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IR-4 Ornamental Horticulture Program
Pyrifluquinazon Crop Safety and Efficacy

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Acknowledgements

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Table of Contents

Table of Contents	2
Table of Tables	3
Abstract	4
Introduction.....	5
Materials & Methods	5
Results.....	5
Results: Scale & Mealybug.....	5
Armored Scale	5
Euonymus Scale.....	7
Holly Pit Scale	7
False Florida Red Scale	8
Results: Thrips	10
Chili Thrips (<i>Scirtothrips dorsalis</i>)	10
Comparative Efficacy on Gladiolus Bulb Thrips (<i>Thrips simplex</i>).....	12
Comparative Efficacy on Privet Thrips (<i>Dendothrips ornatus</i>)	14
Comparative Efficacy on Western Flower Thrips (<i>Frankliniella occidentalis</i>)	14
Marigold.....	16
Verbena.....	18
Phytotoxicity	21
Label Suggestions	24
Appendix 1: Protocols.....	25
Appendix 2: Contributing Researchers.....	29
Appendix 3: Submitted Data Reports	30

Table of Tables

Table 1.	Efficacy on Armored Scale on Wax Myrtle, Chong, SC, 2009a.	6
Table 2.	Efficacy on Euonymus Scale on Spindle Tree ‘Microphylla’, Frank, NC, 2009.....	6
Table 3.	Efficacy on Euonymus Scale on Euonymus ‘Sunspot’, Nielsen, OH, 2009.....	7
Table 4.	Efficacy on Holly Pit Scale on Holly, ‘East Palatka’, Buss, FL, 2009.....	8
Table 5.	Population Averages False Florida Red Scale on Chinese Holly ‘Carissa’, Chong, SC, 2009.	9
Table 6.	Average Percent Mortality of False Florida Red Scale on Chinese Holly , ‘Carissa’, Chong, SC, 2009.....	9
Table 7.	Efficacy of several insecticides for <i>Scirtothrips dorsalis</i> on ‘Knockout’ Rose – Experiment 3 – Application Rates and Dates, Ludwig, 2008a.	10
Table 8.	Efficacy of several insecticides for <i>Scirtothrips dorsalis</i> on ‘Knockout’ Rose – Experiment 3, Ludwig, 2008a.....	11
Table 9.	Efficacy of Gladiolus Bulb Dip Applications on Gladiolus Thrips (<i>Thrips simplex</i>), Smitley & Davis, MI, 2006.	12
Table 10.	Privet Thrips Control on New Mexican Privet (<i>Foresteria neomexicana</i>), Cranshaw, CO 2008.....	14
Table 11.	Western Flower Thrips Control on Cosmos (<i>Cosmos bipinnatus</i>) ‘Picotee’, Cranshaw, 2008a.....	15
Table 12.	Western Flower Thrips Control on Marigold (<i>Tagetes patula</i>) ‘Yellow Boy’ – Application Rates and Dates, Davis, MI 2008.....	16
Table 13.	Western Flower Thrips Control on Marigold (<i>Tagetes patula</i>) ‘Yellow Boy’, Davis, MI 2008.	17
Table 14.	Western Flower Thrips Control on Marigold (<i>Tagetes patula</i>) ‘Jaguar’, Gilrein, NY 2008.....	17
Table 15.	Western Flower Thrips Control on Marigold ‘Hero Mix’ – Application Rates and Dates, Oetting, GA 2008.....	18
Table 16.	Western Flower Thrips Control and Flower Damage Rating on Marigold ‘Hero Mix’, Oetting, GA 2008.....	18
Table 17.	Western Flower Thrips Control on Verbena ‘Lorgo Purple’ – Application Rates and Dates, Oetting, GA 2008.....	19
Table 18.	Western Flower Thrips Control on and Damage on Verbena ‘Lorgo Purple’, Oetting, GA 2008.....	20
Table 19.	Summary of Pyrifluquinazon Crop Safety and Efficacy	22

Abstract

Pyriproxyfen is a new active ingredient for the management of sucking pests, such as aphids, thrips, whiteflies and more. Its mode of action is to halt insect feeding so that they starve. This prevents additional damage to plant tissues and limits spread of viral diseases. Pyriproxyfen was initially registered in Japan in 2007, and Nichino America is planning on submitting the US registration package in 2010. IR-4 started including pyriproxyfen into the efficacy testing program in 2006. Pyriproxyfen demonstrated efficacy on several scale species including *Melanaspis deklei*, euonymus scale, and false florida red scale, but the level of efficacy did vary among species and between experiments. Pyriproxyfen provide some reduction of western flower thrips immatures but this was highly variable from some suppression to little impact. For chili thrips, pyriproxyfen did provide excellent efficacy through 20DAT. No significant phytotoxicity was observed.

Introduction

Pyriproxyfen is a new insecticide which causes insects to stop feeding, preventing further plant damage and minimizing the transmission of viral diseases. This chemistry is active on aphids, whiteflies, mealybugs, thrips, leafhoppers, scale and true bugs. IR-4 started including NNI-0101 (pyriproxyfen) in the efficacy testing program in 2006.

Materials & Methods

This summary covers crop safety and efficacy research on NNI-0101 (pyriproxyfen). The efficacy research has been summarized previously within the 2009 Thrips Efficacy Summary and the 2010 Scale and Mealybug Summary. Details on the efficacy protocols and methodology can be found in these reports posted at <http://ir4.rutgers.edu/Ornamental/ornamentalSummaryReports.cfm>. This summary also covers preliminary reports on crop safety.

Pyriproxyfen was provided to researchers by Nichino USA.

Results

Pyriproxyfen demonstrated efficacy on several scale species including *Melanaspis deklei*, euonymus scale, and false florida red scale, but the level of efficacy did vary among species and between experiments.

Pyriproxyfen provide some reduction of western flower thrips immatures but this was highly variable from some suppression to little impact. For chili thrips, pyriproxyfen did provide excellent efficacy through 20DAT.

Results: Scale & Mealybug

Armored Scale.

In 2009, Chong conducted studied efficacy for armored scale (*Melanaspis deklei*) on wax myrtle (*Myrica cerifera*). All insecticides, Distance, Talus, Safari and paraffinic oil, significantly reduced armored scale population by 6 weeks after treatment (Table 1). The management of *M. deklei* may require repeated applications of insecticides at the time of crawler emergence over a 2-3 year period.

No phytotoxicity was observed on any of the treated wax myrtle shrubs.

Table 1. Efficacy on Armored Scale on Wax Myrtle, Chong, SC, 2009a.

Treatment	Rate	Application Method	Population Averages (Henderson's Percent Control)				
			Pretreatment Counts	1 WAT	2 WAT	4 WAT	8 WAT
Aloft LC SC(Clothianidin + Bifenthrin)	10 fl oz/100 gal	Sprench	1.6 a	0.6 a (0)	0.8 a (0)	3.2 a (0)	0.4 a (32)
Flagship 25 WG (thiamethoxam)	4 g/ft height	Drench	0.5 a	0.9 a (0)	0.2 a (5)	0.1 a (90)	0.2 a (0)
Flagship 0.22G (thiamethoxam)	227 g/ft height	Broadcast	10.1 a	0.6 a (81)	1.0 a (76)	15.7 a (20)	3.2 a (14)
NNI-0101 (pyrifluquinazon)	18 fl oz/100 gal	Foliar	4.6 a	1.8 a (0)	1.6 a (17)	5.0 a (44)	0.4 a (76)
Orthene TTO (acephate)	8 oz/100 gal	Foliar	0.6 a	1.1 a (0)	2.0 a (0)	4.7 a (0)	3.1 a (0)
Safari 20SG (dinotefuran)	6 g/ft height	Drench	0.2 a	0.9 a (0)	0.3 a (0)	0.7 a (0)	0.2 a (0)
Safari 2G (dinotefuran)	60 g/ft height	Soil surface	3.2 a	0.7 a (31)	0.7 a (48)	0.5 a (92)	0.0 a (100)
TriStar 30 SG (acetamiprid) + Capsil	8 oz/100 gal + 6 fl oz/100 gal	Foliar	2.8 a	0.8 a (10)	0.6 a (49)	3.3 a (39)	1.3 a (0)
Untreated	-	-	1.9 a	0.6 a (0)	0.8 a (0)	3.7 a (0)	0.7 a (0)

* Means within a column followed by the same letter are not significantly different based on data analysis using PROC GLM for completely randomized design with sub-sampling (SAS).

Table 2. Efficacy on Euonymus Scale on Spindle Tree 'Microphylla', Frank, NC, 2009.

Treatment	Rate	Application Method	Population Averages (Henderson's Percent Control)				
			Pretreatment Counts	1 WAT	2 WAT	4 WAT	6 WAT
Acephate 75WP	0.67 lb/100 gal	Foliar	151.2 a	68.0 c (45)	4.3 d (82)	2.5 c (85)	0.5 b (93)
Distance 10EC (pyriproxyfen)	12 fl oz/100 gal	Foliar	102.3 a	50.8 c (40)	5.7 d (64)	0.5 c (96)	0.2 b (96)
Flagship 0.22G (thiamethoxam)	60 g/plant	Broadcast	203.7 a	108.0 bc (0)	32.0 abc (0)	18.0 b (0)	3.7 b (0)
Flagship 25WG (thiamethoxam) + Dyne-Amic	8 oz/100gal	Foliar	184.5 a	103.0 bc (32)	12.3 cd (57)	0.5 c (98)	1.3 b (86)
NNI-0101 20SC (pyrifluquinazon)	18 fl oz/100 gal	Foliar	265.2 a	160.2 ab (27)	9.5 cd (77)	1.3 c (96)	1.2 b (91)
Safari 2G (dinotefuran)	7.8 g/plant	Broadcast	166.7 a	167.0 bc (0)	3.2 ab (88)	1.0 c (95)	0.5 b (94)
Safari 20SG (dinotefuran)	24 oz/100gal	Drench	213.0 a	129.7 ab (0)	39.7 d (0)	5.0 c (0)	1.2 b (0)
Talus 40 SC (buprofezin)	21.5 fl oz/100 gal	Foliar	204.3 a	65.0 c (61)	4.7 d (85)	2.7 c (88)	0.2 b (98)
TriStar 30 SG (acetamiprid) + Capsil	8 oz/100 gal + 6 fl oz/100 gal	Foliar	158.3 a	111.5 bc (14)	17.3 bcd (30)	4.2 c (76)	2.5 b (68)
Untreated	-	-	151.2 a	68.0 c (45)	4.3 d (82)	2.5 c (85)	0.5 b (93)

* Means followed by same letter do not significantly differ (Duncan's New MRT, P=0.05)

Euonymus Scale.

