Responding to Invasive Species that Threaten Existing IPM Systems (Whitefly as a Model)

FLORICULTURE & NURSERY RESEARCH INITIATIVE

SAF USDA ARS ANLA

October 14, 2009

Co-Authors

- James Bethke
- Luis Canas
- Joe Chamberlin
- Ray Cloyd
- Jeff Dobbs
- Osama El-Lissy
- Richard Fletcher
- Dave Fujino
- Dan Gilrein
- Gary Leibee
- Richard Lindquist
- Scott Ludwig
- Cindy McKenzie
- Ron Oetting
- Lance Osborne
- Cristi Palmer
- John Sanderson
- Lin Schmale

This program will be updated and posted on the Bemisia website:
www.mrec.ifas.ufl.edu/LSO/bemisia/bemisia.htm

Contributors in alphabetical order:

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Note: Mention of a commercial or proprietary product or chemical does not constitute a recommendation or warranty of the product by the authors. Products should be used according to label instructions and safety equipment required on the label and by federal or state law should be employed. Users should avoid the use of chemicals under conditions that could lead to ground water contamination. Pesticide registrations may change so **it is the responsibility of the user to ascertain if a pesticide is registered by the appropriate local, state and federal agencies for an intended use.**

This project was partially funded by the Floriculture & Nursery Research Initiative (USDA-ARS, Society of American Florists, American Nursery & Landscape Association) and the IR-4 Project.

If you have questions, concerns or comments please send them to:

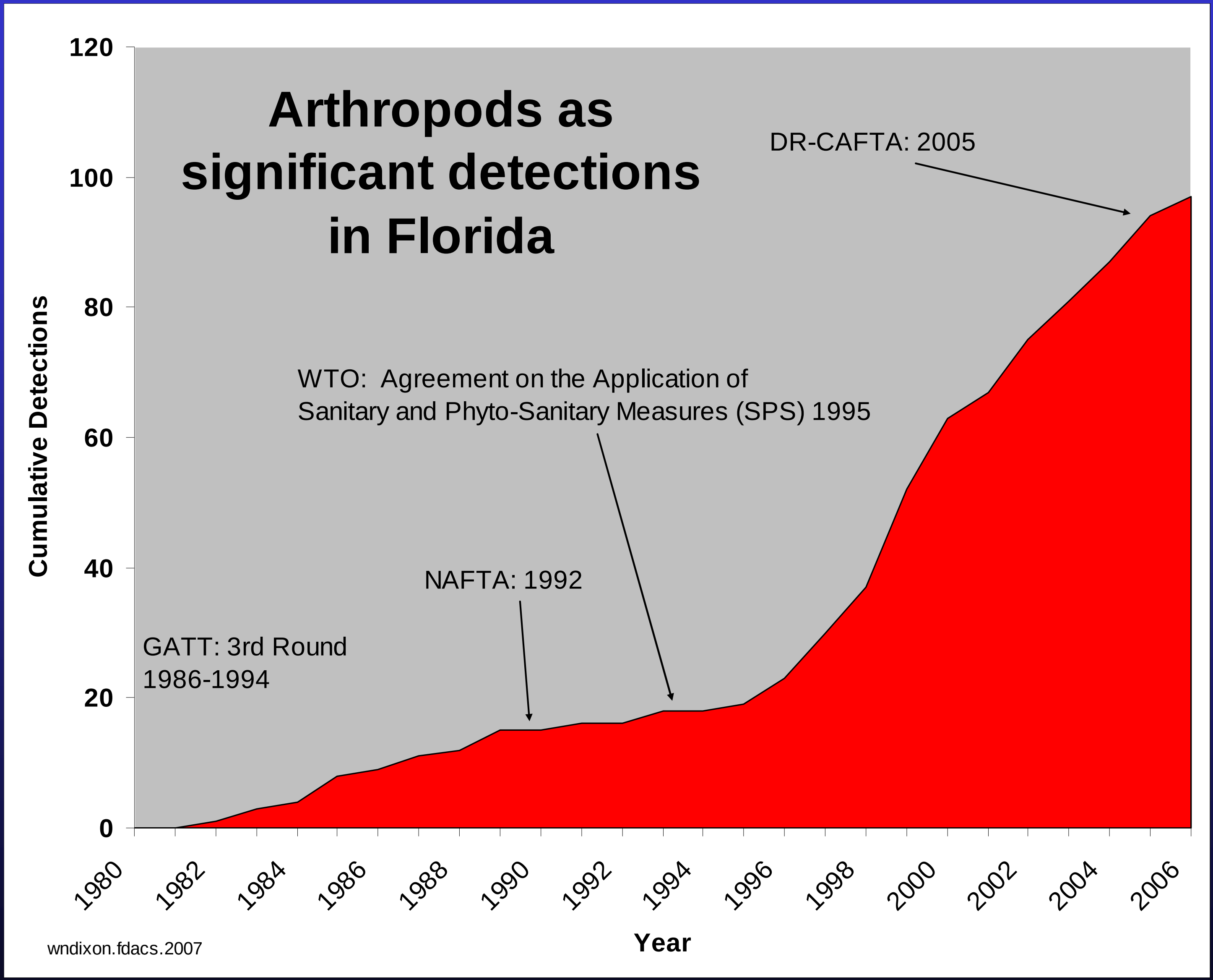
Lance S. Osborne
University of Florida, IFAS
2725 Binion Road
Apopka, Florida 32703
407-884-2034 ext. 163
lsosborn@ufl.edu

