



Cultivate[™]18

On the Front Lines: IR-4 Project and New Active Ingredients for Plant Success

Cristi L Palmer

IR-4 Environmental Horticulture Program Manager

Outline

- Who we are
- What we do for registration support activities
- Entomology Research Outcomes
- Pathology Research Outcomes
- Weed Science Research Outcomes



IR-4 Environmental Horticulture Program

- Registration Support Research
- Invasive Species Projects
 - Boxwood Blight
 - Impatiens Downy Mildew
- Pollinator Protection

Acknowledgements

- NIFA IR-4 Grant 2015-34383-23710
- USDA-ARS
- State Agricultural Experiment Stations
- APHIS Cooperative agreements from 2011 through 2018
- NIFA SCRI Grant 2016-51181-25399 “Protecting Pollinators with Economically Feasible and Environmentally Sound Ornamental Horticulture”



IR-4 Activities on behalf of the Green Industry

Data development for
registration support

Photos by Cristi Palmer

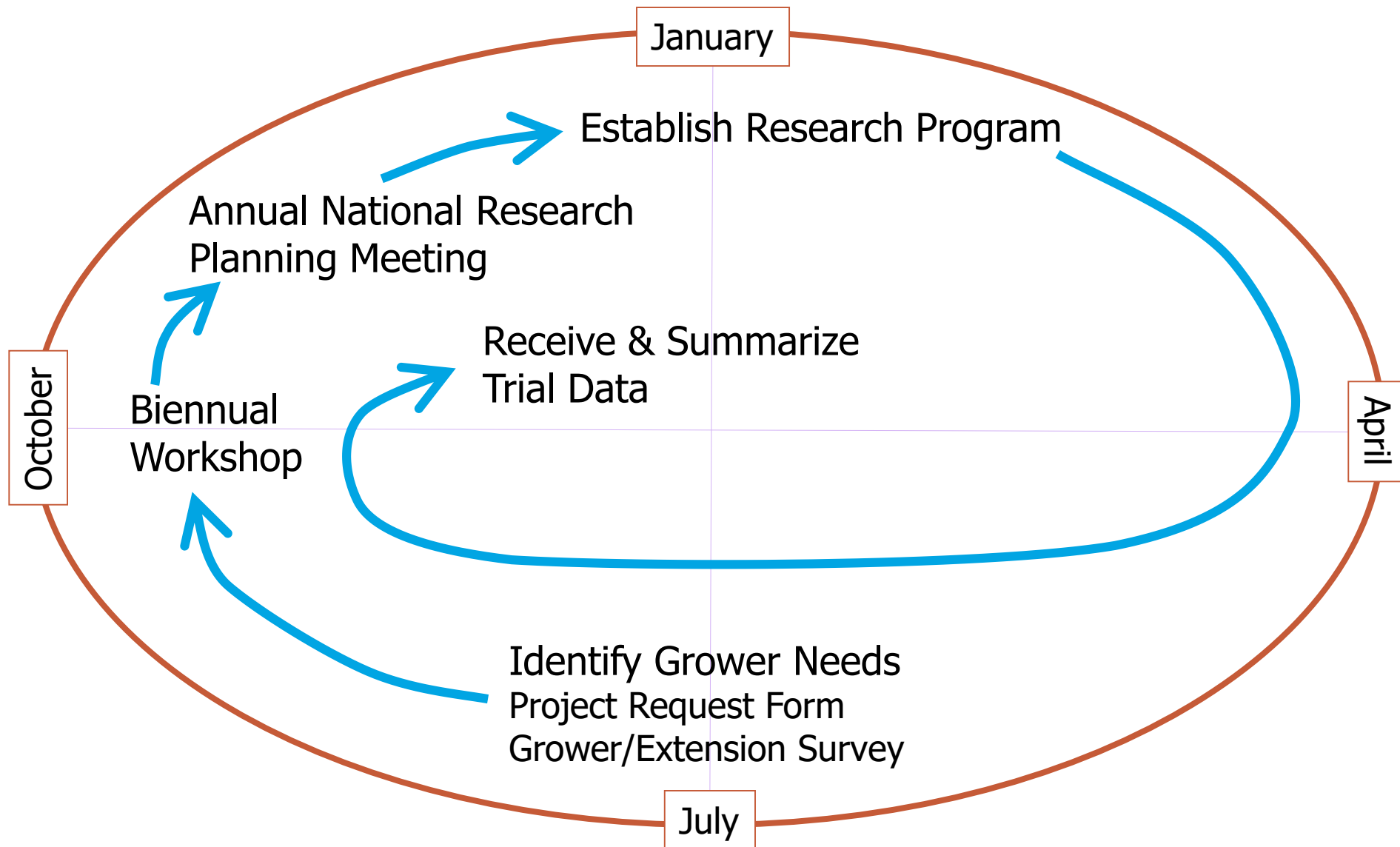
What is IR-4?

The IR-4 Project (or Inter-Regional project number 4) was created in 1963 to facilitate



Photo by Cristi Palmer

registration of sustainable pest management technology for specialty crops and minor uses



How are research projects selected?

Stakeholder Input *balanced with*

Researcher & Registrant Input



Online Project Request Form

Paper or Online Biennial Survey

Diseases (including how to find them)	Type of Plant Materials									
	Shrubbery	Ornamental Grasses	Palms	Palms	Palms	Palms	Palms	Palms	Palms	Palms
1. Insects	0	0	0	0	0	0	0	0	0	0
2. Diseases	0	0	0	0	0	0	0	0	0	0
3. Weeds	0	0	0	0	0	0	0	0	0	0
4. Other	0	0	0	0	0	0	0	0	0	0

Project Criteria

- Availability & effectiveness of current options
- Damage potential of target
- Performance and crop safety of proposed products
- Compatibility with IPM, resistance management programs
- Economics
- Geographic distribution
- Registrant interest in labeling product(s)
- Other

What does this mean for **Environmental Horticulture**?

Since the EnvironHort Program was added in 1977,

- more than **840** products & numbered active ingredients have been screened for performance
- over **34,500** trials have been conducted
- and more than **38,000** crop uses are now available for growers and landscape managers