In 2009, Frank evaluated the efficacy of neonicotinoids (Flagship, Safari and TriStar), insect growth regulators (Distance and Talus) and NNI-0101 on Euonymus scale (*Unaspis euonymi*) infesting Spindle Tree (*Euonymus japonica*) ‘Mycrophylla’. All treatments significantly reduced scale population, comparable to the standard Acephate (Table 3).

No phytotoxicity was observed on any of the treated plants.

In 2009, Nielsen investigated the efficacy of neonicotinoids (Flagship, Safari and TriStar), insect growth regulators (Distance and Talus) and NNI-0101 (pyrifluquinazon) on Euonymus Scale (*Unaspis euonymi*) infesting Euonymus (*Euonymus vegetus*) ‘Fortunei’ in the landscape.

In this study using euonymus in containers, foliar sprays of Distance, Talus and UltraFine oil, and Safari drench provided a high level of scale control. TriStar looked promising, but Flagship, NNI-0101 and Safari top-dress were relatively ineffective. These statements reflect the number of live adults 91 days after treatment. With a single application during the crawler stage may not be the best timing for systemic products. Or multiple applications may be needed as indicated with the high level of nymph mortality for most products 15 DAT.

No phytotoxicity was observed.

Table 3. Efficacy on Euonymus Scale on Euonymus ‘Sunspot’, Nielsen, OH, 2009.

Treatment	Rate	Application Method, Timing	% Nymph Mortality 15 DAT (6/27/09)	# Live adult scales 91 DAT (9/11/09)
Distance 10EC (pyriproxyfen)	12 fl oz/100 gal	Foliar, June 12, 26	99	0 a
Flagship 0.22G (thiamethoxam)	114 g/ft. ht	Top-dress, June 26	-	100+
Flagship 25WG (thiamethoxam)	8 oz/100gal	Foliar, June 12, 26	63	75 b
NNI-0101 20SC (pyrifluquinazon)	12 fl oz/100 gal	Foliar, June 12, 26	49	100+
Safari 2G (dinotefuran)	60 g/ft. ht	Top-dress, June 12	71	38
Safari 20SG (dinotefuran)	6 g/ft. ht	Drench, June 12	91	3
Talus 40 SC (buprofezin)	21.5 fl oz/100 gal	Foliar, June 12, 26	92	0
TriStar 30 SG (acetamiprid)	8 oz/100 gal	Foliar, June 12, 26	88	91
UltraFine Oil	3 % solution	Foliar, June 12, 26	90	0
Untreated	-	-	15	100+

*/ Treatments were applied 10-14 days after first crawler hatch..

**/ Foliage was examined with the aid of a 10x binocular scope to determine scale health.

a/ Some living nymphs.

b/ Some adults malformed.

Holly Pit Scale

Holly pit scale (*Aterolecanium puteanum*) attacks certain hollies including American holly, Burford holly, and Japanese holly. It causes pitting and distortion of woody tissue on branches and trunk of the tree. Severe infestations may result in branch dieback.

In 2009, Buss conducted a test on the efficacy of neonicotinoids (Aloft, Flagship, Safari and TriStar), insect growth regulators (Distance and Talus) and NNI-0101 (pyrifluquinazon) for control of holly pit scale on holly (*Ilex x attenuata*). A single application was made as the crawlers were emerging.

No statistically significant differences were observed until 6 weeks after treatment (Table 4). At this date, only Aloft provided good control, but according to Buss the scale infestation may have been better managed by the systemic products if another treatment were applied 1-2 months after the first application, or, if a horticultural oil or other contact insecticide had been applied during the extended crawler dispersal period. With systemic insecticides, one has to wait until the crawlers settle, begin feeding, and receive a lethal dose before control is achieved.

Several trees exhibited phytotoxicity by quickly dropping their leaves, but all treatments were statistically similar with very mild impacts numerically. The trees reflushed and did not seem to suffer from the treatments.

Table 4. Efficacy on Holly Pit Scale on Holly, ‘East Palatka’, Buss, FL, 2009.

Treatment	Rate per 100 gal	Application Method	Number of holly pit scale nymphs				
			Pretreat	1 WAT	2 WAT	4 WAT	6 WAT
Aloft SC	10 fl oz	Foliar	44.7 a	131.5 a (0)	90.8 a (0)	123.2 a (0)	26.5 a (80)
Distance IGR	12 fl oz	Foliar	31.0 a	281.3 a (0)	217.5 a (0)	386.7 a (0)	181.8 c (57)
Flagship 25WG	4 gm/in DBH	Drench	55.5 a	343.7 a (0)	243.0 a (0)	177.5 a (0)	74.7 abc (62)
NNI-0101 20SC	18 fl oz	Foliar	64.0 a	137.5 a (17)	153.0 a (0)	155.5 a (0)	58.7 abc (66)
Orthene TTO	8 oz	Foliar	26.2 a	262.7 a (0)	157.8 a (11)	80.2 a (29)	45.8 ab (48)
Safari 20SG	6 g/ft ht	Sprench	38.0 a	170.5 a (0)	153.2 a (0)	108.8 a (0)	43.2 ab (64)
Safari 2G	60 g/ft ht	Soil surface	155.8 a	350.5 a (13)	117.5 a (50)	222.2 a (0)	91.2 abc (63)
Talus 40 SC	21.5 fl oz	Foliar	17.8 a	313.5 a (0)	191.5 a (9)	255.0 a (0)	76.2 abc (73)
TriStar 30 SG	8 oz	Foliar	102.2 a	204.5 a (23)	77.7 a (43)	190.0 a (0)	80.0 abc (62)
Untreated	-	-	122.5 a	316.5 a (0)	212.7 a (0)	151.2 a (0)	166.2 bc (0)

* Means within columns with the same letter are not significantly different ($P < 0.05$, LSD test).

False Florida Red Scale. In 2009, Chong evaluated the efficacy of neonicotinoids (Flagship, Safari and TriStar), insect growth regulators (Distance and Talus) and NNI-0101 (pyrifluquinazon) applied to false Florida red scale (*Chrysomphalus bifasciculatus*) on Chinese Holly (*Ilex cornuta*) ‘Carissa’. Insecticide treatments did not significantly reduce the numbers of live scales in the first 2 weeks after the application (Table 5). At 4 and 6 WAT, only Flagship and Safari provided effective control false Florida red scale, causing 99% mortality (Table 6). However, all products did reduce populations below that of the untreated hollies. For NNI-0101, an additional observation on the next crawler stage could have determined the actual impact because of its unique mode of action as an antifeedant.

No phytotoxicity was observed on any of the treated holly shrubs.

Table 5. Population Averages False Florida Red Scale on Chinese Holly ‘Carissa’, Chong, SC, 2009.

Treatment	Rate	Application Method	Population Averages (Henderson’s Percent Control)				
			Pretreatment Counts	1 WAT	2 WAT	4 WAT	6 WAT
Distance 10EC (pyriproxyfen)	12 fl oz	Foliar	28.9 a	12.4 a (87)	12.9 a (94)	4.5 b (93)	10.7 bc (88)
Flagship 25 WG (thiamethoxam)	4 g/ft height	Drench	33.3 a	24.2 a (78)	84.6 a (64)	14.3 ab (81)	1.1 c (99)
NNI-0101 20SC (pyrifluquinazon)	18 fl oz/100 gal	Foliar	49.5 a	24.6 a (85)	14.2 a (96)	12.3 ab (89)	21.0 abc (86)
Paraffinic oil	2 gal/100 gal	Foliar	49.6 a	44.7 a (73)	47.8 a (86)	14.0 ab (87)	17.6 abc (88)
Safari 20SG (dinotefuran)	6 g/ft height	Drench	11.1 a	16.8 a (55)	24.3 a (69)	2.2 b (91)	0.2 c (99)
Talus 40 SC (buprofezin)	21.5 fl oz/100 gal	Foliar	58.1 a	47.8 a (75)	44.6 a (89)	36.3 a (72)	30.4 ab (82)
TriStar 30 SG (acetamiprid) + Capsil	8 oz/100 gal + 6 fl oz/100 gal	Foliar	41.2 a	50.3 a (63)	30.3 a (90)	15.3 ab (83)	11.6 abc (91)
Untreated	-	-	14.5 a	48.5 a (0)	101.8 a (0)	32.1 a (0)	43.3 a (0)

* Means within columns with the same letter are not significantly different (LSD test, $P < 0.10$).

Table 6. Average Percent Mortality of False Florida Red Scale on Chinese Holly , ‘Carissa’, Chong, SC, 2009.

