies on resistance development indicated potential for Q biotype resistance under intense insecticide pressure.

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

Greenhouse Whitefly (Trialeurodes vaporariorum)	*Bemisia B-Biotype (MEAM1)*
	Bemisia Q-Biotype (MED)

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

Marigold (*Tagetes sp.*)	Sage, Scarlet (*Salvia splendens*)
Pentas (*Pentas sp.*)	Vervain (*Verbena sp.*)
Poinsettia (*Euphorbia pulcherrima*)	Wishbone Flower (*Torenia sp.*)

Target Product(s) (list tested products or numbered compounds if ongoing or completed project)			
Acelepryn Agri 50 Aria 50SG Aria 50WG Avid 0.15EC Botanigard 22WP BotaniGard ES Celero 16WSG DPX-HGW86 EcoTrol Endeavor	ERASE Flagship 25WG GF-2626 1SC GrandEvo (MBI 203 DF) Judo 2SC Kontos Marathon II MilStop M-Pede NoFly WP Ornazin 3%EC	Orthene TTO 97 Pedestal Preferal ProMate Revoke Proud 3 Pyranica QRD 400 Rycar Safari 20SG Sanmite Scimitar CS	Sucrocide SuffOil X Talus 40SC Tame 2.4 EC TriCon (BW 420) TriStar 30SG TriStar 70WSP Ultra Pure Oil Venerate (MBI 206 F) Xxpire 40WG

Product Registration and Research Status			
	Fully Screened (also includes standards)	**Partially Screened through IR-4** [1]	**Need Data Across Species ?**
Labeled for Whiteflies Generally & Commercialized	Flagship 25WG Judo 2SC Marathon II Onyx Ornazin 3%EC Orthene TTO 97 Pedestal **Safari 20SG *** Scimitar CS Sun Spray Ultra-Fine oil Talus 40SC Ultra Pure Oil	Aria 20SG Botanigard 22WP Kontos **Mainspring *** NoFly WP Preferal **Rycar *** TriStar 30SG **Xxpire 40WG ***	EcoTrol Endeavor Flagship 0.22G Grandevo (MBI203) DF Hachi-Hachi M-Pede Safari 2G SuffOil X
Labeled for Whiteflies Generally But NOT Commercialized			
Labeled for Specific Whiteflies & Commercialized	Sanmite		
Labeled for Specific Whiteflies but NOT Commercialized			
Not yet registered or labeled for Whiteflies		A16901B	MilStop
No longer available for development for Whiteflies	**Acelepryn *** DPX-HGW86 GF-2626 1SC	Celero 16WSG	

* IR-4 Data contributed to registration decision – either adding pest to label or not pursuing further research
1 At least one species screened fully, for example Q Biotype Whitefly
2 Product not available for production ornamentals

Project Pros	Project Cons
1 Whiteflies are a chronic problem and resistance can build rapidly in populations 2 There are several new active ingredients not yet registered 3 Efficacy on non Bemisia whiteflies (a number of new invasive species grower & landscape)	1 There are multiple mode of action classes already registered

IR-4 Efficacy Trials to Date

Average rating on a scale of 1 – 5 with 1 = 0 to about 50% efficacy and 5 = 100 efficacy or equivalent to non-inoculated control; minimum to maximum rating; number of trials. For product/insect combinations that are blank, IR-4 has not screened this combination.
A rating of 2 or lower is considered unacceptable efficacy (*red text*). A rating of 3 or higher is considered commercially acceptable and those with more than 3 trials are complete (**green text**). 'Labeled' indicates that IR-4 generated data in at least one trial and that this insect species or genera is listed on the label. For insect/product combinations that are blank, IR-4 has not screened this combination.