Updated: 3/27/06

Rambo

The Problem Facing Industry

My
CHICKEN LITTLE
Presentation

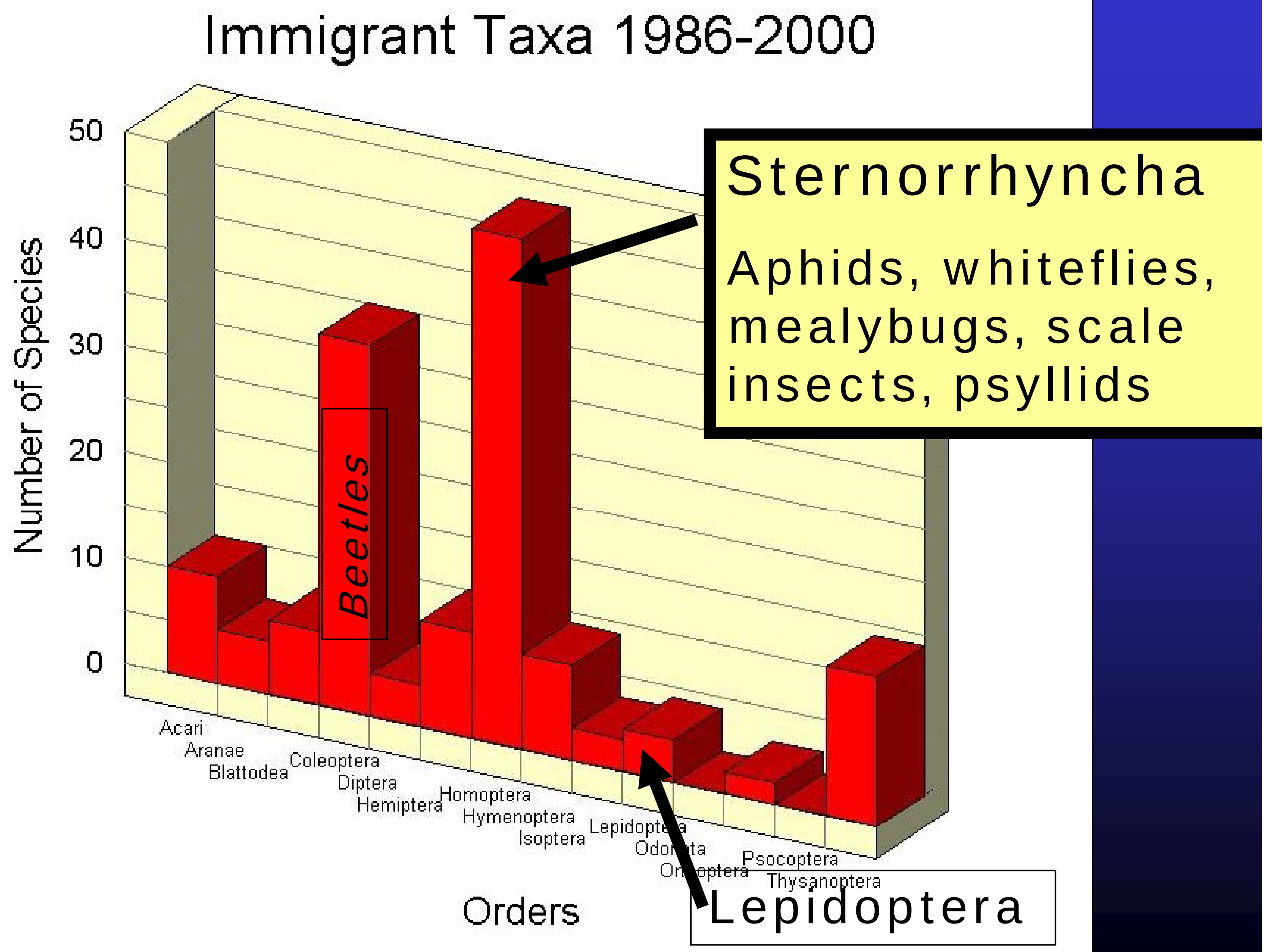


Wayne Dixon-FDACS

1986-2000

150 Exotic Arthropod Species Established in Florida (1/month)

The Exotic Invasion of Florida



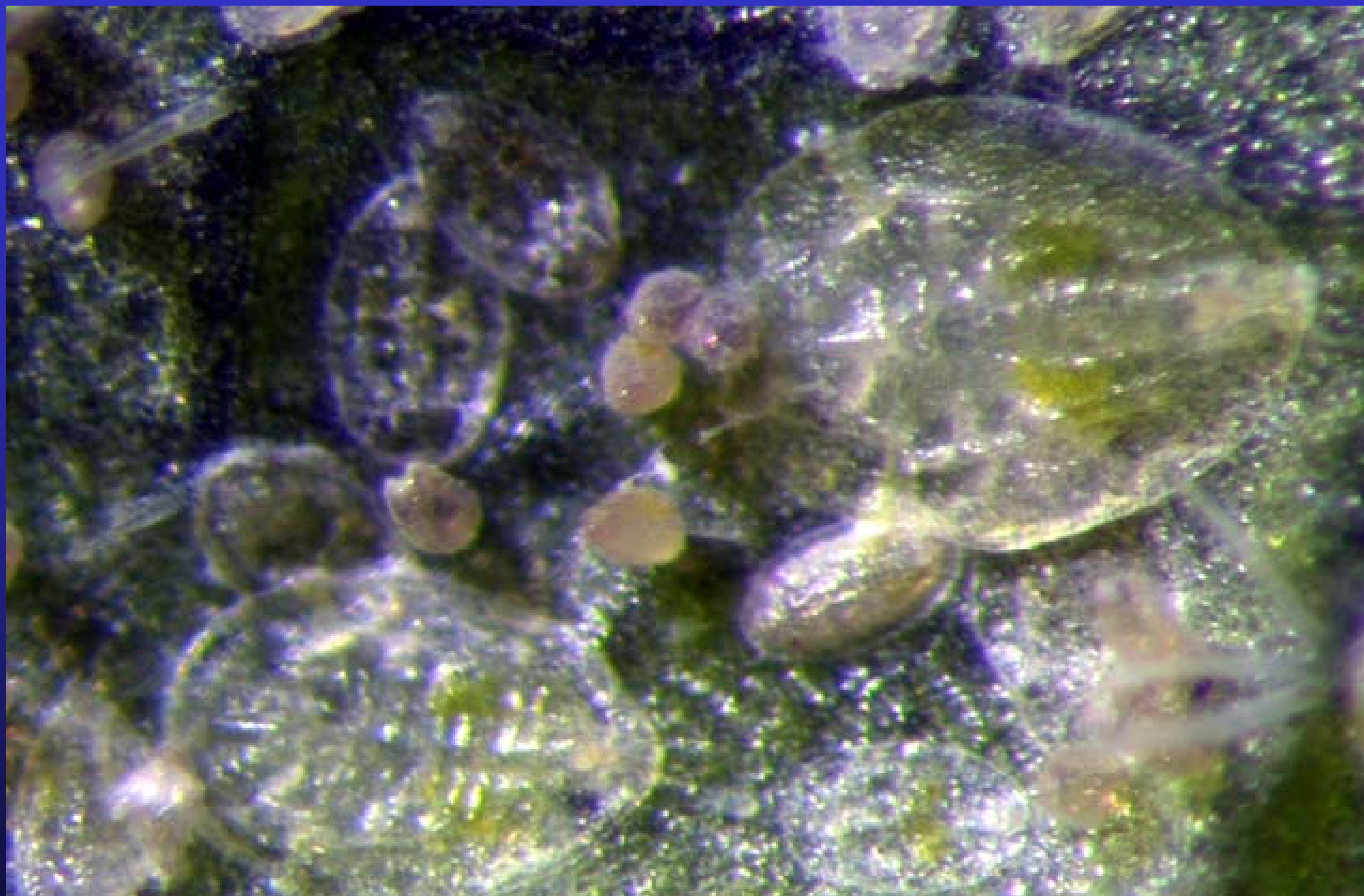
Some Recently Introduced Pests

Lobate lac scale
Cycad aulacaspis scale
Stellate scale
Pink hibiscus mealybug
Bamboo mealybug
Red gum lerp psyllid
Asian citrus psyllid
Giant whitefly
Q Biotype whitefly
Leaf footed bug
Red Palm Mite

Holopothrips
Ficus thrips
Ficus whitefly
Ficus scale
Chilli thrips
Myllocerus weevil
Amaryllis weevil
Twobanded Japanese weevil
Ambrosia beetles
May beetle
Africanized honey bee

Whitefly Invasion

IPM 1985



Geographical Range

- Globally Distributed
- All Continents except Antarctica
- Probably moved on Ornamental plants

Impact of B-biotype

SINCE THE 1980s:

B. tabaci **population outbreaks and** ***B. tabaci*****-transmitted viruses have become a limiting factor in the production of food and fiber crops in many parts of the world (Brown, 1994)**

Significance?