Treatment	Rate	Application Method	Average % Mortality				
			Pretreatment	1 WAT	2 WAT	4 WAT	6 WAT
Distance 10EC (pyriproxyfen)	12 fl oz	Foliar	85.9 a	90.8 a	93.8 a	96.8 a	95.1 ab
Flagship 25WG (thiamethoxam)	4 g/ft height	Drench	72.6 a	80.5 a	81.0 a	90.6 abc	99.4 a
NNI-0101 20SC (pyrifluquinazon)	18 fl oz/100 gal	Foliar	73.5 a	84.6 a	89.8 a	93.3 abc	90.9 bc
Paraffinic oil	2 gal/100 gal	Foliar	67.5 a	83.9 a	79.4 a	94.0 abc	89.3 bc
Safari 20SG (dinotefuran)	6 g/ft height	Drench	85.8 a	89.6 a	91.8 a	98.5 a	99.9 a
Talus 40SC (buprofezin)	21.5 fl oz/100 gal	Foliar	71.3 a	80.0 a	76.4 a	82.1 bc	88.6 bc
TriStar 30SG (acetamiprid) + Capsil	8 oz/100 gal + 6 fl oz/100 gal	Foliar	62.3 a	71.9 a	81.3 a	90.0 abc	90.6 bc
Untreated	-	-	86.7 a	80.9 a	73.3 a	75.8 c	80.3 c

* Means within columns with the same letter are not significantly different (LSD test, $P < 0.10$).

Results: Thrips

IR-4 has sponsored research on several thrips species – chilli thrips (*Scirtothrips dorsalis*), gladiolus thrips (*Thrips simplex*), privet thrips (*Dendothrips ornatus*), weeping fig thrips (*Gynaikothrips uzeli*), and western flower thrips (*Frankliniella occidentalis*). The following discussions are organized by thrips species. Within each species the experiments are presented in groups based on crop and then by researcher.

Chili Thrips (*Scirtothrips dorsalis*)

Chilli thrips (*Scirtothrips dorsalis*) is a newly invasive species to the United States. Since its introduction in 2006, chilli thrips has been moved throughout the southern U.S. on nursery stock. It has been found in commercial retail nurseries as well as established in landscapes. Chilli thrips is known to infest over 250 ornamental horticulture plant species and also can cause significant damage to food crops such as pepper and blueberry.

During 2008, Ludwig conducted an containing Hachi-Hachi and NNI-0101 (Table 7). By 13 DAT, Avid, Conserve, MOI 201, NNI 0101, Pylon, and Hachi-Hachi (tolfenpyrad) provided good to excellent control; Avid, MOI 201, NNI0101, and Pylon continued to provide good control through 20 DAT (Table 8).

Table 7. Efficacy of several insecticides for *Scirtothrips dorsalis* on ‘Knockout’ Rose – Experiment 3 – Application Rates and Dates, Ludwig, 2008a.

Treatment (Active Ingredient)	Application Method – Rate per 100 gal	Application Dates		
		6/10 0 DAT	6/17 7 DAT	6/24 14 DAT
Avid (abamectin)	Foliar – 8 fl oz	X	X	
Conserve SC (spinosad)	Foliar – 6 fl oz	X	X	
Hachi-Hachi (tolfenpyrad)	Foliar – 21 fl oz	X	X	
MOI 201	Foliar – 0.8 quarts	X	X	
NNI 0101	Foliar – 6.38 fl oz	X	X	
NNI 0101	Foliar – 3.19 fl oz	X	X	
Overture 35WP (pyridalyl)	Foliar – 8 fl oz	X	X	
Pylon (chlorfenapyr)	Foliar – 5 fl oz	X	X	
QRD400	Foliar – 130 fl oz	X	X	X
Scimitar	Foliar – 5 fl oz	X	X	
Talstar	Foliar – 21.5 fl oz	X	X	
Unsprayed Control				

Table 8. Efficacy of several insecticides for *Scirtothrips dorsalis* on ‘Knockout’ Rose – Experiment 3, Ludwig, 2008a.

Treatment (Active Ingredient)	Population Counts ^z , Means Separations ^y , and Percent Control ^x				
	-1 DAT Meristems	6 DAT Meristems	13 DAT Meristems	20 DAT Meristems	27 DAT Flowers
<i>Adults</i>					
Avid (8 fl oz)	7.7 cde	0.3 d (91)	0.0 f (100)	0.5 de (78)	0.2 d (65)
Conserve (6 fl oz)	4.2 e	3.0 cd (0)	0.7 cdef (55)	0.2 e (84)	0.5 cd (0)
Hachi-Hachi (tolfenpyrad) (21 fl oz)	11.5 bcd	6.2 ab (0)	0.5 cdef (88)	0.5 de (85)	0.8 cd (5)
MOI201 (0.8 quarts)	9.2 bcd	3.2 abcd (21)	1.0 cde (70)	0.8 cde (70)	0.2 d (70)
NNI 0101 (6.38 fl oz)	7.0 de	0.7 cd (0)	0.3 def (0)	1.3 cde (0)	2.3 bc (0)
NNI 0101 (3.19 fl oz)	9.2 bcd	1.8 cd (0)	0.3 ef (0)	0.2 e (0)	0.2 d (0)
Overture (8 fl oz)	7.7 cde	8.8 a (0)	2.0 abcd (0)	2.7 bc (0)	1.0 cd (0)
Pylon (5 fl oz)	9.7 bcd	3.2 abc (0)	1.5 bcde (0)	0.8 de (0)	0.2 d (0)
QRD400 (130 fl oz)	17.8 ab	2.0 bcd (75)	0.7 cdef (89)	1.5 cde (71)	3.5 ab (0)
Scimitar (5 fl oz)	13.0 abc	2.2 bcd (62)	3.2 a (33)	5.2 b (0)	7.0 a (0)
Talstar (21.5 fl oz)	24.7 a	4.5 abc (59)	3.0 ab (67)	8.0 a (0)	9.3 a (0)
Untreated	6.8 de	3.0 abc (0)	2.5 abc (0)	2.0 bcd (0)	0.5 cd (0)
<i>Nymphs</i>					
Avid (8 fl oz)	18.8 abc	2.7 ef (78)	0.0 f (100)	0.0 e (100)	0.2 e (91)
Conserve (6 fl oz)	13.5 cd	2.0 f (78)	0.7 ed (95)	1.3 cde (85)	0.3 e (82)
Hachi-Hachi (tolfenpyrad) (21 fl oz)	21.3 abc	13.3 bcd (6)	2.0 cde (91)	3.3 bc (76)	2.5 cd (4)
MOI201 (0.8 quarts)	14.5 bcd	5.0 ef (48)	1.3 def (91)	0.3 de (97)	3.5 cd (0)
NNI 0101 (6.38 fl oz)	17.5 abc	3.0 ef (74)	1.8 def (90)	1.3 bcde (89)	5.3 cd (0)
NNI 0101 (3.19 fl oz)	17.0 abcd	5.5 def (51)	0.3 ef (98)	0.0 e (100)	0.0 e (100)
Overture (8 fl oz)	10.0 d	20.3 bc (0)	4.0 bcd (60)	15.0 a (0)	11.8 b (0)
Pylon (5 fl oz)	14.7 bcd	6.3 def (36)	0.0 f (100)	0.2 de (98)	0.7 de (61)
QRD400 (130 fl oz)	23.3 ab	15.8 bcd (0)	3.7 bcd (84)	4.0 bcd (74)	4.5 c (0)
Scimitar (5 fl oz)	27.5 a	27.3 ab (0)	9.0 ab (67)	11.5 a (36)	19.2 ab (0)
Talstar (21.5 fl oz)	30.2 a	42.2 a (0)	5.7 abc (81)	12.0 a (39)	30.0 a (0)
Untreated	12.3 bcd	8.2 cde (0)	12.2 a (0)	8.0 b (0)	1.5 cde (0)
<i>Total Population</i>					
Avid (8 fl oz)	26.5	3.0 (81)	0.0 (100)	0.5 (96)	0.4 (86)
Conserve (6 fl oz)	17.7	5.0 (52)	1.4 (90)	1.5 (84)	0.8 (57)
Hachi-Hachi (tolfenpyrad) (21 fl oz)	32.8	19.5 (0)	2.5 (90)	3.8 (78)	3.3 (4)
MOI201 (0.8 quarts)	23.7	8.2 (41)	2.3 (87)	1.1 (91)	3.7 (0)
NNI 0101 (6.38 fl oz)	24.5	3.7 (74)	2.1 (89)	2.6 (80)	7.6 (0)
NNI 0101 (3.19 fl oz)	26.2	7.3 (52)	0.6 (97)	0.2 (99)	0.2 (93)
Overture (8 fl oz)	17.7	29.1 (0)	6.0 (56)	17.7 (0)	12.8 (0)
Pylon (5 fl oz)	24.4	9.5 (34)	1.5 (92)	1.0 (92)	0.9 (65)
QRD400 (130 fl oz)	41.1	17.8 (26)	4.4 (86)	5.5 (74)	8.0 (0)
Scimitar (5 fl oz)	40.5	29.5 (0)	12.2 (61)	16.7 (21)	26.2 (0)
Talstar (21.5 fl oz)	54.9	46.7 (0)	8.7 (79)	20.0 (30)	39.3 (0)
Untreated	19.1	11.2 (0)	14.7 (0)	10.0 (0)	2.0 (0)

^z Mean number of thrips were counted from alcohol extraction of 5 meristems or 5 flowers.

^y Means within column followed by the same letter are not significantly different (P>0.05, Tukeys HSD).

^x Henderson’s percent control was calculated on the meristem and flower counts.