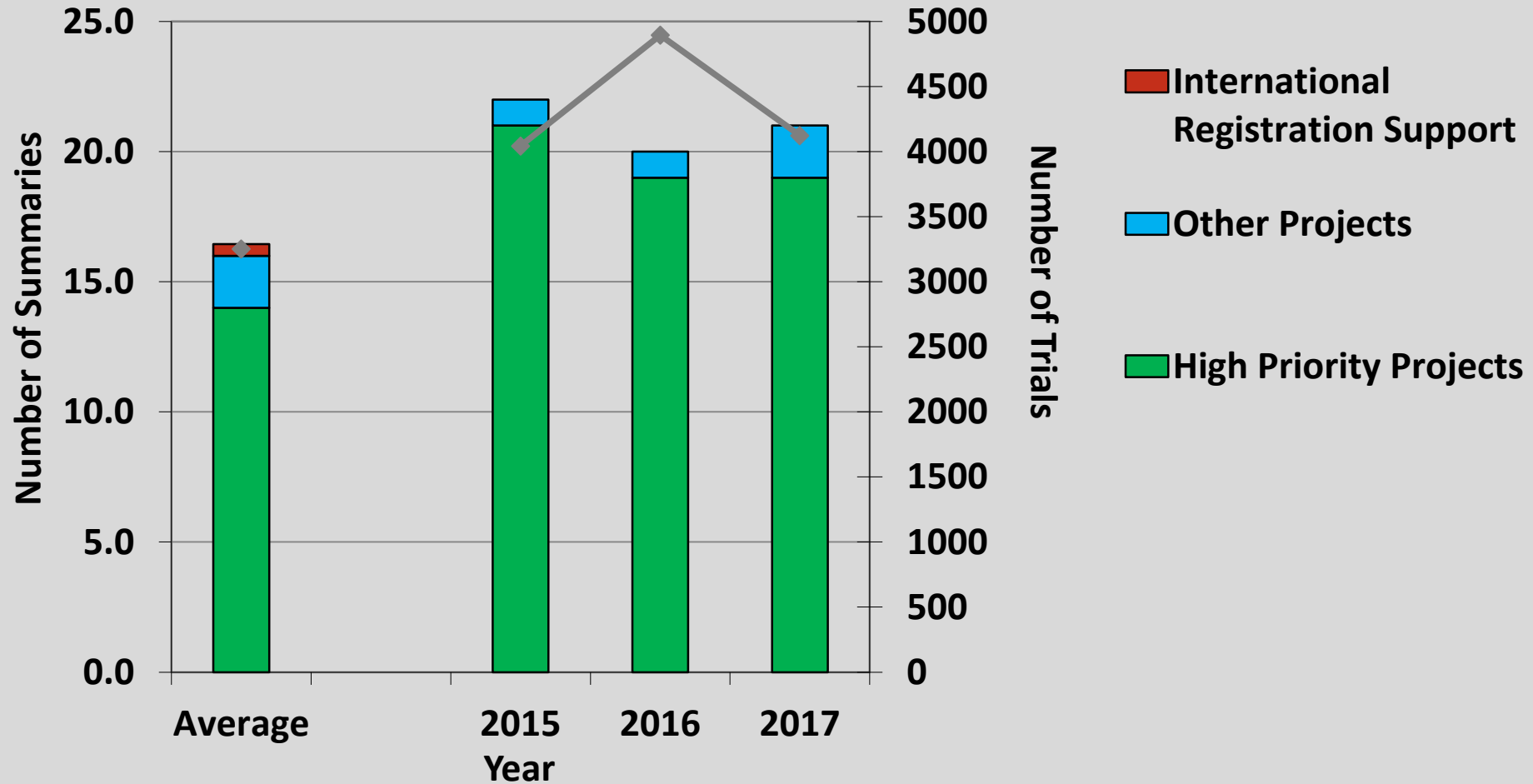
Photo by Cristi Palmer

Program statistics as of Jan 2017

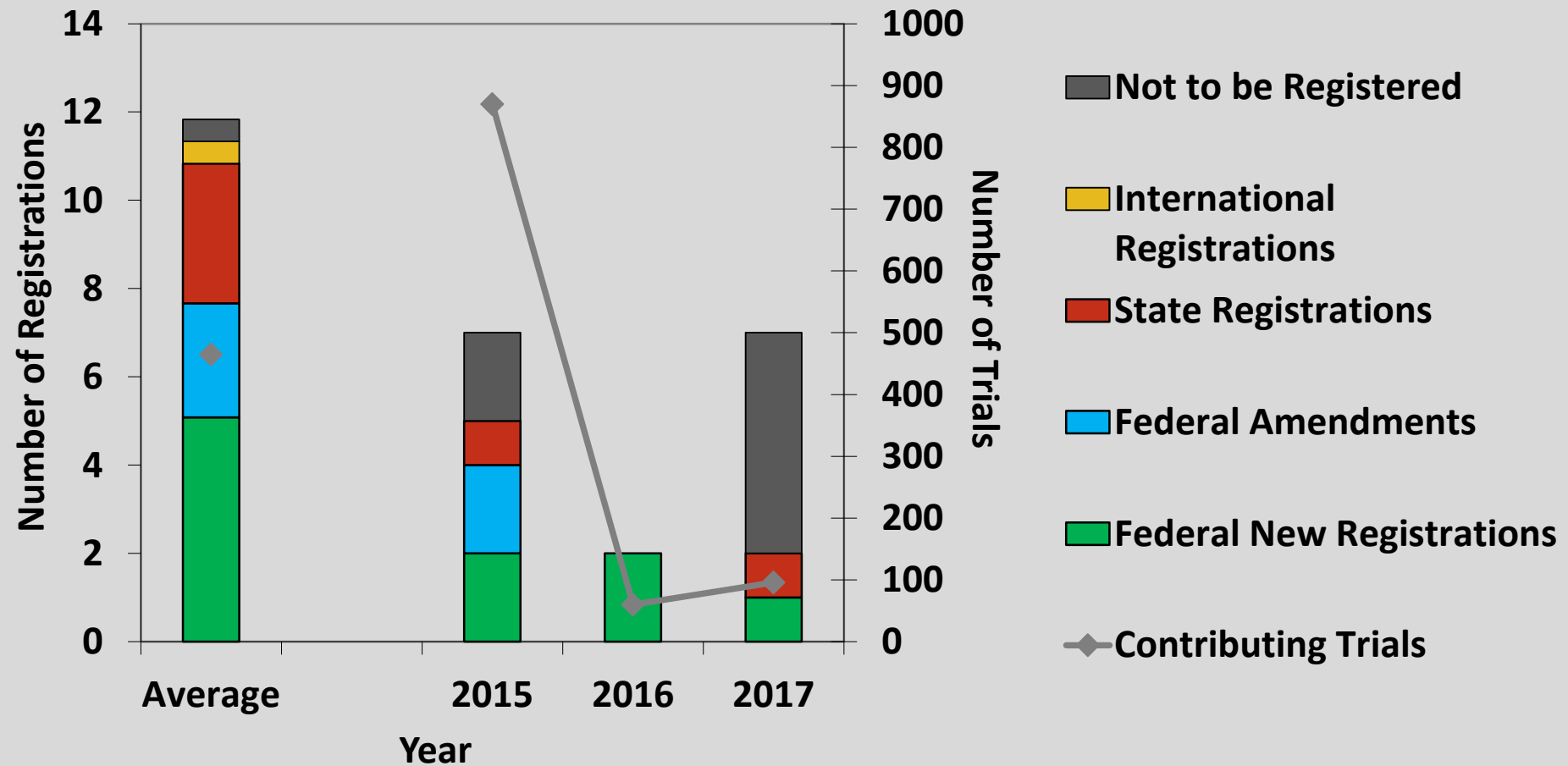
The New Website

The screenshot displays a web browser window with the URL <https://www.ir4project.org/about-environmental-horticulture/>. The website header includes the IR-4 Project logo and navigation links: About IR-4, Programs, Workshops and Events, Contacts: HQ, Regions, Directory, Upload File, and Submit a Request. A search bar is located below the navigation. The main content area features a blue sidebar with the title "Environmental Horticulture" and a list of sub-topics: About the Environmental Horticulture Program, Registration Support, Research, Invasive Species, Pollinator Protection, Program History, History of Environmental (Ornamental) Horticulture in the United States, Data Management (Authorized Users), Grower Needs, Biennial Workshop, Grower Resources, Researcher Resources, Extension Resources, Registrant Resources, Research Summaries, Search the Database, and Where to find ... The main content area has a heading "About the Environmental Horticulture Program" followed by a photograph of numerous purple flowers in pots. Below the photo is a blue text box with the text: "To facilitate regulatory approval of sustainable pest management technology for environmental horticulture crops to promote public health and wellbeing." Further down, there are two paragraphs of text: "The IR-4 Environmental Horticulture Program enables a diverse selection of healthy plants for bouquets, houseplants, landscapes and urban forests." and "Healthy plants provide numerous physical and mental benefits including filtering impurities out of air and water, providing food and habitat, and reducing stress levels which improves productivity and conflict resolution. Mature, well-kept landscapes enhance property value and tend to reduce neighborhood crime rates." The Windows taskbar at the bottom shows the search bar, taskbar icons, and system tray with the date 7/14/2018 and time 9:45 PM.

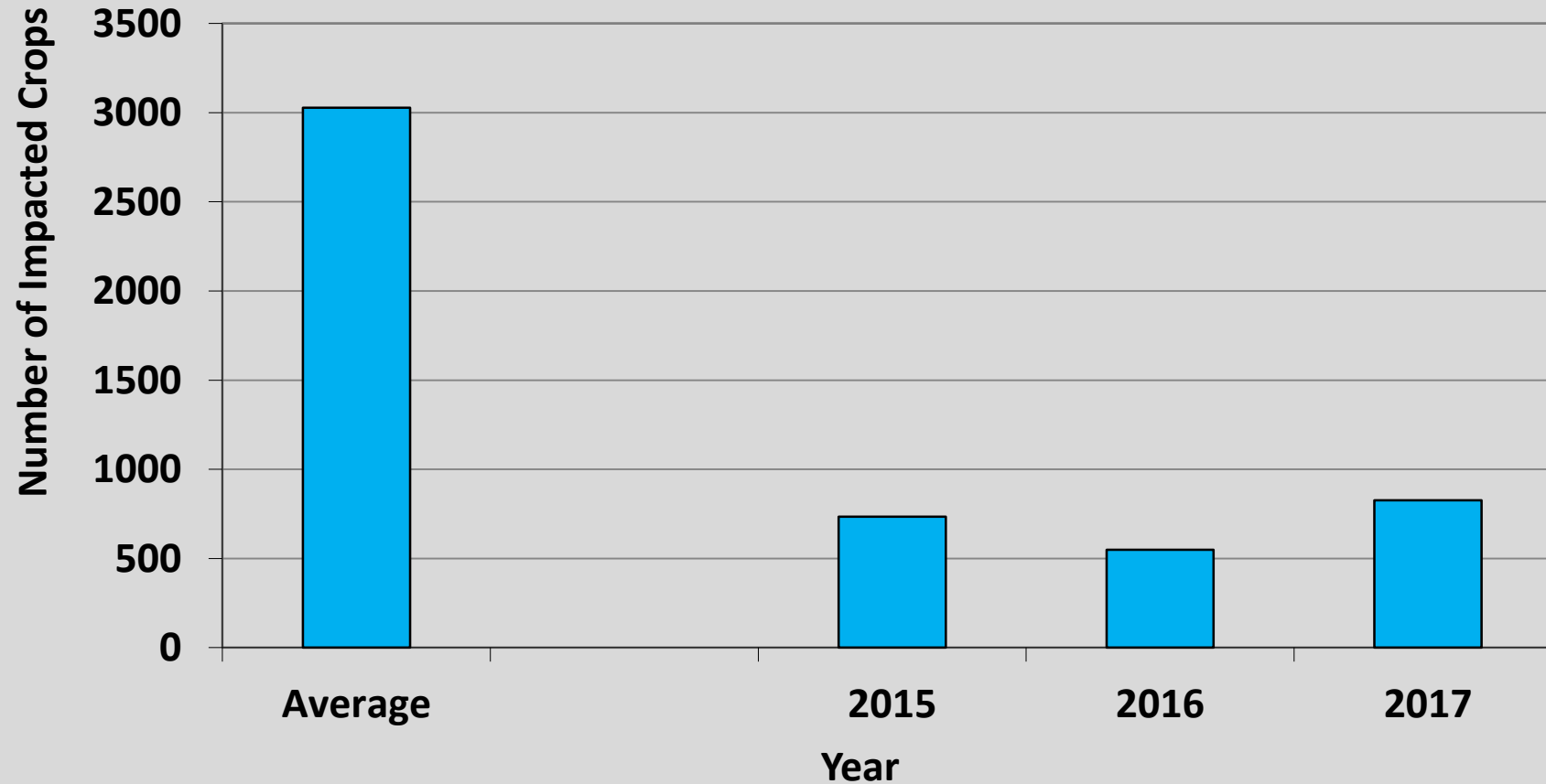
Ornamental Horticulture Program Data Summaries – 2017 Final