- Major economic losses
- Jobs lost
- People displaced
- Contributes to Famine and even death in Africa

Factors Contributing to the Invasiveness of B-biotype

- Increase Reproductive Potential
- Ability to Disperse
- Large Host Range
- Agricultural Intensification
- Pesticide Resistance

Ornamental Growers

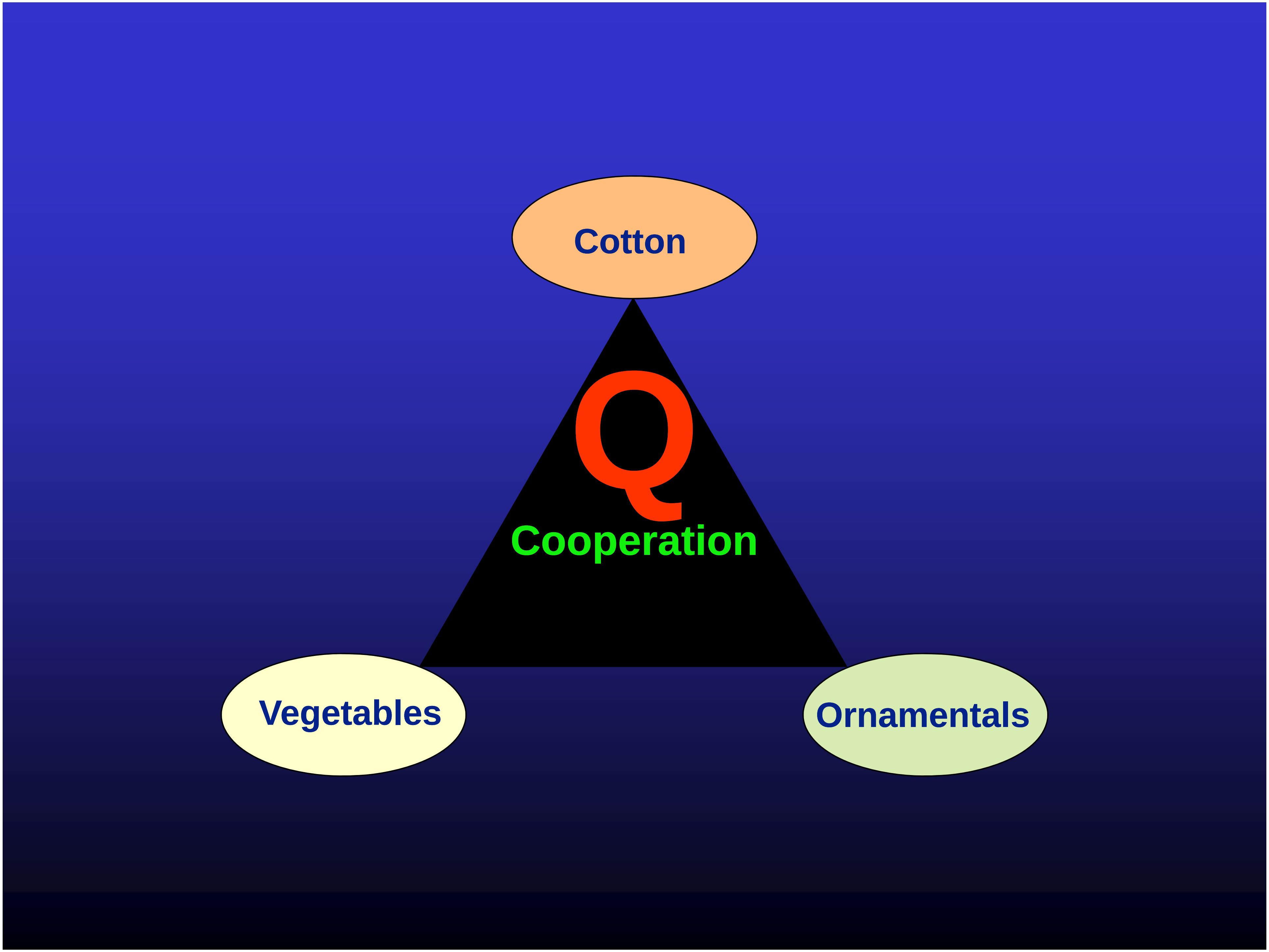
- Many quit growing certain plants because of whiteflies.
- Some growers "forced" to look at biological controls because of pesticide expenses and questionable efficacy.

Biotype Comparisons

Pest Characteristic	Biotype "A"	Biotype "B"	Biotype "Q"
Host plant range	x	xxxx	xxxx
Biotic potential	xx	xxxx	xxx
TYLCV vector	x	xxx	xxxx
Plant disorders		xxxx	x
Biocontrol	xxx	xxx	xxxx
Insecticide resistance	x	xx	xxxx

Dr. Cindy McKenzie

Response to the Q-biotype



Cotton
Q
Cooperation
Vegetables
Ornamentals

B. tabaci Q-Biotype – Cross Commodity Task Force

- Cross Commodity Task Force established to address issues surrounding introduction of Q Biotype (Facilitated by USDA-APHIS).
- Three sub-groups:
  - Industry (ornamentals, cotton, vegetables)
  - Regulatory (states, APHIS)
  - Scientists (Technical Advisory Group)

Regulatory Issues

TRADE

Increased Regulation

- Short term and short-sighted solution for a complex problem.
- Without the proper tools and consideration this could lead to disaster.
- Growers will spray more than they ever have if they are faced with Zero Tolerances.
- Zero Tolerance = RESISTANCE!!!!
- We haven't prevented the whitefly from invading yet, if we develop a SUPER BUG we will all loose.