Comparative Efficacy on *Gladiolus Bulb Thrips (Thrips simplex)*

Gladiolus thrips (Thrips simplex) which overwinter in bulbs are problematic for the production of bulbs used for landscape and indoor pot plantings as well as bulbs grown for sale to produce cut flowers. One method of treatment can be to dip gladiolus bulbs in the application materials, similar to the methods used to treat bulbs for diseases. However, no thrips insecticides are currently registered for this use. This research was undertaken to provide some answers for a Michigan bulb grower to initiate 24c label registration(s) of suitable products.

In a single experiment conducted in 2005, 24 products with potential for controlling *Gladiolus thrips* were tested as bulb dip applications (Table 9). Adult and immature thrips were counted on bulbs before treatment and at 1, 2, 4, and 8 weeks after treatment. Phytotoxicity due to the treatments was also assessed. In general, most products provided outstanding control of *Thrips simplex* adults and immature: Allectus, Avid, BYI 8330, Celero, Conserve, Diazinon, Discus, Flagship, Hachi-Hachi, Orthene, Pedestal, Safari, Tristar 70WSP, Merit 75W, Pylon, and Talstar F, provided good efficacy initially, but they started to taper off by 8 WAT. Those that did not give acceptable control included Aria, NNI-0101 and Tricon. While Azatin and Carzol did not provide acceptable control of adults until 8 WAT, Azatin appeared to have little initial impact on immatures even though Carzol did.

Table 9. Efficacy of *Gladiolus Bulb Dip Applications on Gladiolus Thrips (Thrips simplex)*, Smitley & Davis, MI, 2006.

Treatment	Rate / 100 gal	Pretreatment	1 WAT	2 WAT	4 WAT	8 WAT
Adults						
Allectus SC	21.3 oz	20.2 ghij	0.0 a (100)	0.0 a (100)	0.0 a (100)	0.0 a (100)
Aria	100 oz	15.0 cdefghi	4.0 ef (47)	4.4 de (0)	5.8 bc (0)	1.0 cd (0)
Avid	8 oz	28.8 j	0.2 a (99)	0.0 a (100)	0.0 a (100)	0.0 a (100)
Azatin	16 oz	9.6 abcdef	2.0 cde (58)	1.6 bc (37)	0.2 a (86)	0.0 a (100)
Carzol	1 lb	6.6 abc	3.0 def (9)	2.4 bc (0)	0.4 a (60)	0.0 a (100)
Celero 16 WSG	4 oz	12.6 bcdefgh	0.8 abc (87)	0.2 a (94)	0.0 a (100)	0.2 ab (66)
Conserve	11 oz	18.2 ghij	0.0 a (100)	0.0 a (100)	0.0 a (100)	0.0 a (100)
Diazinon 4E	3 pts	13.2 cdefghij	0.0 a (100)	0.0 a (100)	0.0 a (100)	0.0 a (100)
Discus	25 oz	26.2 ij	0.0 a (100)	0.0 a (100)	0.0 a (100)	0.0 a (100)
Flagship 25WG	2 oz	12.6 bcdefg	0.2 a (97)	0.0 a (100)	0.0 a (100)	0.0 a (100)
Flagship 25WG	8 oz	3.4 a	0.4 ab (76)	0.2 a (78)	0.0 a (100)	0.0 a (100)
Hachi-Hachi	10.5 oz	11.0 bcdefgh	0.2 a (96)	0.0 a (100)	0.2 a (88)	0.0 a (100)
Kontos (BYI-8330)	1.7 fl oz	6.2 abc	0.2 a (94)	0.0 a (100)	0.0 a (100)	0.0 a (100)
Merit 75	16 gr	17.4 fghij	1.2 abc (86)	0.0 a (100)	0.0 a (100)	0.4 abc (51)
Mesurool 75W	1 lb	9.4 abcd	0.2 a (96)	0.0 a (100)	0.0 a (100)	0.0 a (100)
NNI-0101	9.5 oz	13.0 cdefghij	5.6 fg (14)	2.6 cd (24)	7.2 bc (0)	0.4 ab (35)
Orthene 97	8 oz	17.8 fghij	0.0 a (100)	0.0 a (100)	0.2 a (93)	0.0 a (100)
Overture	8 oz	20.8 hij	0.6 ab (94)	0.0 a (100)	0.0 a (100)	0.0 a (100)
Pedestal	8 oz	12.2 cdefghi	1.2 bcd (80)	0.2 a (94)	0.0 a (100)	0.0 a (100)
Pylon	10 oz	14.6 bcdefgh	1.0 ab (86)	0.2 a (95)	0.0 a (100)	0.0 a (100)
Safari	24 oz	12.4 cdefghij	0.4 ab (94)	0.4 a (88)	0.2 a (89)	0.0 a (100)
Talstar F	21.7 oz	17.0 efghij	0.4 ab (95)	0.0 a (100)	0.0 a (100)	0.0 a (100)
Tricon (BW 420)	100 oz	15.8 defghij	0.6 ab (92)	0.4 a (90)	6.2 c (0)	0.6 bc (19)
TriStar 70WSP	64 g	12.2 bcdefgh	0.4 ab (93)	0.4 a (88)	0.2 a (89)	0.0 a (100)
TriStar 70WSP + Capsil	64 g + 6 oz	5.4 ab	0.2 a (93)	0.0 a (100)	0.4 a (51)	0.0 a (100)
Clearys 3336 WP	24 oz	8.2 abcde	5.0 ef (0)	2.4 b (0)	5.0 bc (0)	1.2 d (0)
Water Control		21.2 efghij	10.6 g (0)	5.6 e (0)	3.2 b (0)	1.0 cd (0)
Immatures						
Allectus SC	21.3 oz	22.4 fgh	0.8 abcd (97)	0.4 a (97)	0.0 a (100)	0.0 a (100)
Aria	100 oz	13.0 bcdefgh	9.2 f (47)	17.2 d (0)	4.4 e (0)	0.8 bc (0)

Treatment	Rate / 100 gal	Pretreatment	1 WAT	2 WAT	4 WAT	8 WAT
Avid	8 oz	19.6 defgh	0.6 abc (98)	0.0 a (100)	0.2 ab (85)	0.2 ab (83)
Azatin	16 oz	7.2 abc	3.0 cde (69)	3.2 b (15)	1.2 bc (0)	0.0 a (100)
Carzol	1 lb	11.6 bcdefgh	1.8 bcde (88)	1.2 a (80)	0.0 a (100)	0.4 abc (41)
Celero 16 WSG	4 oz	9.8 abc	1.2 abcde (91)	0.2 a (96)	0.0 a (100)	0.0 a (100)
Conserve	11 oz	9.4 abcdefgh	1.2 abcd (90)	0.0 a (100)	0.0 a (100)	0.6 abc (0)
Diazinon 4E	3 pts	9.6 bcdefgh	0.6 abc (95)	0.6 a (88)	0.0 a (100)	0.0 a (100)
Discus	25 oz	18.4 gh	0.6 abc (98)	0.2 a (98)	0.2 ab (84)	0.0 a (100)
Flagship 25WG	2 oz	6.6 ab	1.0 abcd (89)	0.0 a (100)	0.0 a (100)	0.0 a (100)
Flagship 25WG	8 oz	12.6 bcdefgh	0.4 ab (98)	0.2 a (97)	0.0 a (100)	0.0 a (100)
Hachi-Hachi	10.5 oz	7.2 abcde	0.8 abcd (92)	0.6 a (84)	1.0 abc (0)	0.2 ab (53)
Kontos (BYI-8330)	1.7 fl oz	8.2 abcde	0.2 a (98)	0.4 a (91)	1.2 ab (0)	0.0 a (100)
Merit 75	16 gr	16.6 efgh	0.4 abc (98)	0.2 a (98)	0.2 ab (82)	0.0 a (100)
Mesurool 75W	1 lb	5.4 a	0.4 abc (94)	0.6 a (79)	0.0 a (100)	0.2 ab (37)
NNI-0101	9.5 oz	9.4 abcdefgh	16.6 fg (0)	9.0 c (0)	4.2 de (0)	0.2 ab (64)
Othene 97	8 oz	11.8 bcdefgh	1.0 abcd (94)	0.4 a (93)	0.0 a (100)	0.0 a (100)
Overture	8 oz	6.2 abc	2.8 e (66)	0.8 a (75)	0.4 ab (4)	0.2 ab (45)
Pedestal	8 oz	7.8 abcd	2.6 de (75)	0.6 a (85)	0.0 a (100)	0.0 a (100)
Pylon	10 oz	8.0 abcdef	0.2 a (98)	0.4 a (90)	0.0 a (100)	0.8 bc (0)
Safari	24 oz	6.2 abc	0.4 abc (95)	0.4 a (88)	0.0 a (100)	0.0 a (100)
Talstar F	21.7 oz	9.4 abcdefg	1.0 abcde (92)	0.0 a (100)	0.0 a (100)	0.2 ab (64)
TriCon (BW 420)	100 oz	18.8 defgh	2.6 (90)	9.6 cd (2)	7.8 e (0)	2.6 d (0)
TriStar 70WSP	64 g	15.0 cdefgh	0.2 a (99)	0.0 a (100)	0.2 ab (80)	0.0 a (100)
TriStar 70WSP & Capsil	64 g + 6 oz	8.2 abcdefg	0.2 a (98)	0.4 a (91)	0.2 ab (64)	0.0 a (100)
Clearys 3336 WP	24 oz	12.2 bcdefgh	11.6 f (28)	14.0 cd (0)	6.0 e (0)	1.2 cd (0)
Water Control		23.8 h	31.6 g (0)	12.4 cd (0)	1.6 cd (0)	1.4 cd (0)
Total Population						
Allectus SC	21.3 oz	42.6 hij	0.8 a (98)	0.4 a (98)	0.0 a (100)	0.0 a (100)
Aria	100 oz	28.0 bcdefghi	13.2 e (50)	21.6 d (0)	10.2 cd (0)	1.8 bc (0)
Avid	8 oz	48.4 j	0.8 a (98)	0.0 a (100)	0.2 ab (96)	0.2 a (92)
Azatin	16 oz	16.8 abcd	5.0 cd (68)	4.8 b (29)	1.4 b (22)	0.0 a (100)
Carzol	1 lb	18.2 abcdefg	4.8 d (72)	3.6 b (51)	0.4 ab (79)	0.4 a (59)
Celero 16 WSG	4 oz	22.4 bcdefgh	2.0 abcd (90)	0.4 a (96)	0.0 a (100)	0.2 a (83)
Conserve	11 oz	27.6 defghij	1.2 ab (95)	0.0 a (100)	0.0 a (100)	0.6 ab (59)
Diazinon 4E	3 pts	22.8 bcdefgh	0.6 a (97)	0.6 a (93)	0.0 a (100)	0.0 a (100)
Discus	25 oz	44.6 ij	0.6 a (99)	0.2 a (99)	0.2 ab (96)	0.0 a (100)
Flagship 25WG	2 oz	19.2 bcdefg	1.2 ab (93)	0.0 a (100)	0.0 a (100)	0.0 a (100)
Flagship 25WG	8 oz	16.0 abcde	0.8 ab (95)	0.4 a (94)	0.0 a (100)	0.0 a (100)
Hachi-Hachi	10.5 oz	18.2 abcdefg	1.0 ab (94)	0.6 a (92)	1.2 ab (38)	0.2 a (79)
Kontos (BYI-8330)	1.7 fl oz	14.4 abc	0.4 a (97)	0.4 a (93)	1.2 ab (22)	0.0 a (100)
Merit 75	16 gr	34.0 ghij	1.6 abc (95)	0.2 a (99)	0.2 ab (94)	0.4 a (78)
Mesurool 75W	1 lb	14.8 a	0.6 a (96)	0.6 a (90)	0.0 a (100)	0.2 a (75)
NNI-0101	9.5 oz	22.4 bcdefghi	22.2 ef (0)	11.6 c (0)	11.4 cd (0)	0.6 a (50)
Othene 97	8 oz	29.6 efghij	1.0 ab (96)	0.4 a (97)	0.2 ab (94)	0.0 a (100)
Overture	8 oz	27.0 cdefghij	3.4 cd (87)	0.8 a (93)	0.4 ab (86)	0.2 a (86)
Pedestal	8 oz	20.0 bcdefgh	3.8 cd (80)	0.8 a (90)	0.0 a (100)	0.0 a (100)
Pylon	10 oz	22.6 bcdefgh	1.2 a (94)	0.6 a (93)	0.0 a (100)	0.8 ab (34)
Safari	24 oz	18.6 abcdefg	0.8 ab (95)	0.8 a (89)	0.2 ab (90)	0.0 a (100)
Talstar F	21.7 oz	26.4 bcdefghij	1.4 abc (94)	0.0 a (100)	0.0 a (100)	0.2 a (86)
TriCon (BW 420)	100 oz	34.6 fghij	3.2 bcd (90)	10.0 c (28)	14.0 d (0)	3.2 c (0)
TriStar 70WSP	64 g	27.2 bcdefghij	0.6 a (98)	0.4 a (96)	0.4 ab (86)	0.0 a (100)
TriStar 70WSP & Capsil	64 g + 6 oz	13.6 ab	0.4 a (97)	0.4 a (93)	0.6 ab (59)	0.0 a (100)
Clearys 3336 WP	24 oz	20.4 abcdefg	16.6 e (13)	16.4 cd (0)	11.0 c (0)	2.4 c (0)
Water Control		45.0 efghij	42.2 f (0)	18.0 cd (0)	4.8 c (0)	2.4 c (0)