Ornamental Horticulture Program – Registrations – 2017 Final



Ornamental Horticulture Program – Crops Impacted by Registrations – 2017 Final



List of 2018 Protocols

- 18-001-Botrytis Efficacy: Greenhouse Crops
- 18-002-Botrytis Efficacy: Greenhouse Crops Post-Harvest/Shelf-life Evaluations
- 18-005-Non-Oomycete Root & Crown Rot Efficacy
- 18-006-New Disease Products Crop Safety - Foliar
- 18-007-New Disease Products Crop Safety - Soil
- 18-008-Foliar Feeding Beetle Efficacy
- 18-009-Coleopteran Borer Efficacy
- 18-010-Mealybug & Scale Efficacy
- 18-011-New Pest Products Crop Safety
- 18-012-Pre-emergent Herbicide Crop Safety (In Season)
- 18-013-Post-emergent Herbicide Crop Safety (In Season)
- 18-014-NCR/WSR Regional Thrips Efficacy
- 18-015-NCR Regional Nematode Efficacy
- 18-016-NER/WSR Regional Snail & Slug Efficacy
- 18-017-WSR Regional Liverwort Efficacy
- 18-018-SOR Regional Cover Crop Management for Christmas Tree Production
- 18-019-Post-emergent Herbicide Efficacy (In Season)
- 18-020-NER Pre-emergent Herbicide Crop Safety for In Ground Cut Flowers
- 18-021 Post-emergent Directed Herbicide Crop Safety





Registration Support Research

Recent Data

Botrytis Efficacy Research Team

Dr. Janna Beckerman

Dr. Mike Benson *

Dr. James Buck

Dr. Nora Catlin

Dr. Gary Chastagner

Dr. Mary Hausbeck

Dr. Cai-Zhong Jiang

Mr. Bob Lambe *

Dr. Kevin Ong





Botrytis Efficacy Project

- Project Duration: 2004, 2005, 2011-2018
- Reason(s): Concerns about developing resistance and lack of data on species other than *B. cinerea*
- Targets: *B. cinerea*, *B. elliptica*, *B. paeoniae*, *B. tulipae*
- New products in protocols 2013-2018:

Botector	IKF-5411	Picatina
BW165N	MBI 110	Picatina Flora
Ecoswing	Medallion	Tourney 50WDG
Emblem	Mural WDG	Trinity 2SC
F9110-1	Orkestra	V-10135

Botrytis Efficacy Outcomes

- 275 trials in 24 experiments from 2005 through 2017 with 9 researchers looking at 49 different products from 22 registrants on 4 different Botrytis species



Botrytis Efficacy: Cross Trial Summary

(A level treatments 2013 – 2018 protocols)

Product (Active Ingredients)	<i>Botrytis elliptica</i>	<i>Botrytis cinerea</i>	<i>Botrytis tulipae</i>	IR-4 Data Impacted Registration
Botector (<i>Aureobasidium pullans</i> strain DSM 14940 + strain DSM 14941)		1.4 (1 - 2) n5		
BW165N (<i>Ulocladium oudemansii</i> strain U3)		3.0 (3 - 3) n1		
Emblem (aka NUP 09092) (Fludioxonil)	5.0 (5 - 5) n1	5.0 (5 - 5) n1	3.0 (3 - 3) n1	
F9110-1 (F9110)	1.0 (1 - 1) n2	1.3 (1 - 3) n7	1.5 (1 - 2) n2	Yes
IKF-5411 (isofentamid)		4.0 (4 - 4) n1		
MBI 110 (MBI110)	1.0 (1 - 1) n1	4.0 (4 - 4) n1	1.0 (1 - 1) n1	
Medallion (Fludioxonil)	3.0 (3 - 3) n1	2.8 (1 - 5) n4		
Mural WDG (Azoxystrobin + benzovindiflupyr)	5.0 (5 - 5) n2	2.5 (2 - 3) n2		
Orkestra Intrinsic (Fluxapyroxad + pyraclostrobin)	5.0 (5 - 5) n2	5.0 (5 - 5) n1	4.0 (3 - 5) n2	Yes
Palladium (Cyprodinil + fludioxonil)	1.5 (1 - 2) n2	4.0 (4 - 4) n1		
Proud 3 (Thyme oil (5.6%))	1.0 (1 - 1) n2	1.3 (1 - 3) n9	1.0 (1 - 1) n2	
S2200 4SC (Mandestrobin)	4.5 (4 - 5) n2	4.0 (4 - 4) n1	2.5 (2 - 3) n2	
Torque 3.6SC (Tebuconazole)	1.0 (1 - 1) n2	5.0 (5 - 5) n1	2.0 (2 - 2) n1	
Tourney 50WDG (Metconazole)	1.0 (1 - 1) n1	2.5 (1 - 4) n2		
Trinity 2SC (Triticonazole)	1.0 (1 - 1) n2	5.0 (5 - 5) n1		
V-10135 (Fenpyrazamine)	1.0 (1 - 1) n1	1.0 (1 - 1) n1		

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. For product/disease combinations that are blank, IR-4 has not screened this combination.

Ecoswing (*Swinglea glutinosa*), Picatina (pydoflumetofen), Picatina Flora (pydiflumetofen + fludioxonil), and SP2480 added in 2018



Botrytis Efficacy: Cross Trial Summary

(A level treatments 2013 – 2018 protocols)

Product (Active Ingredients)	<i>Botrytis elliptica</i>	<i>Botrytis cinerea</i>	<i>Botrytis tulipae</i>	IR-4 Data Impacted Registration
Botector (<i>Aureobasidium pullans</i> strain DSM 14940 + strain DSM 14941)		1.4 (1 - 2) n5		
BW165N (<i>Ulocladium oudemansii</i> strain U3)		3.0 (3 - 3) n1		
Emblem (aka NUP 09092) (Fludioxonil)	5.0 (5 - 5) n1	5.0 (5 - 5) n1	3.0 (3 - 3) n1	
F9110-1 (F9110)	1.0 (1 - 1) n2	1.3 (1 - 3) n7	1.5 (1 - 2) n2	Yes
IKF-5411 (isofentamid)		4.0 (4 - 4) n1		
MBI 110 (MBI110)	1.0 (1 - 1) n1	4.0 (4 - 4) n1	1.0 (1 - 1) n1	
Medallion (Fludioxonil)	3.0 (3 - 3) n1	2.8 (1 - 5) n4		
Mural WDG (Azoxystrobin + benzovindiflupyr)	5.0 (5 - 5) n2	2.5 (2 - 3) n2		
Orkestra Intrinsic (Fluxapyroxad + pyraclostrobin)	5.0 (5 - 5) n2	5.0 (5 - 5) n1	4.0 (3 - 5) n2	Yes
Palladium (Cyprodinil + fludioxonil)	1.5 (1 - 2) n2	4.0 (4 - 4) n1		
Proud 3 (Thyme oil (5.6%))	1.0 (1 - 1) n2	1.3 (1 - 3) n9	1.0 (1 - 1) n2	
S2200 4SC (Mandestrobin)	4.5 (4 - 5) n2	4.0 (4 - 4) n1	2.5 (2 - 3) n2	
Torque 3.6SC (Tebuconazole)	1.0 (1 - 1) n2	5.0 (5 - 5) n1	2.0 (2 - 2) n1	
Tourney 50WDG (Metconazole)	1.0 (1 - 1) n1	2.5 (1 - 4) n2		
Trinity 2SC (Triticonazole)	1.0 (1 - 1) n2	5.0 (5 - 5) n1		
V-10135 (Fenpyrazamine)	1.0 (1 - 1) n1	1.0 (1 - 1) n1		

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. For product/disease combinations that are blank, IR-4 has not screened this combination.