In my opinion:

A resistant B is far worse than a resistant Q

NATURE|Vol 443|26 October 2006

M. CASTILLO/AP

THE CHRISTMAS INVASION

The cheerful leaves of the poinsettia could be hiding an unwelcome visitor this festive season. **Rex Dalton** goes in search of the whitefly, a potentially devastating pest.

For many Americans, the festive season is hardly seasonal without a centrepiece of poinsettias. But for some entomologists the annual flood of red foliage is not such a welcome sight. When Timothy Dennehy lifts up a potted plant in a store or a nursery to inspect it — as he will be doing more and more over the next couple of months — he's not admiring the shape or the colour with an eye to how it might look sitting in his home. He's looking for little greenish-white harbingers of agricultural chaos.

Every autumn, Dennehy, an entomologist at the University of Arizona, Tucson, hits the state's flower stalls searching for whitefly (*Bemisia tabaci*) on the poinsettias shipped in for the festive holidays. In December 2004, his horticultural gumshoe work paid off in a Tucson market with the first US identification of the whitefly variant in question — the pesticide-resistant Q-biotype[1]. The following year, the Q-biotype was found in stores across Arizona, spurring a nationwide survey that found the superfly in 22 states.

In the 1990s, the B-biotype whitefly swept through North American crops, inflicting more than a billion dollars' worth of damage on farmers in the United States and Mexico; it had hitch-hiked from Israel to Florida to California, and from there it seems likely to have been spread nationwide via the imported poinsettias. Cotton crops were devastated, melons withered on stunted vines, lettuces wilted. US farmers scrambled for scientific assistance, successfully beating the pest with a new class of insect-growth regulators — such as buprofezin and pyriproxyfen, which were rushed through the approval process — and other pest management measures.

Now the spreading of whitefly by poinsettia is at risk of repeating itself in an even more devastating way. The Q-biotype, originally observed in Spain in 1997 (ref. 2), "is resistant to every pesticide we've tested", says Dennehy, who co-chairs a scientific panel on the pest convened by the US Department of Agriculture (USDA)[3]. So far, the superfly has been found only in retail shops or nurseries. But the fear that it will one day find its way into the fields is growing. "It scares me to death; it is one pest that could completely bury us," says Larry Antilla, an entomologist with the Arizona Cotton Research and Protection Council in Phoenix.

> **"It scares me to death; it is one pest that could completely bury us."**
> — Larry Antilla

Festive pests

America is not the only country concerned about whitefly. Some scientists rank it as one of the world's most destructive pests to crops. Robert Gilbertson, a plant pathologist from the University of California, Davis, says damage caused by whitefly makes it "the worst [agricultural pest] problem in regions of Africa, Asia and South America". The flies' increased resistance to pesticides and indifference to drought — many actually prefer things hot and dry — make them a grave threat to crops in parts of the developing world. Elsewhere, international trade has put tomatoes in Japan, cassava in Africa and soya beans in Australia at increased risk.

In the worst infestations, the flies can form visible clouds, coating windscreens and clogging the mouths and nostrils of field workers. Not only does the fly kill flowers, vegetables and cotton, it spreads viruses that are equally deadly in plants (see 'At the sharp end', overleaf). The high doses of pesticides used in attempts to control them can do more collateral damage to the insects that feed on whitefly — such as ladybirds — than to the whitefly themselves.

The best way for a country to fight the whitefly is to stop them entering in the first place. But with today's one-world agriculture, there are enormous economic and political pressures that can hamper effective inspection and regulation. In the United States, for instance, there has been a heated behind-the-scenes battle over the invasion of the Q-biotype.

The cotton industry, fearing for its fields, has fought for more aggressive control methods; the ornamental flower trade, dependent on imports that could be quarantined at borders, has opposed them. The former is a $6-billion industry, the latter is worth $19 billion. After Dennehy and his colleagues found the Q-biotype in Arizona — a state where the B-biotype cost cotton growers $180 million in the first half of the 1990s — representatives of the flower industry fought against plans for a nationwide survey to check for the new variant.

Dennehy, who receives some funding from cotton growers, was displeased. As he wrote to the task force on the subject at the USDA:

Impact of Q

- Put a name on RESISTANCE
- Allows us to track movement of resistance
- Gives us a tool that can be used to identify problems
- Forced 3 commodities to start a dialogue

Management Program for Whiteflies on Propagated Ornamentals with an Emphasis on the Q-Biotype:

Efficacy Studies on Q

- Trials conducted in:
  - California (Jim Bethke)
  - New York (Dan Gilrein)
  - Georgia (Ronald Oetting)
  - Florida (Osborne and Leibee)

PLAN

Management Program for Whiteflies on Propagated Ornamentals

with an Emphasis on the Q-biotype

Each of the shaded boxes below represents a different stage of propagation and growth. Start with Stage 1: Propagation Misting Conditions and then work your way through each box to the growth stage of your crop. Then refer to the tables (A – E) for suggested products. There are also three tables (F, G, and H) summarizing the efficacy data generated in 2005.