Product (Active Ingredients)	Greenhouse Whitefly	Bemisia B-biotype	Bemisia Q-biotype
Acelepryn (aka DPX-E2Y45) 1.67 (Chlorantraniliprole)		*2.0 (1 - 3) n2*	*1.5 (1 - 2) n2*
Agri-50 (Propylene glycol alginate (hydrated))		*1.0 (1 - 1) n2*	
Aria 50SG (Flonicamid)	5.0 (5 - 5) n1 Labeled		*2.5 (2 - 3) n2 Labeled*
Aria N 50WG (Flonicamid)		*1.0 (1 - 1) n3 Labeled*	
Avid 0.15EC (Abamectin)			3.3 (2 - 4) n3 Labeled
Botanigard 22WP (Beauveria bassiana GHA)			*1.5 (1 - 2) n2 Labeled*
BotaniGard ES (BioWorks) (Beauveria bassiana)		*1.0 (1 - 1) n2 Labeled*	*1.5 (1 - 2) n2 Labeled*
Celero 16WSG (Clothianidin)			*2.3 (2 - 3) n3 Labeled*
DPX-HGW86 (Cyantraniliprole)			3.0 (3 - 3) n1 Labeled
EcoTrol (Rosemary Oil)		*1.0 (1 - 1) n2*	*2.0 (2 - 2) n1*
Endeavor (Pymetrozine)		*1.0 (1 - 1) n2 Labeled*	
ERASE (Jojoba oil)			*1.0 (1 - 1) n1*
Flagship 25WG (Thiamethoxam)	5.0 (5 - 5) n1 Labeled	5.0 (5 - 5) n1 Labeled	3.0 (2 - 4) n6 Labeled
GF-2626 1SC (Sulfoxaflor)		**4.0 (3 - 5) n2**	
Grandevo (MBI 203 DF) (Chromobacterium subtsugae NRRL B-30655)		*2.3 (1 - 4) n3 Labeled*	
Judo 2SC (Spiromesifen)		5.0 (5 - 5) n3 Labeled	3.9 (3 - 5) n8 Labeled
Kontos (BYI 8330 240SC) (Spirotetramat)			3.4 (1 - 5) n9 Labeled
Mainspring (A20520A) 200SC (Cyantraniliprole)		5.0 (5 - 5) n2 Labeled	
Marathon II (Imidacloprid)			*1.6 (1 - 5) n10 Labeled*