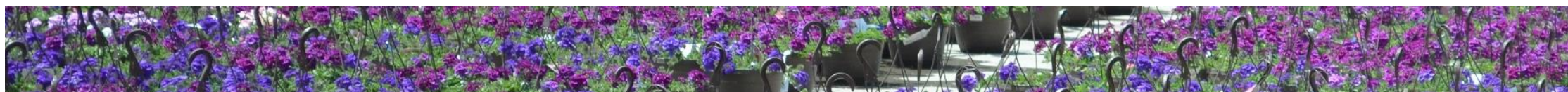
Ecoswing (*Swinglea glutinosa*), Picatina (pydiflumetofen), Picatina Flora (pydiflumetofen + fludioxonil), and SP2480 added in 2018



Botrytis Efficacy on Geranium, Hausbeck 2017

- Target: *Botrytis cinerea*
- Crop: Geranium (*Pelargonium x hortorum*) 'Pinto Premium White'
- Application dates Nov 9, 16, 25
- Treatments:

Product	Rate (per 100 gal)	Reapplication Interval	Days					
			-7	-3	0	1	7	14*
Botector	8 oz	Weekly			A	I	A	A
BW165N + spreader	3 lbs	Weekly			A	I	A	A
F9110	45.7 fl oz	Weekly			A	I	A	A
IKF-5411 (isofetamid)	13.5 fl oz	Biweekly			A	I		A
MBI 110 (<i>Bacillus amyloliquifaciens</i> strain F727)	6 qt	Weekly			A	I	A	A
Orkestra (fluxapyroxad + pyraclostrobin)	8 fl oz	Biweekly			A	I		A
Prophytex EC (<i>Bacillus subtilis</i> strain B1111)	40 fl oz	Weekly			A	I	A	A
Prophytex WP (<i>Bacillus subtilis</i> strain B1111)	20 oz	Weekly			A	I	A	A
Proud 3 (thyme oil)	1 gal	Weekly			A	I	A	A
S2200 (mandestrobin)	7.5 or 15 fl oz	Biweekly			A	I		A



Botrytis Efficacy on Geranium, Hausbeck 2017

Treatment and rate/100, application interval	Leaves with sporulating <i>B. cinerea</i> (%)						Disease severity*					
	16 Nov		25 Nov		4 Dec		16 Nov		25 Nov		4 Dec	
Untreated uninoculated	8.5	ab**	51.3	ab	69.8	b	2.3	ab	5.5	bc	6.0	ab
Untreated inoculated	12.1	ab	45.0	ab	68.0	b	3.1	bc	6.3	c	6.5	ab
Botector 8 oz, 7-day	12.5	ab	38.0	ab	53.0	ab	3.1	bc	5.3	bc	5.6	ab
F9110 45.7 fl oz, 7-day	13.1	ab	41.8	ab	64.1	b	3.3	bc	6.3	c	6.3	ab
IKF-5411 13.5 fl oz, 14-day	1.8	a	33.0	ab	59.0	b	1.3	ab	3.3	ab	5.6	ab
MBI 110 6 qt, 7-day	17.6	b	63.6	b	80.4	b	4.0	c	8.0	c	8.4	b
Orkestra SC 8 fl oz, 14-day	0.5	a	22.3	a	62.3	b	1.1	a	2.6	a	5.3	ab
Proud 3 128 fl oz, 7-day	17.3	b	42.8	ab	62.8	b	3.5	bc	6.1	c	5.5	ab
PinPoint SC 15 fl oz, 14-day	9.3	ab	38.8	ab	75.0	b	2.5	b	5.6	bc	7.1	ab
Affirm WG 0.5 lb, 7-day	0.8	a	13.5	a	34.5	a	1.1	a	2.5	a	4.1	a

*Severity rated on a scale of 0 to 10, where 0=healthy, 1-9=increased levels of disease symptoms observed, 10=plant death.

**Column means with a letter in common are not significantly different (Student-Newman-Keuls; $P=0.05$).



Botrytis Efficacy on Geranium, Meadows 2017

- Target: *Botrytis cinerea*
- Crop: Geranium (*Pelargonium x hortorum*) ‘Maverick Scarlet’
- Application dates Mar 5, 8, 15, 22, 29, Apr 5

- Treatments:

Product	Rate (per 100 gal)	Reapplication Interval	Days					
			-7	-3	0	1	7	14*
Botector	8 oz	Weekly			A	I	A	A
BW165N + spreader	3 lbs	Weekly			A	I	A	A
F9110	45.7 fl oz	Weekly			A	I	A	A
IKF-5411 (isofetamid)	13.5 fl oz	Biweekly			A	I		A
MBI 110 (<i>Bacillus amyloliquifaciens</i> strain F727)	6 qt	Weekly			A	I	A	A
Orkestra (fluxapyroxad + pyraclostrobin)	8 fl oz	Biweekly			A	I		A
Prophytex EC (<i>Bacillus subtilis</i> strain B1111)	40 fl oz	Weekly			A	I	A	A
Prophytex WP (<i>Bacillus subtilis</i> strain B1111)	20 oz	Weekly			A	I	A	A
Proud 3 (thyme oil)	1 gal	Weekly			A	I	A	A
S2200 (mandestrobin)	7.5 or 15 fl oz	Biweekly			A	I		A



Botrytis Efficacy on Geranium, Hausbeck 2017

Treatment	Rate/100 gal	Salability z	Disease Incidence x		AUDPC w
			Foliar	Floral	
Non-treated, noninoculated	N/A	4.7 y	6/6	3/6	118.8 b
Non-treated, inoculated	N/A	5.3	6/6	2/6	255.2 a
BW165N + Activator 90	3 lbs	3.8	6/6	1/6	133.2 b
Botector	8 oz	4.5	6/6	1/6	135.4 b
IKF-5411	13.5 fl oz	3.3	6/6	1/6	91.3 b
Proud 3	1 gal	4.8	6/6	3/6	333.1 a
Decree 50 WDG	1.5 lb	3.5	6/6	1/6	92.7 b
PreStop	13.2 oz	3.8	6/6	1/6	157.7 b

z Salability is reported as the average score of six replicates for each treatment (0= completely salable, no adverse impacts, 10= Complete plant affected) at the end of the trial.

y Data collected on 15, 22, 29 Mar and 5, 12 Apr.

x The total number of plants with symptoms on the foliage or flowers and buds (floral) out of the total number of replicates.

w Numbers in columns followed by the same letter are not significantly different ($P < 0.001$), Fisher's Least Significant Difference (LSD) Test.





Botrytis Efficacy Outcomes

- 275 trials in 24 experiments from 2005 through 2017 with 9 researchers looking at 49 different products from 22 registrants on 4 different Botrytis species
- Botrytis Efficacy Summary 2017 (3rd Ed)
- Products Registered:

Endorse
F9110-1
Insignia
Orkestra

Pageant
Palladium
Picatina Flora
Verando O



Registration Support Research

Thrips Efficacy

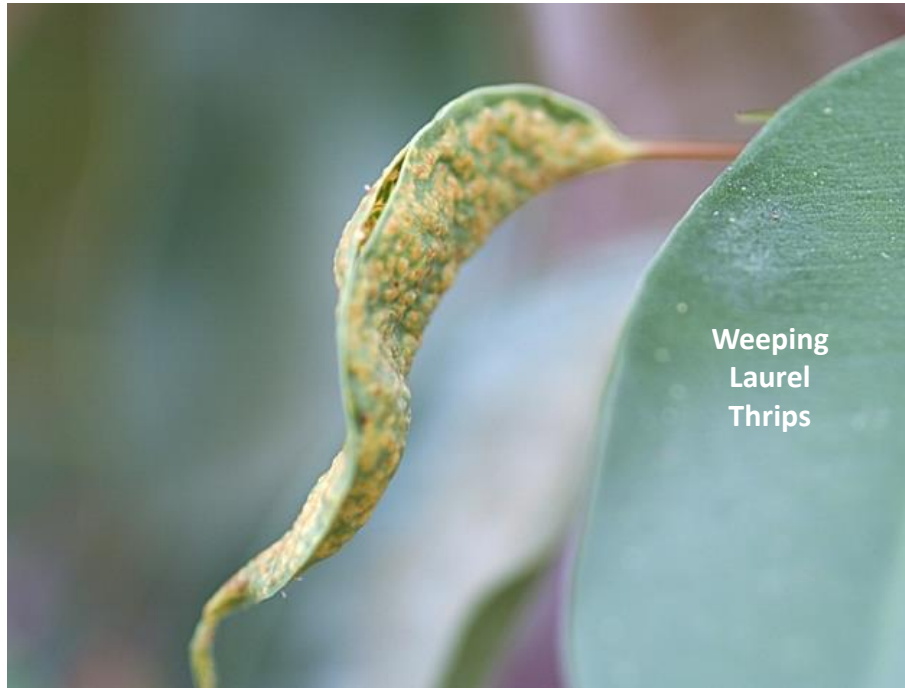
Photos by Cristi Palmer

Thrips Efficacy Research Team



T. Davis, MSU

L. Osborne, UFL



Dr. Steven Arthurs *

Dr. James Bethke

Dr. Luis Canas

Dr. Christine Casey

Dr. Yan Chen

Dr. Juang-Horng Chong

Dr. Ray Cloyd

Dr. Whitney Cranshaw

Mr. Terry Davis *

Dr. Steven Frank

Mr. Dan Gilrein

Dr. Kevin Heinz

Dr. David Held

Dr. Dick Lindquist *

Dr. Scott Ludwig *

Dr. Ron Oetting *

Dr. Michael Parrella *

Dr. Michael Reding

Dr. Dave Smitley

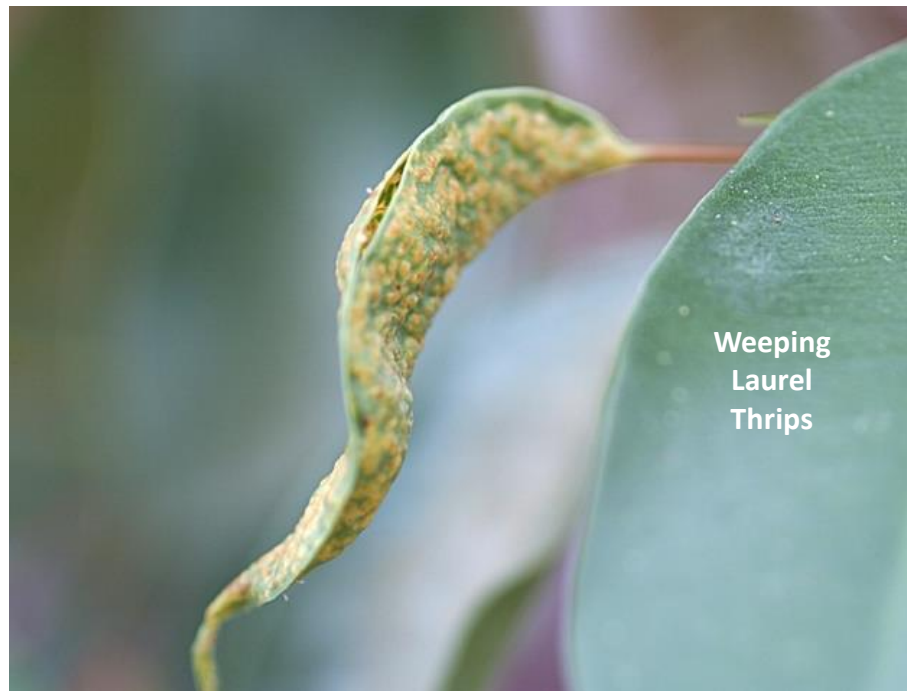
Dr. Lucia Villavicencio *

Dr. Doug Walsh



T. Davis, MSU

L. Osborne, UFL



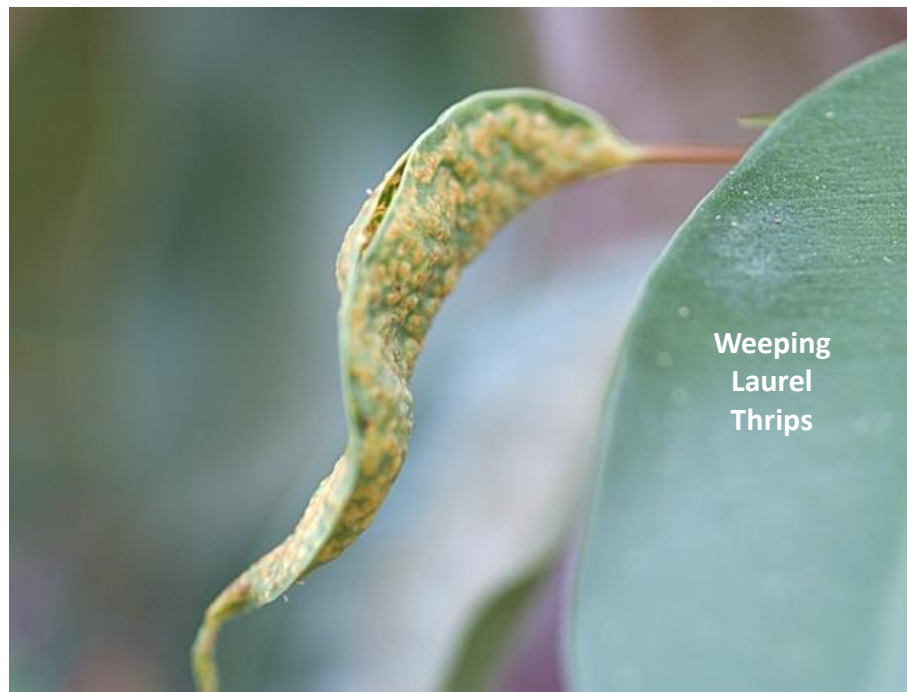
Thrips Efficacy Research Goals

- Screen new active ingredients for managing:
 - Western Flower Thrips
 - Chilli Thrips
 - Cuban Laurel Thrips
 - Weeping Fig Thrips
 - Orchid Thrips
 - Privet Thrips
 - Gladiolus Thrips
- Integrate biopesticides and ‘softer’ chemistries
- Determine impact of newer actives on beneficial organisms
- Determine level of crop safety for new products



T. Davis, MSU

L. Osborne, UFL



Thrips Efficacy Project

- Project Duration: 2004, 2005, 2011-2018
- Reason(s): Concerns about resistance and lack of data on species other than WFT
- Targets: *Western Flower Thrips*, Chilli Thrips, Cuban Laurel Thrips, Weeping Fig Thrips, Orchid Thrips, Privet Thrips, Gladiolus Thrips
- New products in protocols 2013-2018:

BCS-507	SP3014
Grandevo	V-10433
IKI-3106 (cyclaniliprole)	Venerate
Mainspring	XXpire
Rycar	

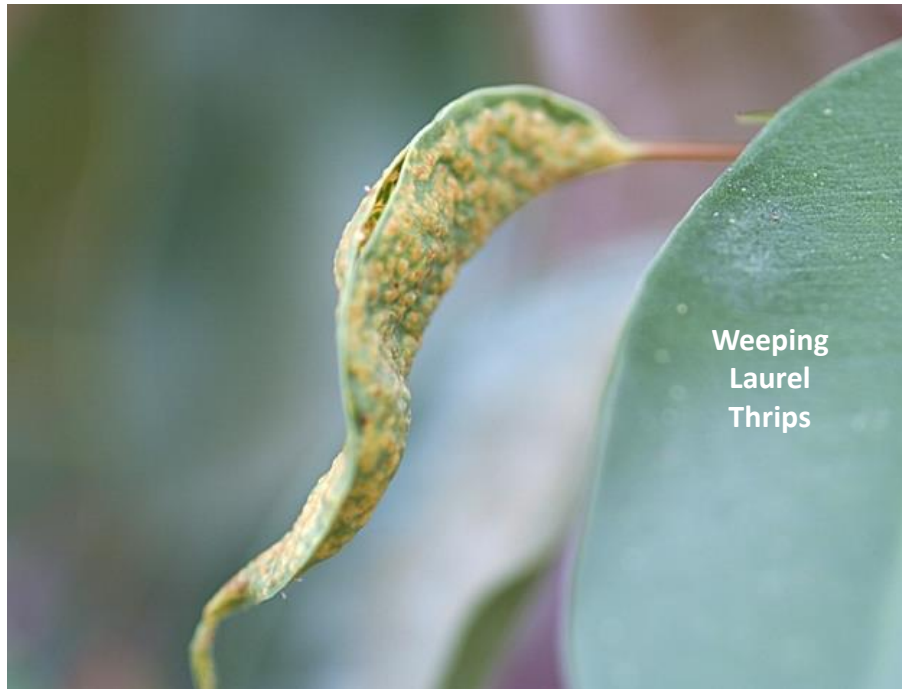
Thrips Efficacy Outcomes

- 395 trials in 52 experiments from 2005 through 2017 with 20 researchers looking at 75 different products from 30 registrants on 7 different thrips species



T. Davis, MSU

L. Osborne, UFL



Thrips Efficacy across Experiments – Stand Alone

Products (Active Ingredients)	Chilli (<i>Scirtothrips dorsalis</i>)	Western Flower (<i>Frankliniella occidentalis</i>)
A16901B 45WG (Cyantraniliprole + thiamethoxam)		3.3 (1 - 5) n6 Labeled
Aria 50SG (Flonicamid)	4.0 (4 - 4) n1 Labeled	2.4 (1 - 5) n8 Labeled
Avid 0.15EC (Abamectin)	4.0 (4 - 4) n1 Labeled	2.9 (1 - 5) n9 Labeled
AzaGuard (Azadirachtin)		2.2 (1 - 3) n6 Labeled
BotaniGard ES (<i>Beauveria bassiana</i>)		3.5 (1 - 5) n8 Labeled
Conserve SC (Spinosad)	3.5 (3 - 4) n2 Labeled	2.8 (1 - 5) n31 Labeled
DPX-HGW86 (Cyantraniliprole)		2.2 (2 - 5) n13 Labeled
Flagship 25WG (Thiamethoxam)	3.7 (1 - 5) n3 Labeled	2.3 (1 - 5) n20 Labeled
Grandevo (MBI 203 DF) (<i>Chromobacterium subtsugae</i> NRRL B-30655)		1.5 (1 - 3) n6 Labeled
Hachi-Hachi EC (Tolfenpyrad)	3.0 (3 - 3) n1 Labeled	3.4 (1 - 5) n20 Labeled
Kontos (BYI 8330 240SC) (Spirotetramat)	1.0 (1 - 1) n3 Labeled	2.3 (1 - 5) n18 Labeled
Mesurol 75-W (Methiocarb)		2.6 (1 - 5) n5 Labeled
Mainspring (A20520A) 200SC (Cyantraniliprole)		3.3 (3 - 4) n3 Labeled
Overture 35WP (Pyridalyl)	3.0 (3 - 3) n1 Labeled	3.8 (1 - 5) n9 Labeled
Proud 3 (Thyme oil 5.6%)		2.1 (1 - 5) n7 Labeled
Pylon (Chlorfenapyr)	5.0 (5 - 5) n1 Labeled	3.6 (1 - 5) n14 Labeled
Rycar (SP3009/NNI-0101) (Pyrifluquinazon)		1.5 (1 - 4) n11
Safari 20SG (Dinotefuran)	4.0 (4 - 4) n2 Labeled	2.5 (1 - 3) n4 Labeled
TickEx EC (<i>Metarhizium anisopliae</i>)		1.7 (1 - 5) n13 Labeled
TriCon (BW 420) (Sodium tetraborahydrate decahydrate)		3.3 (1 - 5) n6
TriStar 30SG (Acetamiprid)	4.0 (3 - 5) n2 Labeled	2.4 (1 - 5) n5 Labeled
Venerate (MBI 206 F) (<i>Burkholderia sp.</i> strain A396)		1.3 (1 - 2) n7