Stage 1: Propagation Misting Conditions

1a Mist on . . . . Go to **Stage 2**
1b Mist off . . . . Go to **Stage 3**

Stage 2: Rooting Level after Propagation

2a Cuttings are newly stuck and not anchored in the soil . . . . Go to Table A
2b Cuttings are anchored in the soil and able to withstand spray applications . . . . Go to Table B

Stage 3: Development after Transplanting

3a Roots are well established in the soil and penetrating the soil to the sides and bottom of the pots . . . . Go to **Stage 4**
3b The root system is not well developed . . . . Go to Table C

Stage 4: Plant Growth

4a Plants are in the active growth stage ....Go to Table D
4b Plants are showing color or they are nearing the critical flowering stage . . . .Go to Table E

Table A. Cuttings are Not Anchored in Soil

Suggested Products	IRAC Class	Data on Q
Foggers and aerosol generators	Many	No efficacy data are currently available for any pesticides while plants under mist

Table B. Cuttings Able to Withstand Sprays

Suggested Products	IRAC Class	Data on Q
Foggers	Many	No efficacy data are currently available for any pesticides while plants under mist
Avid (abamectin) Sometimes used with acephate or a pyrethroid	6	
Beauveria bassiana	n/a	
Neonicotinoid spray with translaminar and systemic activity	4	

* IRAC Class 9B exhibits cross resistance with IRAC Class 4

Table C. Undeveloped Root System

Suggested Products	IRAC Class	Data on Q
Aria (flonicamid)	9C	Yes
Avid (abamectin)	6	Yes
Azadirachtin	23	No
Beauveria bassiana	n/a	Yes
Distance (pyriproxyfen)	21	Yes
Endeavor (pymetrozine)	9B *	Yes
Endosulfan	2	No
Enstar II (kinoprene)	7A	Yes
MilStop (potassium bicarbonate)	n/a	Yes
Sanmite (pyridaben)	21	Yes
Talus (buprofezin)	16	Yes
Tank Mixes:		
Abamectin + bifenthrin	6 + 3	Yes
Pyrethroids + acephate	3 + 1	Yes
Pyrethroids + azadirachtin	3 + 26	No

Table D. Plants are Actively Growing

Suggested Products	IRAC Class	Data on Q	Notes
Neonicotinoid Soil Drench: Celero (clothianadin) Flagship (thiamethoxam) Marathon (imidacloprid) Safari (dinotefuran)	4	Yes	After drenching, apply foliar sprays as needed if whiteflies are present. Avoid repeated application with a single mode of action (products with the same number in the attached chart). **If plants have received a neonicotinoid drench, DO NOT spray with a neonicotinoid during this phase, if at all possible. If absolutely necessary, make only a single spray prior to shipping.** Tank mixes of pyrethroids with abamectin, azadiractin, or acephate may provide a suitable way to manage Q whiteflies when other pests need to be managed at the same time. * IRAC Class 9B exhibits cross resistance with IRAC Class 4
Foliar Applications:			
Aria (flonicamid)	9C	Yes	
Avid (abamectin)	6	Yes	
Azadirachtin	23	No	
Beauveria bassiana	n/a	Yes	
Celero (clothianadin)	4	Yes	
Distance (pyriproxyfen)	21	Yes	
Endeavor (pymetrozine)	9B *	Yes	
Endosulfan	2	No	
Enstar II (kinoprene)	7A	Yes	
Flagship (thiamethoxam)	4	Yes	
Horticultural Oil	n/a	Yes	
Insecticidal Soap	n/a	Yes	
Judo (spiromesifen)	23	Yes	
Marathon (imidacloprid)	4	Yes	
MilStop (potassium bicarbonate)	n/a	Yes	
Safari (dinotefuran)	4	Yes	
Sanmite (pyridaben)	21	Yes	
Talus (buprofezin)	16	Yes	
TriStar (acetamiprid)	4	Yes	
Foggers and other products whose use is not restricted by the label	Many	No	

Table E. Plants in Flower or Ready for Shipping

NOTE: Control of whiteflies during this time is difficult due the difficulty of achieving effective under leaf spray coverage, lack of labeled products, concerns about phytotoxicity or residue on final product. Therefore, pest management efforts should be concentrated before this phase. Drenches are slower acting and should probably not be within 7 days of shipping.

Suggested Products	IRAC Class	Data on Q
Neonicotinoid Soil Drench: Celero (clothianadin) Flagship (thiamethoxam) Marathon (imidacloprid) Safari (dinotefuran)	4	Yes
Foliar Applications:		
Avid (abamectin)	6	Yes
Flagship (thiamethoxam)	4	Yes
Judo (spiromesifen)	23	Yes
Safari (dinotefuran)	4	Yes
Sanmite (pyridaben)	21	Yes
TriStar (acetamiprid)	4	Yes
Foggers and other products whose use is not restricted by the label	Many	No

Table F. Summary of clip cage efficacy trials conducted in California by Jim Bethke against Q-Biotype whiteflies on poinsettia in 2005.