Comparative Efficacy on Privet Thrips (*Dendrothrips ornatus*)

Privet thrips (*Dendrothrips ornatus*) is known to attack privet, lilac and possibly ash, causing the leaves to become grey and even fall. In a single experiment conducted by a researcher in 2008, 9 products were tested as foliar treatments on 3-year old privet trees (Table 16). Adult and immature thrips were collected from leaflets at 3, 7 and 13 days after treatment. Scimitar, the standard, provided good to excellent control. In general, BYI -8330, Conserve, Flagship, Tick-EX and Hachi-Hachi (tolfenpyrad) provided fair to good efficacy. Ecotrol, MOI 201 and NNI-0101 showed poor efficacy.

Table 10. Privet Thrips Control on New Mexican Privet (*Foresteria neomexicana*), Cranshaw, CO 2008.

Treatment (Active Ingredient)	Rate / 100 gal	Population Counts ^x , Means Separations ^y , and Percent Control		
		3 DAT	7 DAT	13 DAT
Conserve	11 fl oz	5.3 c (77)	4.8 a (66)	5.8 b (74)
Ecotrol	4 pt	16.3 b (31)	28.3 a (0)	14.5 ab (35)
Flagship 25WG	8 oz	4.5 c (81)	17.0 a (0)	10.3 b (54)
Hachi-Hachi (tolfenpyrad) EC	21 fl oz	5.0 c (79)	12.8 a (9)	6.0 b (73)
Kontos (BYI-8330)	1.7 fl oz	4.3 c (82)	19.3 a (0)	10.3 b (54)
MOI 201	1:500	12.8 bc (46)	23.5 a (0)	16.5 ab (26)
NNI-0101SC	6.38 fl oz	10.0 bc (57)	13.0 a (7)	7.3 b (67)
Scimitar SC	5 fl oz	3.0 c (87)	3.5 a(75)	1.0 b (96)
Tick-EX EC	29 fl oz	6.5 c (72)	8.8 a (37)	7.5 b (66)
Untreated		23.5 a (0)	14.0 a (0)	22.3 a (0)

^x Mean number of live thrips per 20 leaflets from plant and extracted with alcohol.

^y Means followed by the same letter are not significantly different at p=0.05 (SNK).

Comparative Efficacy on Western Flower Thrips (*Frankliniella occidentalis*)

Western flower thrips (*Frankliniella occidentalis*) remains the major pest threat for ornamental horticulture growers in the United States. The following is an extract from the 2009 IR-4 Thrips Efficacy Summary focusing on the experiments conducted with Hachi-Hachi as one or more of the treatments. For more details, please refer to that summary.

Cosmos. In 2008, Cranshaw examined the efficacy of various products to control western flower thrips on cosmos (Table 11). Unfortunately under the conditions of this trial, which involved field plantings subject to continuous reinvasion by migrant thrips, none of the treatments provided acceptable control, including NNI-0101.

Table 11. Western Flower Thrips Control on Cosmos (*Cosmos bipinnatus*) ‘Picotee’, Cranshaw, 2008a.

Treatment	Rate Per 100 gal	Population Counts ^x , Means Separations ^y , and Percent Control					
		8/4/08	8/7/08	8/18/08	8/22/08	8/26/08	9/5/08
Conserve	11 fl oz	33.5 bc (31)	59.0 ab (0)	35.5 a (32)	16.0 b (77)	47.5 a (15)	36.3 a (0)
Ecotrol	4 pts	48.3 ab (0)	60.8 ab (0)	46.3 a (12)	62.3 ab (10)	42.0 a (25)	48.0 a (0)
Flagship 25WG	8 oz	58.3 a (0)	75.8 a (0)	40.0 a (24)	50.3 ab (27)	63.5 a (0)	36.3 a (0)
Hachi-Hachi (tolfenpyrad) EC	21 fl oz	41.5 ab (14)	42.8 ab (0)	36.5 a (30)	42.5 ab (39)	50.8 a (9)	39.0 a (0)
Kontos (BYI-8330)	1.7 fl oz	43.0 ab (11)	54.0 ab (0)	38.0 a (28)	47.0 ab (32)	41.0 a (27)	34.5 a (0)
MOI 201	25.6 fl oz (1:500)	57.5 ab (0)	36.5 ab (0)	30.8 a (41)	62.0 ab (11)	56.0 a (0)	40.0 a (0)
NNI-0101SC	6.38 fl oz	53.8 ab (0)	33.0 ab (0)	38.3 a (27)	59.0 ab (15)	56.8 a (0)	33.8 a (0)
Scimitar SC	5 fl oz	22.0 c (55)	28.3 b (11)	44.8 a (15)	26.5a ab (62)	31.8 a (43)	30.8 a (0)
Tick-EX EC	29 fl oz	46.8 ab (4)	45.8 a (0)	45.3 a (14)	79.5 a (0)	56.0 a (0)	47.0 a (0)
Untreated Check		48.5 ab (0)	31.8 ab (0)	52.5 a (0)	69.3 ab (0)	56.0 a (0)	26.5 a (0)
Nymphs							
Conserve	11 fl oz	1.8 a (60)	5.3 a (0)	2.0 a (29)	0.3 c (92)	0.8 a (73)	1.8 a (0)
Ecotrol	4 pt	4.5 a (0)	3.3 a (31)	3.8 a (0)	2.5 ab (34)	3.3 a (0)	1.8 a (0)
Flagship 25WG	8 oz	7.0 a (0)	8.3 a (0)	2.8 a (0)	0.8 bc (79)	1.5 a (50)	1.8 a (0)
Hachi-Hachi (tolfenpyrad) EC	21 fl oz	4.3 a (4)	1.3 a (73)	1.3 a (54)	0.5 bc (87)	1.0 a (67)	2.0 a (0)
Kontos (BYI-8330)	1.7 fl oz	3.3 a (27)	2.0 a (58)	4.3 a (0)	4.8 a (0)	2.8 a (7)	1.8 a (0)
MOI 201	25.6 fl oz (1:500)	4.3 a (4)	5.0 a (0)	0.3 a (89)	4.0 ab (0)	2.8 a (7)	2.5 a (0)
NNI-0101SC	6.38 fl oz	3.8 a (16)	1.5 a (69)	2.3 a (18)	4.0 ab (0)	3.3 a (0)	1.5 a (0)
Scimitar SC	5 fl oz	3.3 a (27)	3.3 a (31)	2.3 a (18)	0.0 c (100)	1.8 a (40)	1.3 a (13)
Tick-EX EC	29 fl oz	5.3 a (0)	0.5 a (90)	2.8 a (0)	3.2 ab (16)	3.3 a (0)	1.5 a (0)
Untreated Check		4.5 a (0)	4.8 a (0)	2.8 a (0)	3.8 bc (0)	3.0 a (0)	1.5 a (0)

^x Mean number of live thrips per 25 blossoms cut from plant and extracted with alcohol.