Thrips Efficacy across Experiments – Rotations & Tank Mixes

Products (Active Ingredients)	Western Flower (<i>Frankliniella occidentalis</i>)
Conserve SC (Spinosad)	2.8 (1 - 5) n31 Labeled
Rotation: Aria / Hachi-Hachi / Pylon (Flonicamid / tolfenpyrad / chlorfenapyr)	3.0 (1 - 5) n2
Rotation: BotaniGard / Hachi-Hachi (<i>Beauveria bassiana</i> / tolfenpyrad)	3.5 (3 - 4) n2
Rotation: BotaniGard + MoltX / BotaniGard (<i>Beauveria bassiana</i> + BW533 / <i>B. bassiana</i>)	1.8 (1 - 3) n4
Rotation: BotaniGard + SuffOil-X / BotaniGard (<i>Beauveria bassiana</i> + paraffin oil / <i>B. bassiana</i>)	2.0 (1 - 3) n5
Rotation: Conserve / Hachi-Hachi / Pylon (Spinosad / tolfenpyrad / chlorfenapyr)	5.0 (5 - 5) n1
Rotation: Rycar / Hachi-Hachi (Pyrfluquinazon / tolfenpyrad)	1.0 (1 - 1) n1
Rotation: Tick-Ex / Hachi-Hachi (<i>Metarhizium anisopliae</i> / tolfenpyrad)	3.5 (2 - 5) n2
Tank Mix: Aria + Rycar (Flonicamid + pyrfluquinazon)	3.3 (1 - 5) n3
Tank Mix: BotaniGard + Tick-Ex (<i>Beauveria bassiana</i> + <i>Metarhizium anisopliae</i>)	1.0 (1 - 1) n3
Tank Mix: BotaniGard 22WP + BW130 (<i>Beauveria bassiana</i> + BW130)	3.0 (3 - 3) n1



Western Flower Thrips Efficacy on Marigold, Vafaie 2017

- Target: *Frankliniella occidentalis*
- Crop: Marigold (*Tagetes*) 'Small Bloom Orange'

Treatment (Active Ingredient)	Rate / 100 gal	Application Dates				
		5/4 0 WAT	5/11 1 WAT	5/18 2 WAT	5/25 3 WAT	6/1 4 WAT
Avid 0.15EC	8 fl oz	X		X		X
IKI-3106 + Capsil	22 fl oz + 6 fl oz	X		X		X
IKI-3106 + Capsil	22 fl oz + 6 fl oz	X	X	X	X	X
IKI-3106 +	27 fl oz + 6 fl oz	X		X		X
IKI-3106 +	27 fl oz + 6 fl oz	X	X	X	X	X
IKI-3106 + Capsil rotated w/ Venerate XC	22 fl oz + 6 fl oz 1 qt	X	X	X	X	X
IKI-3106 + Capsil rotated w/ Venerate XC	27 fl oz + 6 fl oz 1 qt	X	X	X	X	X
Venerate XC	1 qt	X	X	X	X	X
Venerate XC	2 qt	X	X	X	X	X
Water check	-	X	X	X	X	X



Western Flower Thrips Efficacy on Marigold, Vafaie 2017

Treatment	Rate / 100 gal	Population Counts ^x							
		0 DAT ^y	7 DAT	14 DAT	21 DAT	28 DAT	35 DAT	42 DAT	49 DAT
Nymphs									
Avid 0.15EC	8 fl oz	66.33	62.50	44.17	10.33	9.33	5.17	4.33	26.00
IKI-3106 + Capsil biweekly	22 fl oz + 6 fl oz	30.83	3.50	14.83	11.00	2.17	3.83	11.50	30.67
IKI-3106 + Capsil weekly	22 fl oz + 6 fl oz	20.50	3.17	14.50	10.17	9.17	4.50	4.00	28.67
IKI-3106 + Capsil biweekly	27 fl oz + 6 fl oz	16.33	47.00	9.67	6.83	8.17	5.83	8.83	11.50
IKI-3106 + Capsil weekly	27 fl oz + 6 fl oz	31.33	28.67	9.33	15.17	9.17	.67	1.17	16.83
IKI-3106 + Capsil rot. w/Venerate XC	22 fl oz + 6 fl oz / 1 qt	54.33	5.67	37.17	12.67	7.33	2.83	7.50	10.33
IKI-3106 + Capsil rot. w/Venerate XC	27 fl oz + 6 fl oz / 1 qt	22.67	28.33	39.50	21.00	7.50	8.17	17.33	32.00
Venerate XC	1 qt	32.83	42.33	6.50	26.17	5.00	13.00	0.50	16.17
Venerate XC	2 qt	21.00	43.33	7.33	13.17	20.00	5.67	17.17	36.50
Water check	-	41.00	37.17	20.00	28.33	12.33	3.17	4.83	20.50
Nontreated	-	37.50	52.00	20.50	19.00	9.00	3.50	.83	5.67
ANOVA	<i>p-value</i>	0.7752	0.0363	0.7142	0.7718	0.6452	0.8100	0.6849	0.3204

*significantly different compared to nontreated check ($p < 0.05$) using Dunnett's Method $\log(x + 1)$

^x Mean number of thrips per sample (1 flower + 5 leaves).



Western Flower Thrips Efficacy on Marigold, Vafaie 2017

Treatment	Rate / 100 gal	Population Counts ^x							
		0 DAT ^y	7 DAT	14 DAT	21 DAT	28 DAT	35 DAT	42 DAT	49 DAT
Adults									
Avid 0.15EC	8 fl oz	2.33	3.17	6.83	9.17	1.50	1.17	0.83	0.50*
IKI-3106 + Capsil biweekly	22 fl oz + 6 fl oz	1.33	6.50	7.00	2.00	1.67	3.33	1.00	0.50*
IKI-3106 + Capsil weekly	22 fl oz + 6 fl oz	1.00	5.33	8.00	6.00	2.17	2.00	0.83	0.67
IKI-3106 + Capsil biweekly	27 fl oz + 6 fl oz	0.50	3.50	6.00	3.83	3.50	1.83	1.50	0.00*
IKI-3106 + Capsil weekly	27 fl oz + 6 fl oz	1.00	2.50	8.67	5.50	2.83	0.67	0.83	0.67*
IKI-3106 + Capsil rot. w/Venerate XC	22 fl oz + 6 fl oz / 1 qt	2.00	3.17	5.00	2.83	1.00	1.33	0.50	0.67*
IKI-3106 + Capsil rot. w/Venerate XC	27 fl oz + 6 fl oz / 1 qt	0.33	4.83	3.67	2.33	0.67	2.67	1.33	1.17
Venerate XC	1 qt	0.83	6.50	3.83	3.33	3.17	2.00	1.00	1.17
Venerate XC	2 qt	0.33	6.67	6.50	1.83	0.17	1.67	2.33	0.50*
Water check	-	1.17	4.17	4.50	3.17	0.67	2.83	1.17	0.83
Nontreated	-	0.50	5.67	3.67	3.50	0.50	1.83	1.00	2.33
ANOVA	<i>p-value</i>	0.1813	0.8901	0.3935	0.6951	0.4584	0.7524	0.9724	0.0263

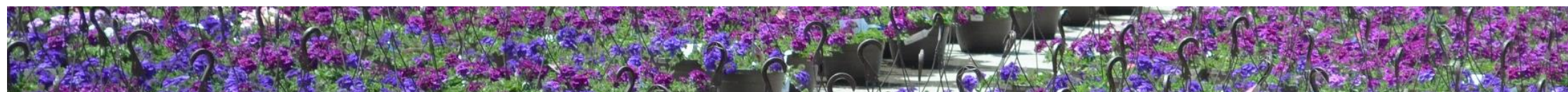
*significantly different compared to nontreated check ($p < 0.05$) using Dunnett's Method $\log(x + 1)$

^x Mean number of thrips per sample (1 flower + 5 leaves).