Product (Active Ingredients)	Greenhouse Whitefly	Bemisia B-biotype	Bemisia Q-biotype
MilStop (Potassium bicarbonate)			*2.0 (2 - 2) n1*
M-Pede (Horticulture Soap)			3.5 (2 - 5) n2 Labeled
NoFly WP (Paecilomyces fumosoroseous strain FE 9901)		3.0 (3 - 3) n2 Labeled	
Ornazin 3%EC (Azadirachtin)			*1.0 (1 - 1) n1 Labeled*
Orthene TTO 97 (Valent) (Acephate)	3.0 (3 - 3) n1 Labeled		
Pedestal (Novaluron)		3.0 (3 - 3) n2 Labeled	*1.0 (1 - 1) n1 Labeled*
Preferal (SePro) (Isaria fumosoroseus)		*2.0 (1 - 3) n2 Labeled*	
ProMate Revoke (Potassium salts of fatty acids)			*2.0 (2 - 2) n1*
Proud 3 (Thyme oil (5.6%))		*1.5 (1 - 2) n2*	
Pyranica (Tebufenpyrad)		*2.0 (2 - 2) n1*	
QRD 400 (Extract of Chenopodium ambrosioides)			*2.0 (2 - 2) n1*
Rotation: Judo 4SC / Avid (Spiromesifen / abamectin)			**5.0 (5 - 5) n1**
Rotation: Marathon / Avid (Imidacloprid / abamectin)			*1.0 (1 - 1) n2*
Rotation: Safari 20SG / Avid (Dinotefuron / abamectin)			**5.0 (5 - 5) n2**
Rotation: Safari 20SG / Judo (Dinotefuran / spiromesefin)			**5.0 (5 - 5) n1**
Rotation: Tristar 30SG / Sanmite (Acetamiprid / pyribdaben)			*2.0 (2 - 2) n1*
Rycar (SP3009/NNI-0101) (Pyrifluquinazon)		5.0 (5 - 5) n4 Labeled	
Safari 20SG (Dinotefuran)	5.0 (5 - 5) n2 Labeled		4.5 (3 - 5) n22 Labeled
Sanmite (BASF) (Pyridaben)			3.0 (3 - 3) n2 Labeled
Scimitar CS (Lambda-cyhalothrin)			*2.0 (2 - 2) n1 Labeled*
Sucrocide (Sucrose octanoate ester)			*2.0 (2 - 2) n1*
SuffOil X (Synergy) (Petroleum Oil)			5.0 (5 - 5) n1 Labeled
Talus 40SC (Buprofezin)	*1.0 (1 - 1) n1 Labeled*	5.0 (5 - 5) n2 Labeled	
Tame 2.4 EC (Fenpropathrin)			*2.0 (2 - 2) n1*
Tank Mix: Avid 0.15EC + Scimitar (Abamectin + cyfluthrin)			*2.0 (2 - 2) n1*
Tank Mix: Avid 0.15EC + Tame (Abamectin + fenpropathrin)			*2.0 (2 - 2) n1*
TriCon (BW 420) (Sodium tetraborahydrate decahydrate)			*2.0 (2 - 2) n1*
TriStar 30SG (Acetamiprid)	5.0 (5 - 5) n1 Labeled	4.0 (3 - 5) n2 Labeled	3.8 (3 - 5) n5 Labeled
TriStar 70WSP (Acetamiprid)			4.0 (3 - 5) n2 Labeled
Ultra Pure Oil (BASF) (Petroleum Oil)		4.0 (3 - 5) n3 Labeled	
Venerate (MBI 206 F) (Burkholderia sp. strain A396)		*2.3 (1 - 4) n3*	
Xxpire (GF-2860) 40WG (Spinetoram + sulfoxaflor)		4.8 (4 - 5) n4 Labeled	