^y Means followed by the same letter are not significantly different at p=0.05 (SNK).

Treatments applied on 8/1/08; a second application of Kontos (BYI-8330), Ecotrol and Tick-EX made on 8/7/08.

Marigold. Three experiments were conducted between 2005 and 2008 on marigold ‘Yellow Boy’ (Tables 43 – 47). In these experiments, flower buds were removed throughout and all thrips were counted on either five or six leaves after alcohol extraction. In the first experiment, by 12 days after the first application all treatments (Avid, Conserve, Mesurol, and TriStar) provided good to excellent control. In the second experiment, Conserve did not provide adequate control levels, while Mesurol performed similarly as in the first experiment. In the third experiment, Conserve, Mesurol and MOI 201 provided adequate control only at 3 days after treatment. Of the other treatments, BAS 350i and Hachi-Hachi (tolfenpyrad) at the 21 oz rate provided good to excellent control. Safari 20SG provided good control, while Kontos (BYI-8330), Botanigard, Acelepryn (DPX-E2Y45), NNI-0101, QRD 416, TickEx and TriCon BW exhibited little impact on thrips populations.

In 2008, two researchers also conducted trials on marigold (Tables 48-50). In one experiment, leaves were tapped over a white board and all stages of live thrips counted. The most effective treatments were Conserve, NAI-2302 and TriStar. In a second experiment, two flowers were tapped five times over a styrofoam bowl 15 cm diam X 5 cm deep, adults and immatures that were moving in the box were counted and then dumped back on the plant. Adult counts were not of much use to determine efficacy because of the movement of adults among treatments (Table 50). The immature counts and overall damage rating were the best estimate of thrips control. Generally, Conserve was the most effective treatment followed by NAI 2302 and BYI 8330. Other treatments were less effective.

Table 12. Western Flower Thrips Control on Marigold (*Tagetes patula*) ‘Yellow Boy’ – Application Rates and Dates, Davis, MI 2008.

Treatment (Active Ingredient)	Rate / 100 gal	Application Dates		
		6/17 0 DAT	6/24 7 DAT	7/1 14 DAT
Botanigard 22 % WP (<i>Beauvaria bassiana</i>)	2 lb	X	X	X
Botanigard 22 % WP (<i>Beauvaria bassiana</i>) + BW130 (unknown)	2 lb /100 gal + 325 ml/100 liters	X	X	X
Conserve SC (spinosad)	11fl oz	X	X	X
Kontos 240SC (spirotetramat)	1.7 fl oz	X		X
Mesurol 75WP (methiocarb)	0.5 lb	X		X
MOI 201 (unknown)	0.8 qt	X	X	X
NNI-0101 SC (pyrifluquinazon)	9.6 fl oz	X		X
QRD 416 (unknown)	128 fl oz	X	X	X
Tick-EX (<i>Metarhizium anisopliae</i> Strain 52)	29 fl oz/100gal	X	X	X
Tolfenpyralid EC (Hachi-Hachi (tolfenpyrad))	21 fl oz/100 gal	X		X
TriCon (Sodium Tetraborohydrate Decahydrate)	50 fl oz	X	X	X
Untreated				

Table 13. Western Flower Thrips Control on Marigold (*Tagetes patula*) ‘Yellow Boy’, Davis, MI 2008.

Treatment	Population Counts ^z , Means Separations ^y , and Henderson’s Percent Control						
	Precount	3 DAT	7 DAT	14 DAT	21 DAT	28 DAT	35 DAT
Total Population							
Botanigard 22 % WP	6.3 a	5.3 ef (36)	6.8 de (0)	2.1 cde (51)	1.0 bcd (0)	1.6 c (0)	0.5 bc (44)
Botanigard 22 % WP + BW130	6.1 a	2.6 bcd (68)	2.3 bc (9)	1.2 abc (18)	0.5 abc (0)	0.4 ab (0)	0.4 bc (0)
Conserve SC	6.4 a	1.8 ab (79)	1.6 ab (9)	0.9 ab (11)	0.5 abc (0)	0.8 abc (0)	0.4 bc (10)
Kontos 240SC	6.0 a	5.8 ef (26)	6.2 de (0)	1.3 bc (67)	0.7 a-d (0)	0.4 a (11)	0.3 ab (0)
Mesuroil 75WP	6.3 a	0.9 a (89)	0.5 a (43)	0.3 a (5)	0.2 a (0)	0.4 a (0)	0.5 bc (0)
MOI 201	6.3 a	1.0 a (88)	1.4 ab (0)	1.4 bcd (0)	0.6 a-d (0)	0.8 abc (0)	0.6 bc (0)
NNI-0101 SC	6.4 a	5.4 ef (36)	4.5 cd (15)	3.4 def (0)	1.1 cde (0)	0.4 ab (53)	0.6 bc (0)
QRD 416	6.1 a	5.6 de (30)	6.8 de (0)	6.5 g (0)	1.2 b-e (31)	1.2 bc (0)	0.1 a (85)
Tick-EX	6.3 a	5.4 de (35)	6.1 de (0)	4.9 efg (0)	2.0 ef (0)	1.1 abc (14)	0.7 c (0)
Tolfenpyralid EC	6.3 a	2.4 bc (71)	1.3 ab(45)	1.1 abc (0)	0.3 ab (0)	0.3 a (0)	0.2 a (0)
TriCon	6.9 a	4.0 cde (56)	6.8 de (0)	5.8 fg (0)	3.0 f (0)	1.4 c (27)	0.6 bc (23)
Untreated	6.4 a	8.4 f (0)	8.2 e (0)	5.2 fg (0)	1.4 de (0)	0.9 abc (0)	0.5 bc (0)

^z Flowers were removed prior to opening throughout the experiment. Mean number of thrips were counted from alcohol extraction of 5 leaves.

^y Means followed by the same letter are not significantly different Fisher’s LSD ($p < 0.05$). Data transformed prior to ANOVA $\log(x+1)$. Untransformed means presented in table.

Table 14. Western Flower Thrips Control on Marigold (*Tagetes patula*) ‘Jaguar’, Gilrein, NY 2008.

Treatment	Rate Per 100 gals	Population Counts ^z , Means Separations ^y , and Henderson’s Percent Control				Immatures % Control
		9/5/08 (precount)	9/15/08	9/23/08*	9/26/08*	
Acelepryn 1.67SC	20 fl oz	4.0 a	3.8 bcd (33)	5.1 bc (0)	6.5 abc (3)	2.9 cd (15)
Conserve 1SC	6 fl oz	4.4 a	2.1 ab (66)	1.6 a (42)	3.5 a (0)	0.5 ab (85)
Kontos (BYI-8330) 2SC (240SC)	1.7 fl oz	4.6 a	6.1 cd (6)	8.3 cd (0)	10.9 c (0)	1.5 bc (56)
NNI-0101 20SC	8 fl oz	3.6 a	4.6 cd (10)	5.0 b (18)	6.1 ab (7)	2.5 cd (26)
Hachi-Hachi (tolfenpyrad) 15EC	27 fl oz	3.5 a	1.9 a (62)	2.6 a (0)	3.1 a (9)	0.0 a (100)
Tristar 30SG	8 oz	3.5 a	3.6 abc (27)	6.0 bcd (0)	8.4 bc (0)	0.4 ab (88)
Untreated		4.6 a	6.5 d (0)	8.6 d (0)	11.3 c (0)	3.4 d (0)

^z Mean number of live thrips per 8 plants.

^y Means followed by the same letter are not significantly different at $p=0.05$ (Fisher’s LSD).

*Data were transformed prior to analysis using $\ln(y+1)$

Treatments applied on 9/8/08, 9/19 and 10/3.

Table 15. Western Flower Thrips Control on Marigold ‘Hero Mix’ – Application Rates and Dates, Oetting, GA 2008.

Treatment (Active Ingredient)	Rate / 100 gal	Application Dates		
		0 DAT	7 DAT	14 DAT
Acelepryn (DPX-E2Y45) (chlorantraniliprole)	20 fl oz	X		X
Conserve (spinosad)	8 fl oz	X		X
Flagship (thiamethoxam)	8 oz	X		X
Hachi-Hachi (tolfenpyrad)	21 fl oz	X		X
Kontos (BYI-8330) (spirotetramat)	1.7 fl oz	X		X
MOI 201	1:500	X	X	X
MOI 201	1:800	X	X	X
NNI-0101 (pyrifluquinazon)	6.3 fl oz	X		X
Tick-EX (<i>Metarhizium anisopliae</i>)	29 fl oz	X	X	X
Untreated				

Treatments applied on Apr 24, May 1, and May 8, 2008.

Table 16. Western Flower Thrips Control and Flower Damage Rating on Marigold ‘Hero Mix’, Oetting, GA 2008.