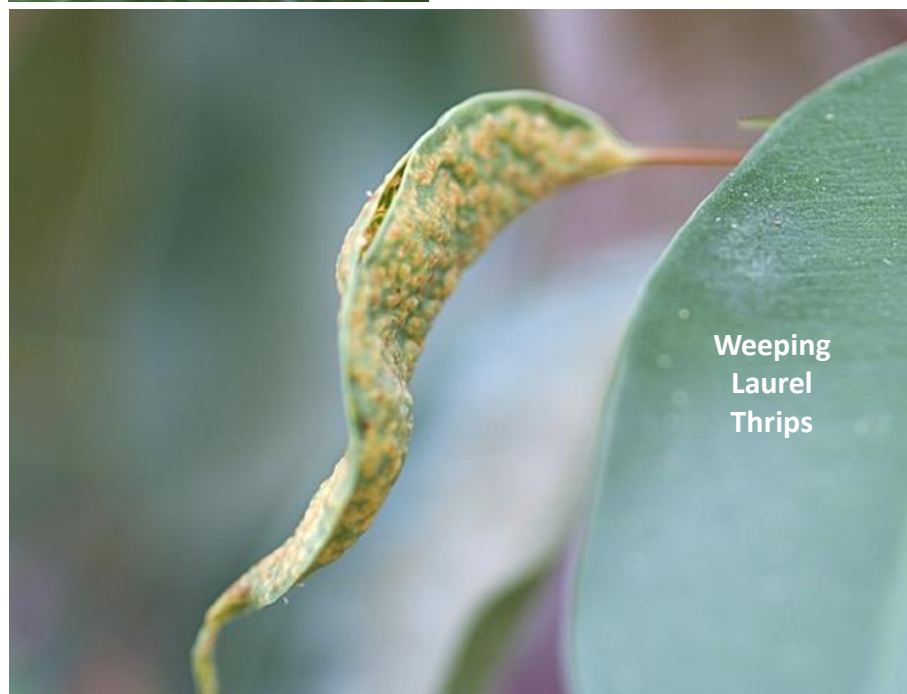
Chili Thrips Efficacy on Indian Hawthorn, Dale 2017

Application frequency	Treatment	Week 0 Total # of damaged leaves (Mean ±SE)	Week 2 Total # of damaged leaves (Mean ±SE)	Week 4 Total # of damaged leaves (Mean ±SE)	Week 6 Total # of damaged leaves (Mean ±SE)
	Product and relative rate				
Weekly	Low Cyclaniliprole *	11.3 ± 1.8	9 ± 1.7	9.8 ± 1.8	9.8 ± 1.5
Every other week	Low Cyclaniliprole *	7.5 ± 1.2	8.2 ± 2.2	10.8 ± 2.4	7.7 ± 1.6
Weekly	High Cyclaniliprole*	10.2 ± 2.7	6.7 ± 2.1	9.5 ± 2	9.5 ± 1.8
Every other week	High Cyclaniliprole*	10.2 ± 2.2	11.2 ± 2.1	11.2 ± 2.5	9.8 ± 2
Alternating weekly	Low Cyclaniliprole*/ VenerateXC	9.2 ± 3.3	11.3 ± 3.2	13.8 ± 2.7	11 ± 2.4
Alternating weekly	High Cyclaniliprole*/ VenerateXC	10.5 ± 1.7	8.8 ± 2	13.5 ± 1.2	10 ± 1.6
Weekly	Low Venerate	10.5 ± 2.2	9.2 ± 1.9	9.8 ± 1.4	9.8 ± 1.3
Weekly	High Venerate	9.3 ± 2.4	8.3 ± 2.3	10 ± 1.7	8.7 ± 2
Weekly	Water	7.8 ± 1.2	7.2 ± 1.4	9.2 ± 0.7	7.7 ± 1
Weekly	Conserve	13 ± 1	11.5 ± 1.6	11.3 ± 2.5	10.2 ± 1.6
*and NuFilm as an adjuvant, active ingredient: alkoxyated polyols					





T. Davis, MSU
L. Osborne, UFL



Thrips Efficacy Outcomes

- 395 trials in 52 experiments from 2005 through 2017 with 20 researchers looking at 59 different products from 30 registrants on 7 different thrips species
- Thrips Efficacy Summary 2017 (6th Edition)
- Registrations approved:

A16901B 45WG

Acelepryn/DPX-HGW

Aria

Conserve

Flagship 25WG

Hachi-Hachi EC

Hachi-Hachi SC

Kontos

Mainspring 200SC

Orthene TTO97 (2008)

Overture 35WP

Pylon

Safari 20SG

TickEx EC

Thrips Efficacy

Research Goals

- Integrate biopesticides and 'softer' chemistries



Outcomes

- Evaluated
 - 13 Rotation and Tank Mix programs
 - 7 stand alone microbial products
 - 7 stand alone plant extracts
 - 6 stand alone softer chemistries





Registration Support Research

Ornamental Grass Crop Safety

Photos by Cristi Palmer

2014-2017 Ornamental Grass Crop Safety

- Products
 - Dimension 2EW (dithiopyr)
 - 2 pt (0.5 lb ai)
 - 4 pt (1.0 lb ai)
 - 8 pt (2.0 lb ai)
 - Gallery (isoxaben)
 - 31 fl oz (1.0 lb ai)
 - 62 fl oz (2.0 lb ai)
 - 123 fl oz (4.0 lb ai)
 - Pendulum 2G (pendimethalin)
 - 150 lb (3 lb ai)
 - 300 lb (6 lb ai)
 - 600 lb (12 lb ai)



2014-2017 Ornamental Grass Crop Safety

- Applications were applied
 - As/after plants broke dormancy, within 1 week after transplanting
 - Six (6) weeks after the first application
- Ratings
 - Phytotoxicity on a scale of 0 to 10
 - 1, 2, and 4 weeks after each application
- During this period, 215 trials planned on 33 different ornamental grasses

Ornamental Grass List

- American beachgrass (*Ammophila breviligulata*)
- Big Blue Stem (*Andropogon gerardii*)
- Broom Sedge Bluestem (*Andropogon virginicus*)
- Feather Reed Grass (*Calamagrostis acutiflora*)
- Leatherleaf Sedge (*Carex buchananii*)
- Sedge, Cherokee (*Carex cherokeensis*)
- Carex morrowii (*Carex morrowii*)
- Indian Woodoats (*Chasmanthium latifolium*)
- Pampas Grass, Uruguayan (*Cortaderia selloana*)
- Tufted Hairgrass (*Deschampsia caespitosa*)
- Weeping Lovegrass (*Eragrostis curvula*)
- Purple Lovegrass (*Eragrostis spectabilis*)
- Blue Fescue (*Festuca cinerea*)
- Field Fescue (*Festuca glauca*)
- Sheep Fescue (*Festuca ovina*)
- Hakone Grass (*Hakonechloa sp.*)
- Sweet Grass (*Hierochloa odorata*)
- Common Rush (*Juncus effusus*)
- Ryegrass, Sand (*Leymus arenarius*)
- Muhly, Hairawn (*Muhlenbergia capillaris*)
- Pine Muhly (*Muhlenbergia dubia*)
- Bamboo Muhly (*Muhlenbergia dumosa*)
- Deer Grass (*Muhlenbergia rigens*)
- Finestem Needlegrass (*Nassella tenuissima*)
- Switch Grass (*Panicum virgatum*)
- Fountaingrass (*Pennisetum alopecuroides*)
- Red Bunny Tails (*Pennisetum messiacum*)
- Oriental Fountain Grass (*Pennisetum orientale*)
- Plumegrass, Ravennagrass (*Saccharum sp.*)
- Little Bluestem (*Schizachyrium scoparium*)
- Indian Grass (*Sorghastrum nutans*)
- Prairie Dropseed (*Sporobolus heterolepis*)
- Feather Grass, Mexican (*Stipa sp.*)

2014-2017 Ornamental Grass Crop Safety

- Research Status
 - 2014: 75 completed, 11 cancelled
 - 2015: 78 completed, 7 cancelled
 - 2016: 36 completed, 1 cancelled, and 3 pending trials
 - 2017: 9 completed, 6 pending

Common Name (<i>Latin Name</i>)	Ranking: Ave. (Range) Count
Fountaingrass (<i>Pennisetum alopecuroides</i>)	1.0 (1 - 1) n2
Purple Lovegrass (<i>Eragrostis spectabilis</i>)	1.0 (1 - 1) n2
Common Rush (<i>Juncus effusus</i>)	1.0 (1 - 1) n3
Ryegrass, Sand (<i>Leymus arenarius</i>)	1.0 (1 - 1) n3
Muhly, Hairawn (<i>Muhlenbergia capillaris</i>)	1.3 (1 - 2) n3
Switch Grass (<i>Panicum virgatum</i>)	1.3 (1 - 2) n3
Weeping Lovegrass (<i>Eragrostis curvula</i>)	1.5 (1 - 3) n4
Hakone Grass (<i>Hakonechloa sp.</i>)	1.7 (1 - 2) n3
Feather Reed Grass (<i>Calamagrostis acutiflora</i>)	1.7 (1 - 3) n3
Finestem Needlegrass (<i>Nassella tenuissima</i>)	1.7 (1 - 3) n3
Big Blue Stem (<i>Andropogon gerardii</i>)	2.3 (1 - 3) n3
Little Bluestem (<i>Schizachyrium scoparium</i>)	2.3 (1 - 3) n4
American beachgrass (<i>Ammophila breviligulata</i>)	2.3 (1 - 4) n3
Field Fescue (<i>Festuca glauca</i>)	2.5 (1 - 4) n4
Indian Woodoats (<i>Chasmanthium latifolium</i>)	2.5 (1 - 4) n4
Oriental Fountain Grass (<i>Pennisetum orientale</i>)	2.7 (1 - 4) n3
Prairie Dropseed (<i>Sporobolus heterolepis</i>)	2.7 (1 - 4) n3
Broom Sedge Bluestem (<i>Andropogon virginicus</i>)	2.7 (2 - 3) n3
Tufted Hairgrass (<i>Deschampsia caespitosa</i>)	3.0 (2 - 4) n3
Pine Muhly (<i>Muhlenbergia dubia</i>)	3.0 (2 - 4) n2
Sheep Fescue (<i>Festuca ovina</i>)	5.0 (5 - 5) n2
Leatherleaf Sedge (<i>Carex buchananii</i>)	1.5 (1 - 2) n2 Labeled
Carex morrowii (<i>Carex morrowii</i>)	2.5 (2 - 3) n2 Labeled
Pampas Grass, Uruguayan (<i>Cortaderia selloana</i>)	2.0 (2 - 2) n1 Labeled
Blue Fescue (<i>Festuca cinerea</i>)	1.5 (1 - 2) n2 Labeled