Trade Name	Common Name	IRAC Class	Rate per 100 gal	Application Method	Relative Efficacy
Avid 0.15EC + Talstar GH (0.67F)	Abamectin + Bifenthrin	6 + 3	8 fl oz + 18 fl oz	Foliar	100%
Judo 4F	Spiromesifen	23	4 fl oz	Foliar	100%
Safari 20SG	Dinotefuran	4	24 oz (4 oz solution per pot)	Drench	100%
Safari 20SG	Dinotefuran	4	8 oz	Foliar	100%
Avid 0.15EC	Abamectin	6	8 fl oz	Foliar	>95%
Sanmite 75WP	Pyridaben	21	6 oz	Foliar	>95%
TriStar 70WSP	Acetamiprid	4	4 pkt (1.6 oz ai)	Foliar	>90%
Flagship 25WG	Thiamethoxam	4	4 oz (1/3 pot volume per pot)	Drench	80 – 90%
Celero 16WSG	Clothianidin	4	4 oz per 2000 6" pots	Drench	70 – 90%
Marathon II 2F	Imidacloprid	4	1.7 fl oz per 1000 6" pots	Drench	60 – 95%
Dursban ME	Chlorpyrifos	1	50 fl oz	Foliar	80%
Flagship 25WG	Thiamethoxam	4	4 oz	Foliar	80%
Celero 16WSG	Clothianidin	4	4 oz	Foliar	70%
Marathon II 2F	Imidacloprid	4	1.7 fl oz	Foliar	70%
Talus 70WP	Buprofezin	16	6 oz	Foliar	60%
Talstar GH (0.67F)	Bifenthrin	3	18 fl oz	Foliar	50%
Aria 50SG	Flonicamid	9C	4.3 oz	Foliar	45%
Tame 2.4EC	Fenpropathrin	3	16 fl oz	Foliar	42 – 70%
Enstar II	S-Kinoprene	7A	10 fl oz	Foliar	38%
Endeavor 50WG	Pymetrozine	9B cross w/ 4	5 oz	Foliar	35%
Distance IGR	Pyriproxyfen	21	8 fl oz	Foliar	30 – 95%
MilStop (85S)	Potassium bicarbonate	n/a	2.5 lb	Foliar	26%
Discus	Imidacloprid+Cyfluthrin	4 + 3	25 fl oz	Foliar	22%
Orthene TT&O	Acephate	1	4 oz	Foliar	18 – 30%

Table G. Summary of whole plant efficacy trials conducted in Georgia by Ron Oetting against Q-Biotype whiteflies on poinsettia in 2005.

Trade Name	Common Name	IRAC Code	Rate per 100 gal	Application Method	Adult Mortality	Immature Mortality
Safari 20SG	Dinotefuran	4	24 oz (4 oz solution per pot)	Drench	89%	100%
Avid 0.15EC + Talstar GH (0.67F)	Abamectin + Bifenthrin	6 + 3	8 fl oz + 20 fl oz	Foliar	98%	98%
TriStar 70WSP + Capsil	Acetamiprid	4	2.25 oz	Foliar	88%	98%
Botanigard ES	*Beauveria bassiana*	n/a	64 fl oz	Foliar	0%	97%
Judo 4F	Spiromesifen	23	4 fl oz	Foliar	71%	97%
Naturalis L	*Beauveria bassiana*	n/a	64 fl oz	Foliar	92%	87%
Marathon II 2F	Imidacloprid	4	5.4 oz	Drench	57%	84%
Flagship 25WG	Thiamethoxam	4	3 oz	Foliar	0%	81%
Sanmite 75WP	Pyridaben	21	6 oz	Foliar	88%	81%
Distance IGR	Pyriproxyfen	21	8 fl oz	Foliar	28%	77%
Orthene TT&O + Tame	Acephate + Fenpropathrin	1 + 3	5.33 oz + 16 fl oz	Foliar	24%	74%
Celero 16WSG	Clothianidin	4	6.3 oz	Drench	57%	60%
Aria 50SG	Flonicamid	9C	120 g	Drench	57%	59%
MilStop (85S)	Potassium bicarbonate	n/a	2.5 lb	Foliar	42%	58%

Table H. Summary of whole plant efficacy trials conducted in New York by Dan Gilrein against Q-Biotype whiteflies on poinsettia in 2005.

Trade Name	Common Name	IRAC Code	Rate per 100 gal	Application Method	Immature Mortality
Judo 4F	Spiromesifen	23	4 fl oz	Foliar	100%
Safari 20SG	Dinotefuran	4	8 oz	Foliar	97%
Flagship 25WG	Thiamethoxam	4	2 oz	Foliar	63%
Marathon II 2F	Imidacloprid	4	1.7 fl oz	Foliar	43%
Distance 0.86EC	Pyriproxyfen	21	8 fl oz	Foliar	25%

***For an explanation of the what the various numbers mean under the "IRAC Code" heading please visit the following site: Insecticide Resistance Action Committee Mode of Action Classification v 5.1 (2005) Revised and re-issued (September, 2005) (http://www.irac-online.org/documents/moa/MoAv5_1.doc)**

Details of the experiments referred to in Tables F-H can be obtained by going to the Bemisia Website (the address is on the last page of this document.