Treatment	Population Counts ^x , Means Separations ^y , and Percent Control					Damage Rating (0-100) 34 DAT
	7 DAT	14 DAT	21 DAT	28 DAT ^z	34 DAT ^z	
	Adults					
Acelepryn (DPX-E2Y45)	2.9 a (22)	4.1 a (0)	1.7 b (0)	2.2 a	7.2 ab	52.6 b
Conserve	1.4 a (62)	6.0 a (0)	3.7 ab (0)	2.6 a	16.3 a	23.3 c
Flagship	2.8 a (24)	6.4 a (0)	6.0 a (0)	5.0 a	17.2 a	52.4 b
Hachi-Hachi (tolfenpyrad)	2.3 a (38)	4.7 a (0)	2.7 b (0)	3.3 a	9.3 ab	28.9 bc
Kontos (BYI-8330)	1.6 a (57)	3.0 a (25)	3.6 ab (0)	3.6 a	15.1 a	31.4 bc
MOI 201	2.9 a(22)	4.9 a (0)	3.6 ab (0)	3.6 a	14.6 a	37.6 bc
MOI 201	2.7 a (27)	5.6 a (0)	1.7 b (0)	3.6 a	15.4 a	55.1 b
NNI-0101 (pyrifluquinazon)	4.6 a (0)	7.0 a (0)	1.4 b (0)	4.1 a	11.6 ab	53.0 b
Tick-EX	3.0 a (19)	2.7 a (33)	1.6 b (0)	2.0 a	9.2 ab	38.3 bc
Untreated	3.7 a (0)	4.0 a (0)	1.1 b (0)	2.4 a	4.0 b	98.0 a
	Immatures					
Acelepryn (DPX-E2Y45)	4.6 ab (8)	8.1bcd (29)	4.3 bc (41)	3.2 a	11.0 a	
Conserve	1.3 c (74)	6.1 cd (46)	3.3 bcd (55)	1.9 a	9.1 a	
Flagship	4.0 ab (20)	9.0 a-d (21)	4.6 bc (37)	3.0a	11.2 a	
Hachi-Hachi (tolfenpyrad)	3.7 b (26)	6.0d (47)	2.7 cd (63)	5.1 a	10.3 a	
Kontos (BYI-8330)	3.3 bc (34)	11.6ab (0)	5.1 ab (30)	3.0 a	8.7 a	
MOI 201	3.9 b (22)	8.7 a-d (24)	3.6 bcd (51)	3.3 a	8.7 a	
MOI 201	3.4 bc (32)	11.3abc (1)	4.7 bc (36)	2.1 a	10.2 a	
NNI-0101 (pyrifluquinazon)	4.7 ab (6)	5.3 d (54)	3.4 bcd (53)	2.9 a	9.2 a	
Tick-EX	6.3 a (0)	13.7a (0)	1.6 d (78)	1.4 a	14.7 a	
Untreated	5.0 ab (0)	11.4 ab (0)	7.3 a (0)	1.1 a	1.5 b	

^x Mean number of immature thrips per 2 flowers knocked five times over a styrofoam bowl 15 cm diam x 5 cm deep .

^y Means followed by the same letter are not significantly different at p=0.05 (ANOVA and mean separation test).

^z Check flowers at 28 and 34 DAT were dead or of poor quality.

Verbena. In 2008, one experiment was conducted to examine various treatments to manage western flower thrips on verbena ‘Lorgo Purple’ (Tables 57 and 58). Counts were made of live thrips and feeding scars on leaves, and damage rating (0-100) taken at the end of experiment. Conserve, Flagship, BYI 8330, NAI 2302 and MOI 201

were effective in reducing the number of thrips and feeding damage. The standard Conserve was consistently the best treatment. Data indicated that Tick-EX has less residual activity.

Table 17. Western Flower Thrips Control on Verbena ‘Lorgo Purple’ – Application Rates and Dates, Oetting, GA 2008.

Treatment (Active Ingredient)	Rate / 100 gal	Application Dates		
		0 DAT	6 DAT	13 DAT
Acelepryn (DPX E2Y45) (chlorantraniliprole)	20 fl oz	X		X
Conserve (spinosad)	8 fl oz	X		X
Flagship (thiamethoxam)	8 oz	X		X
Hachi-Hachi (tolfenpyrad)	21 fl oz	X		X
Kontos (BYI 8330) (spirotetramat)	1.7 fl oz	X		X
MOI 201	1:500	X	X	X
MOI 201	1:800	X	X	X
NNI-0101 (pyrifluquinazon)	6.3 fl oz	X		X
Tick-EX (<i>Metarhizium anisopliae</i>)	29 fl oz	X	X	X
Untreated				

Treatments applied on April 11, 17, and 24, 2008.

Table 18. Western Flower Thrips Control on and Damage on Verbena ‘Lorgo Purple’, Oetting, GA 2008.

Treatment	Population Counts ^x , Means Separations ^y , and Percent Control				Number of Feeding Scars ^x , Means Separations ^y , and Percent Reduction				Damage Rating (0-100) 34 DAT
	6 DAT	13 DAT	27 DAT	34 DAT	6 DAT	13 DAT	27 DAT	34 DAT	
Acelepryn	2.0 a (5)	2.0 b (59)	4.7 c (80)	4.0 bc (79)	37.7 a (0)	25.6 ab (23)	23.3 c (65)	28.1 c (67)	34.3 bcd (55)
Conserve	0.1 b (95)	0.0 c (100)	2.3 c (90)	1.9 c (90)	16.4 cd (50)	4.4 e (87)	10.3 d (84)	10.0 d (88)	24.3 de (68)
Flagship	0.4 b (81)	1.4 bc (71)	4.3 c (81)	1.3 c (93)	21.3 bcd (36)	10.0 de (70)	13.6 cd (79)	17.3 cd (80)	17.9 e (77)
Hachi-Hachi	0.4 b (81)	1.4 bc (71)	3.1 c (87)	1.3 c (93)	27.3 abc (18)	12.1 de (64)	14.4 cd (78)	17.7 cd (79)	25.0 de (67)
Kontos	1.4 ab (33)	2.1 b (57)	3.4 c (85)	2.4 c (87)	26.1 a-d (21)	20.9 bc (37)	21.7 c (67)	26.9 c (69)	28.6 cde (63)
MOI 201 (1:500)	0.9 ab (57)	0.0 c (100)	2.0 c (91)	3.4 bc (82)	13.3 d (60)	3.9 e (88)	15.3 de (77)	23.1 c (73)	27.1 cde (65)
MOI 201 (1:800)	1.1 ab (48)	0.6 bc (88)	5.6 c (76)	2.7 c (86)	18.0 cd (46)	8.0 e (76)	20.9 cd (68)	24.3 c (72)	31.4 cde (59)
NNI-0101	1.1 ab (48)	1.1 bc (78)	6.9 bc (70)	2.3 c (88)	17.4 cd (47)	10.4 de (69)	17.9 cd (73)	17.1 cd (80)	41.1 bc (47)
Tick-EX	1.1 ab (48)	1.4 bc (71)	11.4 b (50)	7.0 b (63)	20.1 bcd (39)	16.7 cd (50)	42.0 b (36)	46.9 b (45)	48.3 b (37)
Untreated	2.1 a (0)	4.9 a (0)	23.0 a (0)	18.8 a (0)	33.1 ab (0)	33.3 a (0)	66.0 a (0)	85.8 a (0)	76.9 a (0)

^x Mean number of live thrips and feeding scars on 18 leaves (6 most fully developed leaves each on 3 stems).

^y Means followed by the same letter are not significantly different at p=0.05 (ANOVA and mean separation test).

Phytotoxicity

No phytotoxicity was observed in the efficacy or crop safety trials.

Table 19. Summary of Pyrifluquinazon Crop Safety and Efficacy

Note: Table entries are sorted by crop Latin name. Only those trials received by 9/27/2010 are included in the table below.

PR #	Pest Common Name	Pest Latin Name	Crop Common Name	Crop Latin Name	Crop Cultivar	Production Site	Researcher	Year	Application Type	Results	File Name
28696	Holly Pit Scale	<i>Asterolecanium puteanum</i>	Holly	<i>Ilex</i> sp.	'East Palatka'	Field In-Ground	Buss	2009	Foliar	Did not significantly reduce number of immatures at 18 fl oz per 100 gal.	20091215a.pdf
28688	False Florida Red Scale	<i>Chrysomphalus bifasciculatus</i>	Holly, Chinese	<i>Ilex cornuta</i>	'Cassina'	Field In-Ground	Chong	2009	Foliar	Did not significantly reduce scale population at 18 fl oz per 100 gal + Capsil; similar to paraffinic oil std	20090819b.pdf
28764	Privet Thrips	<i>Dendrothrips ornatus</i>	New Mexican Privet	<i>Forestiera neomexicana</i>		Field In-Ground	Cranshaw	2008	Foliar	Trial was sprinkler irrigated 3 hours after treatment. Fair control at 6.38 fl oz per 100 gal; inferior to Conserve	20090129o.pdf
27980	Western Flower Thrips	<i>Frankliniella occidentalis</i>	Cosmos	<i>Cosmos</i> sp.	<i>C. binnatus</i> 'Picotee'	Field In-Ground	Cranshaw	2008	Foliar	Under continuous reinvasion by migrant thrips in this trial, no treatment provided significant control	20090129o.pdf
28012	Western Flower Thrips	<i>Frankliniella occidentalis</i>	Marigold	<i>Tagetes</i> sp.	<i>T. patula</i> 'Yellow Boy'	Greenhouse	Davis	2008	Foliar	Poor control at 9.6 fl oz per 100 gal	20090122a.pdf
28012	Western Flower Thrips	<i>Frankliniella occidentalis</i>	Marigold	<i>Tagetes</i> sp.	<i>T. patula</i> 'Yellow Boy'	Greenhouse	Davis	2009	Foliar	Fair control of immatures at 6.38 fl oz + NIS per 100 gal applied 2 times; almost equal to Conserve applied 4 times	20090930b.pdf
28012	Western Flower Thrips	<i>Frankliniella occidentalis</i>	Marigold	<i>Tagetes</i> sp.	'Jaguar'	Greenhouse	Gilrein	2008	Foliar	Some reduction of adult and immature populations with 8 fl oz per 100 gal.	20090319g.pdf
28012	Western Flower Thrips	<i>Frankliniella occidentalis</i>	Marigold	<i>Tagetes</i> sp.	'Hero Mix'	Greenhouse	Oetting	2008	Foliar	Significantly reduced immatures on flowers and damage to flowers and foliage at 6.4 fl oz per 100 gal; inferior to standard	20081021a.pdf
28047	Western Flower Thrips	<i>Frankliniella occidentalis</i>	Zinnia	<i>Zinnia</i> sp.	<i>Z. elegans</i> 'Short Stuff'	Greenhouse	Parrella	2008	Foliar	Low thrips density; no significant difference from untreated check at 6.38 fl oz per 100 gal	20081217a.pdf
8919	Melanaspis deklei	<i>Melanaspis deklei</i>	Wax Myrtle	<i>Myrica cerifera</i>		Commercial Landscape	Chong	2009	Foliar	Did not significantly reduce scale population at 18 oz per 100 gal; similar to Orthene std	20090824a.pdf