2014-2017 Results: Dimension 2EW

Key:

- 1 = No injury
- 2 = Minor injury
- 3 = Moderate injury
- 4 = Severe injury
- 5 = Mortality

An average of 3 or higher should preclude application onto that species

Dimension EW on *Andropogon gerardii* and *Leymus arenarius*

Hannah Mathers: *Andropogon gerardii* stunting with Dimension (4X, 2X, 1X, nontreated)



Hannah Mathers: *Leymus arenarius* with Dimension (nontreated, 1X, 2X, 4X)

Common Name (<i>Latin Name</i>)	Ranking: Ave. (Range) Count
Deer Grass (<i>Muhlenbergia rigens</i>)	1.0 (1 - 1) n1
Bamboo Muhly (<i>Muhlenbergia dumosa</i>)	1.0 (1 - 1) n2
Big Blue Stem (<i>Andropogon gerardii</i>)	1.0 (1 - 1) n2
Feather Grass, Mexican (<i>Stipa sp.</i>)	1.0 (1 - 1) n2
Finestem Needlegrass (<i>Nassella tenuissima</i>)	1.0 (1 - 1) n2
Purple Lovegrass (<i>Eragrostis spectabilis</i>)	1.0 (1 - 1) n2
Sweet Grass (<i>Hierochloe odorata</i>)	1.0 (1 - 1) n2
Pine Muhly (<i>Muhlenbergia dubia</i>)	2.0 (1 - 3) n2
Tufted Hairgrass (<i>Deschampsia caespitosa</i>)	3.0 (3 - 3) n1
Indian Grass (<i>Sorghastrum nutans</i>)	1.0 (1 - 1) n3
Prairie Dropseed (<i>Sporobolus heterolepis</i>)	1.0 (1 - 1) n3
Ryegrass, Sand (<i>Leymus arenarius</i>)	1.0 (1 - 1) n3
Switch Grass (<i>Panicum virgatum</i>)	1.0 (1 - 1) n3
Common Rush (<i>Juncus effusus</i>)	1.3 (1 - 2) n3
Muhly, Hairyawn (<i>Muhlenbergia capillaris</i>)	2.0 (1 - 3) n3
Carex morrowii (<i>Carex morrowii</i>)	2.3 (1 - 3) n3
Leatherleaf Sedge (<i>Carex buchananii</i>)	2.0 (1 - 4) n3
Feather Reed Grass (<i>Calamagrostis acutiflora</i>)	2.7 (1 - 4) n3
Sedge, Cherokee (<i>Carex cherokeensis</i>)	3.0 (1 - 4) n3
Indian Woodoats (<i>Chasmanthium latifolium</i>)	1.3 (1 - 2) n3 Labeled
Pampas Grass, Uruguayan (<i>Cortaderia selloana</i>)	1.0 (1 - 1) n1 Labeled
Field Fescue (<i>Festuca glauca</i>)	3.0 (3 - 3) n1 Labeled
Hakone Grass (<i>Hakonechloa sp.</i>)	1.0 (1 - 1) n2 Labeled
Fountaingrass (<i>Pennisetum alopecuroides</i>)	1.0 (1 - 1) n1 Labeled
Plumegrass, Ravennagrass (<i>Saccharum sp.</i>)	1.0 (1 - 1) n1 Labeled

2014-2017 Results: Gallery SC

Key:

- 1 = No injury
- 2 = Minor injury
- 3 = Moderate injury
- 4 = Severe injury
- 5 = Mortality

An average of 3 or higher should preclude application onto that species

Gallery SC on *Carex spp*



Joe Neal: Carex 'Red Rooster' tip damage 1-week after treatment with Gallery SC @ 1.3 lbai/A



Andy Senesac: Carex (nontreated, 1X, 2X, 4X) four weeks after treatment with Gallery SC

Common Name (<i>Latin Name</i>)	Ranking: Ave. (Range) Count
Hakone Grass (<i>Hakonechloa sp.</i>)	1.0 (1 - 1) n1
Sedge, Cherokee (<i>Carex cherokeensis</i>)	1.0 (1 - 1) n1
Sweet Grass (<i>Hierochloe odorata</i>)	1.0 (1 - 1) n1
Pine Muhly (<i>Muhlenbergia dubia</i>)	1.0 (1 - 1) n2
Plumegrass, Ravennagrass (<i>Saccharum sp.</i>)	1.0 (1 - 1) n2
Big Blue Stem (<i>Andropogon gerardii</i>)	1.5 (1 - 2) n2
Purple Lovegrass (<i>Eragrostis spectabilis</i>)	1.5 (1 - 2) n2
American beachgrass (<i>Ammophila breviligulata</i>)	1.0 (1 - 1) n3
Common Rush (<i>Juncus effusus</i>)	1.0 (1 - 1) n3
Feather Reed Grass (<i>Calamagrostis acutiflora</i>)	1.0 (1 - 1) n3
Fountaingrass (<i>Pennisetum alopecuroides</i>)	1.0 (1 - 1) n3
Leatherleaf Sedge (<i>Carex buchananii</i>)	1.0 (1 - 1) n3
Muhly, Hairyawn (<i>Muhlenbergia capillaris</i>)	1.0 (1 - 1) n3
Prairie Dropseed (<i>Sporobolus heterolepis</i>)	1.0 (1 - 1) n3
Ryegrass, Sand (<i>Leymus arenarius</i>)	1.0 (1 - 1) n3
Weeping Lovegrass (<i>Eragrostis curvula</i>)	1.0 (1 - 1) n3
Carex morrowii (<i>Carex morrowii</i>)	1.3 (1 - 2) n3
Indian Grass (<i>Sorghastrum nutans</i>)	1.3 (1 - 2) n3
Indian Woodoats (<i>Chasmanthium latifolium</i>)	1.3 (1 - 2) n4
Switch Grass (<i>Panicum virgatum</i>)	1.3 (1 - 2) n6
Bamboo Muhly (<i>Muhlenbergia dumosa</i>)	1.7 (1 - 2) n3
Tufted Hairgrass (<i>Deschampsia caespitosa</i>)	1.7 (1 - 3) n3
Oriental Fountain Grass (<i>Pennisetum orientale</i>)	1.8 (1 - 2) n4
Little Bluestem (<i>Schizachyrium scoparium</i>)	1.8 (1 - 3) n4
Finestem Needlegrass (<i>Nassella tenuissima</i>)	2.7 (1 - 4) n3
Flax, New Zealand (<i>Phormium tenax</i>)	1.0 (1 - 1) n1 Labeled

2014-2017 Results: Pendulum 2G

Key:

- 1 = No injury
- 2 = Minor injury
- 3 = Moderate injury
- 4 = Severe injury
- 5 = Mortality

An average of 3 or higher should preclude application onto that species

Product/Crop Combinations with Registration Potential

- Dimension 2EW (dithiopyr)
 - All but three grasses screened so far exhibited no or low injury with over the top applications
 - Exceptions: *Deschampsia caespitosa*, *Festuca ovina* and *Muhlenbergia dubia*
- Gallery SC (isoxaben)
 - All but three grasses screened so far exhibited no or low injury with over the top applications
 - Exceptions: *Carex cherokeensis*, *Deschampsia caespitosa*, and *Festuca glauca*
- Pendulum 2G (pendimethalin)
 - All grasses tested to date exhibited no to minimal injury with over the top applications
- New crops can be added to these labels (Dimension – 10, Gallery – 7, Pendulum – 17)



The New Website

The screenshot displays a web browser window with the URL <https://www.ir4project.org/about-environmental-horticulture/>. The website header includes the IR-4 Project logo and navigation links: About IR-4, Programs, Workshops and Events, Contacts: HQ, Regions, Directory, Upload File, and Submit a Request. A search bar is located below the navigation. The main content area features a blue sidebar with the title "Environmental Horticulture" and a list of sub-topics: About the Environmental Horticulture Program, Registration Support, Research, Invasive Species, Pollinator Protection, Program History, History of Environmental (Ornamental) Horticulture in the United States, Data Management (Authorized Users), Grower Needs, Biennial Workshop, Grower Resources, Researcher Resources, Extension Resources, Registrant Resources, Research Summaries, Search the Database, and Where to find ... The main content area has a heading "About the Environmental Horticulture Program" followed by a photograph of purple flowers in pots. Below the photo is a blue text box with the text: "To facilitate regulatory approval of sustainable pest management technology for environmental horticulture crops to promote public health and wellbeing." Further down, there are two paragraphs of text: "The IR-4 Environmental Horticulture Program enables a diverse selection of healthy plants for bouquets, houseplants, landscapes and urban forests." and "Healthy plants provide numerous physical and mental benefits including filtering impurities out of air and water, providing food and habitat, and reducing stress levels which improves productivity and conflict resolution. Mature, well-kept landscapes enhance property value and tend to reduce neighborhood crime rates." The Windows taskbar at the bottom shows the search bar and various application icons, with the system tray displaying the time as 9:45 PM on 7/14/2018.

Take Home Points

- IR-4 researches late-stage development compounds for broader initial labels
- IR-4 researches current products to expand labels
- IR-4 is an advocate for research activities related to specific problems





Photo by Crisi Palmer

Thank you !