We highly recommend that no more than 2-3 applications be made during the entire growing season of compounds belonging to any IRAC-Mode of Action Group and especially those in Group 4 (see tables). Talus and Distance should not be used more than twice during a crop cycle. We also recommend that growers utilize, as often as possible, non-selective mortality factors such soaps, oils and biological controls (i.e., pathogens and parasitoids).

LABORATORIES AUTHORIZED TO TEST TO DETERMINE Q-BIOTYPE FROM B-BIOTYPE

There are a number of specifics concerning how one collects a sample and preserves it for evaluation. For these specifics, scheduling and pricing information you MUST contact the individual laboratories.

Judith K. Brown, Ph. D.
Plant Sciences Department
The University of Arizona
Tel.: (520) 621-1230
Tucson, AZ 85721 U.S.A.
Email: jbrown@ag.arizona.edu

Cindy McKenzie, Ph.D.
Research Entomologist
USDA, ARS, US Horticultural Research Laboratory
2001 South Rock Road
Fort Pierce, FL 34945
Tel.: (772) 462-5917
Email: cmckenzie@ushrl.ars.usda.gov

Frank J. Byrne, Ph. D.
Assistant Researcher
Dept of Entomology
University of California, Riverside
3401 Watkins Drive
Riverside, CA 92521
Tel.: (951) 827-7078
Email: frank.byrne@ucr.edu

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Lance S. Osborne
University of Florida, IFAS
2725 Binion Road
Apopka, Florida 32703
407-884-2034 ext. 163
lsosborn@ufl.edu

Updated: 3/27/06

Accomplishments-

- Collectively the team has published 6 refereed journal articles, over 40 popular press articles and made over 80 presentations on *Bemisia* biotypes and how to control them. Two whitefly websites have been developed and maintained for disseminating whitefly information.

Accomplishments-

- Two management programs were developed and technology transferred to growers for controlling whitefly on propagated ornamentals with an emphasis on biotype Q and plants for planting intended for export. One was circulated to over 10,000 ornamental growers and propagators.

Accomplishments-

- *Bemisia* gene sequences (2 data sets) were submitted to the National Center for Biotechnology Information (NCBI) and made available to the research community(Public Database).

Accomplishments-

Diagnostic tools were developed that allowed rapid whitefly biotype determination. The new primer design yielded band sizes that were unique for biotypes B, Q and New World (native biotype) so there was no need to sequence the products which is time consuming and very expensive. By combining new primers and using rapid PCR and electrophoretic techniques, biotype determination can be made within 3 hours for up to 96 samples at a time. Now any researcher with a PCR machine has the ability to identify these two biotypes.

Accomplishments-

Pesticide Effect on Predatory Mites:

Accomplishments-

Distribution of *Bemisia* Biotypes in Florida – Investigating the Q Invasion:

The Florida Entomological Society awarded the Team Research award for this work in 2009.

Accomplishments-

Fig Whitefly (*Singhiella simplex*) Management program for Commercial Plant Production

Accomplishments-

Additional Funding/External Support:

EPA

Commercial Sources of Parasitoids

Solution?

Modified Banker Plants

(Open Rearing Systems)

Banker

Process-Challenges and opportunities of industry-driven team research

- Pests impact more than one commodity or one sector of the ornamental industry.
- Tuff to get all parties involved.
- Difficult to do research on a pest with limited distribution…
- Communication between all possible stake holders is very hard.

Process-Challenges and opportunities of industry-driven team research

- Trade implications that most people don't understand or appreciate.

- Most rewarding thing I've done in my career.

IT'S THE PEOPLE

Process-Lessons learned

- Websites

Aids in information exchange and educational process.

Removes misunderstandings

Helps organize process

Helps reduce the nature and severity of RUMORS

Time consuming and difficult to make everyone understand that their input is valued …no ownership issues.

- Funding distribution difficult, impossible and very embarrassing when dealing with the

UNIVERISTY OF FLORIDA

Process-What should we do differently?

- Sub-contracts through the University did not work.

- Establish programs with major projects and outcomes and let one of the Excellent ADODRs establish the sub-contracts. Smaller grants ($10,000) to many people for targeted research.

Process-What should we do the same?

- Work with many of the same people and possibly extend it more of them… based on experience from IR-4.

- Continue our approach of developing management programs for the “Worst of the Bunch” or the “Bad Actors” that we currently have in the US

We Could Develop Management Programs for What Could Invade

Aphids

Beetles

Mites

Scales

Snails

Thrips

Worms…

"Mr. Osborne, may I be excused?
My brain is full."

FLORICULTURE
& NURSERY
RESEARCH
INITIATIVE

SAF
SOCIETY of AMERICAN FLORISTS
Your Growth is Our Business

USDA
ARS

ANLA
American Nursery &
Landscape Association

Thank you!