PR #	Pest Common Name	Pest Latin Name	Crop Common Name	Crop Latin Name	Crop Cultivar	Production Site	Researcher	Year	Application Type	Results	File Name
29317	Phytotoxicity	Phytotoxicity	Begonia	Begonia sp.	B. semperflorens 'Green Leaf'	Greenhouse	Davis	2010	Foliar	No significant injury at 6.38, 12.76, and 25.52 fl oz per 100 gal.	
29320	Phytotoxicity	Phytotoxicity	Balsam	Impatiens sp.	I. walleriana 'Dazzler Pink'	Greenhouse	Davis	2010	Foliar	No significant injury at 6.38, 12.76, and 25.52 fl oz per 100 gal.	
29322	Phytotoxicity	Phytotoxicity	Petunia	Petunia sp.	P. x hybrida 'Prism Sunshine'	Greenhouse	Davis	2010	Foliar	No significant injury at 6.38, 12.76, and 25.52 fl oz per 100 gal.	
29323	Phytotoxicity	Phytotoxicity	Marigold	Tagetes sp.	T. erecta 'Inca Orange'	Greenhouse	Davis	2010	Foliar	No significant injury at 6.38, 12.76, and 25.52 fl oz per 100 gal.	
25556	Gladiolus Thrips	Thrips simplex	Corn Flag, Sword Lily	Gladiolus sp.		Cold Storage	Davis	2006	Dipped in solution	No efficacy at 8.41 ml per 3 gal	20070202a.pdf
28873	Euonymus Scale	Unaspis euonymi	Spindle Tree	Euonymus japonicus	'Microphylla'	Field Container	Frank	2009	Foliar	Excellent control at 18 fl oz per 100 gal; slower acting than Acephate	20090811a.pdf
28873	Euonymus Scale	Unaspis euonymi	Spindle Tree	Euonymus japonicus	E. vegetus 'Sunspot'	Field Container	Nielsen	2009	Foliar	Poor control at 18 fl oz per 100 gal	20090925a.pdf

Label Suggestions

Pyrifluquinazon has some potential for managing ornamental horticulture pests, but additional research is needed on scale insects to determine how best to apply and assess efficacy. In general, there are too few data points sponsored by IR-4 to recommend specific scale species be placed on the label at this time. For chili thrips, pyrifluquinazon may provide an alternative product for resistance management rotations because it does provide excellent efficacy. However, the level of management of western flower thrips populations was highly variable.

Appendix 1: Protocols

Efficacy of Management Tools for Armored Scale in Ground **Final**

Ornamental Protocol Number: 09-009

Objective: Determine efficacy of various products against armored scale on ornamental plants grown in ground. Do not conduct in containerized ornamentals..

Experimental Design:

Plot Size: Must be adequate to reflect actual use conditions.

Replicates: Minimum of 6 replications

Application Instructions: Applications should be made targeting crawler stage and using application equipment consistent with conventional commercial equipment.

Target Species: Camellia, Euonymus, Japanese Maple, and Tea scales. Contact your regional coordinator if other target species are of interest.

Plant Hosts: Use a plant host suitable for target scale species, recording species and variety used.

Use Site: Field In Ground. For greenhouse or field container, refer to protocol 09-005.

Evaluations: Record initial insect counts and then 7, 14 (prior to 2nd application), 28 and 42 days after initial application. Record phytotoxicity at each rating date on a scale of 0 to 10 (0 = no phytotoxicity; 10 = complete kill). If phytotoxicity is observed in treated plants, take pictures comparing treated and untreated plant material.

Recordkeeping: Keep detailed records of weather conditions throughout the test including temperature and precipitation, soil-type or soil-less media, application equipment, application volume per acre, irrigation, liner size, plant height & width, and plant growth stage at application and data collection dates.

Reports:

Reports submitted on the standard IR-4 Ornamental Horticulture Research Report Form are preferred. However, reports in the AMT Tests format are acceptable as long as those reports are amended with detailed experimental design and materials and methods, along with raw data, recordkeeping information, and any pictures.

A report submitted electronically is preferred but not required. If the report is provided electronically, the basic report can be sent in MS Word or WordPerfect, the recordkeeping information as pdf or other electronic documents, and the raw data in MS Excel or other suitable program such as ARM.

Please direct questions to: Cristi Palmer, IR-4 HQ, Rutgers University, 500 College Road East, Suite 201W, Princeton, NJ 08540, Phone 732-932-9575 x4629, palmer@aesop.rutgers.edu OR Ely Vea, 308 Aston Forest Lane, Crownsville, MD 21032, Phone & FAX#: 410-923-4880, E-mail: evvea@comcast.net.

Revision Date: 3/18/09
Revised By: CLP

Treatments:

Priority	#	Product	Rate	Application Instructions	Contact Information to obtain materials and any needed adjuvants
B	1	Aloft SC (clothianidin +bifenthrin)	10 fl oz per 100 gal	Sprinch	Arysia, Doug Houseworth, 904-321-0795, JHouse9@aol.com
S/A	2	Distance (pyriproxifen)	12 fl oz per 100 gal	Apply as foliar spray to runoff when crawlers begin emerging.. Make second application after 21 days	Valent, Joe Chamberlin, 770-985-0303, jcham@valent.com
A	3	Flagship G (thiamethoxam)	22.7g per foot of height for shrubs	Broadcast evenly around the surface of the growing media	Syngenta, Nancy Rechsigt, 941-708-9338, nancy.rechsigt@syngenta.com
	3a		Optional: 114g per foot of height for shrubs		
A	4	Flagship 25WG (thiamethoxam)	4gm/ft of shrub height or per inch of trunk dbh	One drench application	Syngenta, Nancy Rechsigt, 941-238-7413, nancy.rechsigt@syngenta.com
	4a		Optional: 1gm/ft shrub height or per inch of trunk dbh		
A	5	NNI-0101 (pyrifluquazon)	18 fl oz per 100 gal	Foliar	Nichino, James C. Adams, 302-636-9001, jadams@nichino.net
A	6	Safari 2G (dimotefuran)	60 grams/ inch dbh for trees or foot of height for shrubs	One application. Broadcast dry by hand to the soil at base of trunk within 1 foot of trunk. Rake back mulch first if more than 1/2"	Valent, Joe Chamberlin, 770-985-0303, jcham@valent.com
S/A	7	Safari 20SG (dinotefuran)	In-ground: 6 grams/ inch dbh for trees or foot of height for shrubs	One application. Apply 1-2 quarts of drench solution/ foot of height for shrubs or inch of trunk diameter for trees. Apply to soil at base of trunk within 1 foot of trunk	Valent, Joe Chamberlin, 770-985-0303, jcham@valent.com
A	8	Talus (buprofezin)	21.5 fl oz/100 gal	Foliar application	SePro, Todd Bunnell, 317-216-5667, todd@sepro.com
S/A	9	TnStar 30SG (acetamiprid)	8 oz per 100gal	Spray to wet; two foliar sprays on a 14 d interval with a wetting agent such as Captail.	Cleary Chemical, Rick Fletcher, 732-329-8399, rick.fletcher@clearychemical.com
Standards (Pick One)	10a	Orthene JTO	See label directions		
	10b	Horticultural Oil	See label directions		
	11	Untreated	--	--	--

Optional	Arena 50 WDG (clothianid m)	In-ground: 2.4 grams/ inch dbh for trees or foot of height for shrubs	One application. Apply 1-2 quarts of drench solution/ foot of height for shrubs or inch of trunk diameter for trees. Apply to soil at base of trunk within 1 foot of trunk	Valent, Joe Chamberlin, 770-985-0303, jcham@valent.com
B?	Kontos Optional	3.4 oz 3.4 oz	Foliar Drench	OHP OHP

Appendix 2: Contributing Researchers

Dr. Eileen Buss	University of Florida Entomology & Nematology Department P. O. Box 110620 Gainesville, FL 32611-0620
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Appendix 3: Submitted Data Reports

The reports in this Appendix cover multiple PR numbers and are arranged alphabetically by researcher and year the experiments were conducted.

These reports can also be found at www.rutgers.ir4.edu by searching under the thrips efficacy project.