Registered and Experimental Products for Whitefly Management

Foliar Applied Insecticides (active ingredients)	IRAC Class	Registered Use Site(s)	Knock Down	Residual Control (days)	REI	Whitefly Efficacy			Life Stage			Treatment Program			
												A	B	C	D
						B. tabaci B- Biotype	*B. tabaci* Q- Biotype	Greenhouse Whitefly	Immatures	Pupae	Adults	Aggressive	Maintenance w/out biological	Maintenance with Biologicals	Maintenance prior to biologicals
Adept (diflubenzuron)	15	G, I, S	S	7	12 h	?	?	?	x	?	?	?	B	C	D
Aria (flonicamid)	9C	G, I, N	M	7-14	12 h	F	P-E	E	x	?	x	?	B	C	D
Astro, Permethrin.Pro, etc. (permethrin)	3A	G, I	F	5-7	12 h	?	?	?	x	?	?	?	B	NO	NO
Avid EC (abamectin)	6	G, N, S	F	Contact 7	12 h	P-E	G-E	?	x	?	x	A	B	C **	D
Azatin XL, Ornazin, etc. (azadirachtin)	18B	G, I, N, S	S	7	4 h	E	P	?	x	?	?	?	?	C	D
BotaniGard, Mycotrol-O, etc. (*Beauveria bassiana*)	-	G, I, N, S	M	3	4 h	P-G	P-E	?	x	x	x	A	B	C *	D
Decathlon (cyfluthrin)	3A	G, I, N	F	7	12 h	?	?	?	x	?	x	?	B	NO	NO
Discus (cyfluthrin+imidacloprid)	3 + 4A	N	F	5-7	12 h	?	?	?	x	?	x	?	B	NO	NO
Distance (pyriproxyfen)	7C	G, I, L, S	S	?	12 h	E	P-E	?	x	x		A	?	C	D
Duraguard, Dursban (chlorpyrifos)	1B	G, N	F	5-7	24 h	?	P	?	x	?	x	?	B	NO	NO
Ecotrol (rosemary and peppermint oils)	-	G, N	?	?	-	?	?	?	x	?	x	?	?	?	?
Endeavor (pymetrozine)	9B	G, I, L, N, S	M	2-4	12 h	P	?	?	x	?	x	?	?	C	D
Enstar AQ (kinoprene)	7A	G, I, L, S	S	7	4 h	P	?	?	x	?	?	A	A	C	D
Flagship 25WG (thiamethoxam)	4A	G, I, L, N, S	F	7-14 [b]	12 h	G-E	P-E	G	x	?	x	A	B	NO	? [c]
Grandevo, MBI-203 DF (*Chromobacterium subtsugae* strain PRAA4-1^{T})	-	G, N	S	?	4 h	P-G	?	?	x	?	x	?	?	?	?
Hachi-Hachi EC (tolfenpyrad)	21A	G	F	7-14	12 h	?	?	?	x	?	x	A	B	NO	?
Judo (spiromesifen)	23	G, N, S	M	7	12 h	F-E	G-E	G	x	?	x	A	B	?	?
Kontos, BYI-8330 (spirotetramat)	23	G, I, N	S	7-14	24 h	E	G-E	?	x	?	x	A	B	?	?
Magus (fenazaquin)	21	G, I, N, S	F	Contact	12 h	?	?	?	x	?	x	?	B	C**	D
Mainspring, A20520A, DPX-HGW86 (cyantraniliprole)	28	G, I	F	?	4 h	G-E	?	?	x	?	?	?	B	?	?
Malathion	1B	G, N	F	5-7	12 h	?	?	?	x	?	x	?	B	NO	NO
Marathon (imidacloprid)	4A	G, I, N	F	5-7	12 h	F-E	P-E	G	x	?	x	?	B	NO	NO
Mavrik (fluvalinate)	3A	G, I, N	F	14	12 h	?	?	?	x	?	x	?	B	NO	NO
Milstop [d] (potassium bicarbonate)	NC	G, I, L, N, S	?	?	4 h	?	?	?	x	?	?	?	?	?	?
M-Pede, Safer Soap (potassium salts of fatty acids)	-	G, I, N	F	Contact	12 h	E	F-E	?	x	?	?	A	B	C **	D
NoFly WP (*Paecilomyces fumosoroseus* strain FE 9901)	-	G	M	3-7	4 h	F -E	F-E	F-E	x	?	x	A	B	C	D
Orthene T&O, Acephate 97 UP (acephate)	1B	G, N	F	7	24 h	?	?	G	x	?	x	A	B	NO	NO
Pedestal (novaluron)	15	G, N, S	S	7-14	12 h	?	P	?	x	?	?	A	B	C **	D
Preclude-TR (fenoxycarb)	7B	G	S	7	12 h	?	?	?	x	?	?	?	B	?	?
Preferal, PFR-97 (*Isaria fumosoroseus)*	-	G, L, N, S	S	Contact	4 h	G	?	?	x	?	x	A	B	C	D

Information presented is based on the best data available on *July 23, 2015*.

Registered and Experimental Products for Whitefly Management

Foliar Applied Insecticides (active ingredients)	IRAC Class	Registered Use Site(s)	Knock Down	Residual Control (days)	REI	Whitefly Efficacy			Life Stage			Treatment Program			
						B. tabaci B- Biotype	*B. tabaci* Q- Biotype	Greenhouse Whitefly	Immatures	Pupae	Adults	A Aggressive	B Maintenance w/out biological	C Maintenance with Biologicals	D Maintenance prior to biologicals
Prentox Pyronyl Crop Spray, Pyrenone Crop Spray, etc. (pyrethrins + PBO)	3A +	G, N	F	Contact	12 h	?	?	?	x	?	x	?	B	NO	NO
Proud 3 (thyme oil)	-	?	?	5-7	0 h	P	?	?	x	?	x	?	?	?	?
Rycar, NNI-0101 (pyrifluquinazon)	UN	G	?	10	12 h	E	?	?	x	?	x	?	B	?	?
Safari 20SG (dinotefuran)	4A	G, N	M	7	12 h	E	G-E	E	x	?	x	A	B	?	?
Sanmite (pyridaben)	21	G	M	Contact	12 h	P	G-E	G	x	?	x	A	B	NO	NO
Scimitar GC (lambda-cyhalothrin)	3A	G, N, S	F	7	24 h	?	?	?	x	?	x	?	B	NO	NO
Sucrashield (sucrose octanoate)	-	G, N	?	Contact	48 h	?	?	?	x	?	x	?	B	?	?
Sorbishield 90 (sorbitol octanoate)	-	G, N	?	Contact	24 h	?	?	?	x	?	x	?	B	?	?
Talstar (bifenthrin)	3A	G, I, N	F	7	12 h	?	P	?	x	?	x	?	B	NO	NO
Talus (buprofezin)	16	G, L, N, S	S	14	12 h	E	P	G	x	?	?	A	B	C	D
Tame (fenpropathrin)	3	G, I, L, N, S	F	7	24 h	?	P	?	x	?	x	?	B	NO	NO
Triact, Trilogy Neem Oil (extract of neem oil)	18B	G, N	S	7	4 h	?	?	?	x	?	?	?	?	C	D
TriStar (acetamiprid)	4A	G, L, N, S	F	7	12 h	E	E	G	x	?	x	A	B	NO	NO
Ultra pure oil, SuffOil-X, etc. (paraffinic oil)	-	G, N	F	Contact	4 h	G-E	G	?	x	x	x	A	B	C **	D
XXpire GF-2860 (spinoteram+sulfoxaflor)	5+4C	G, N	F	14	12 h	G-E	?	?	x	?	x	?	B	?	?
Experimental Products															
Arena, Celero (clothianidin)	4A	TBD	F	?	12 h	F-G	P-E	?	x	?	x	?	B	?	?
GF-2626 1SC	-	TBD	?	?	?	E	?	?	?	?	?	?	?	?	?
IKI-3106 (cyclaniliprole)	-	TBD	?	?	?	?	?	?	?	?	?	?	?	?	?
Venerate, MBI-206 (*Burkholderia* sp. strain A396)	-	G, N	?	?	?	P-G	?	?	x	?	?	?	?	?	?

Registered Use Sites: G = Greenhouse; L = Lath House; I = Indoors; N = Nursery; S = Shade House; TBD = To Be Determined
Knockdown: Fast (< 1 day), Medium (1-7 days), Slow (>7 days).
Efficacy: P = Poor (< 70% control); F = Fair (70% to 85% control); G = Good (85% to 95% control), E = Excellent (>95% control) on immatures and/or adults 1 to 3 weeks after first app.

Residual Control taken from product technical and label info, recommendations on earliest application intervals; Whitefly Efficacy taken from latest IR-4 efficacy summary draft; Effect on biological control agents for whiteflies taken from Koppert, Biobest and some extension publications/recommendations.

* Results of efficacy trials have been variable for entomopathogens and impact on beneficial organisms is presumed to be less than that of traditional pesticide chemistries but the data are sparse.
** This insecticide is toxic to many BCA's but has a short residual and may be suitable for treating hot spots and re-introducing BCA's soon thereafter.
**** Drenches of this product are typically less problematic than foliar applications and can be used in a maintenance program if additional releases are made.
[a] No longer available for testing
[b] Flagship applied as drench can provide over 60 days residual activity.
[c] Syngenta comment: It is possible that a 2-3 week wait time after a spray treatment could allow releases to occur later. More info is needed.
[d] Milstop has a New York 2ee recommendation to control whiteflies, aphids, mealybugs, spider mites and stink bugs.

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