Invasion and Response: Impacts of *Bemisia* on Worldwide Agriculture.

Keynote Address

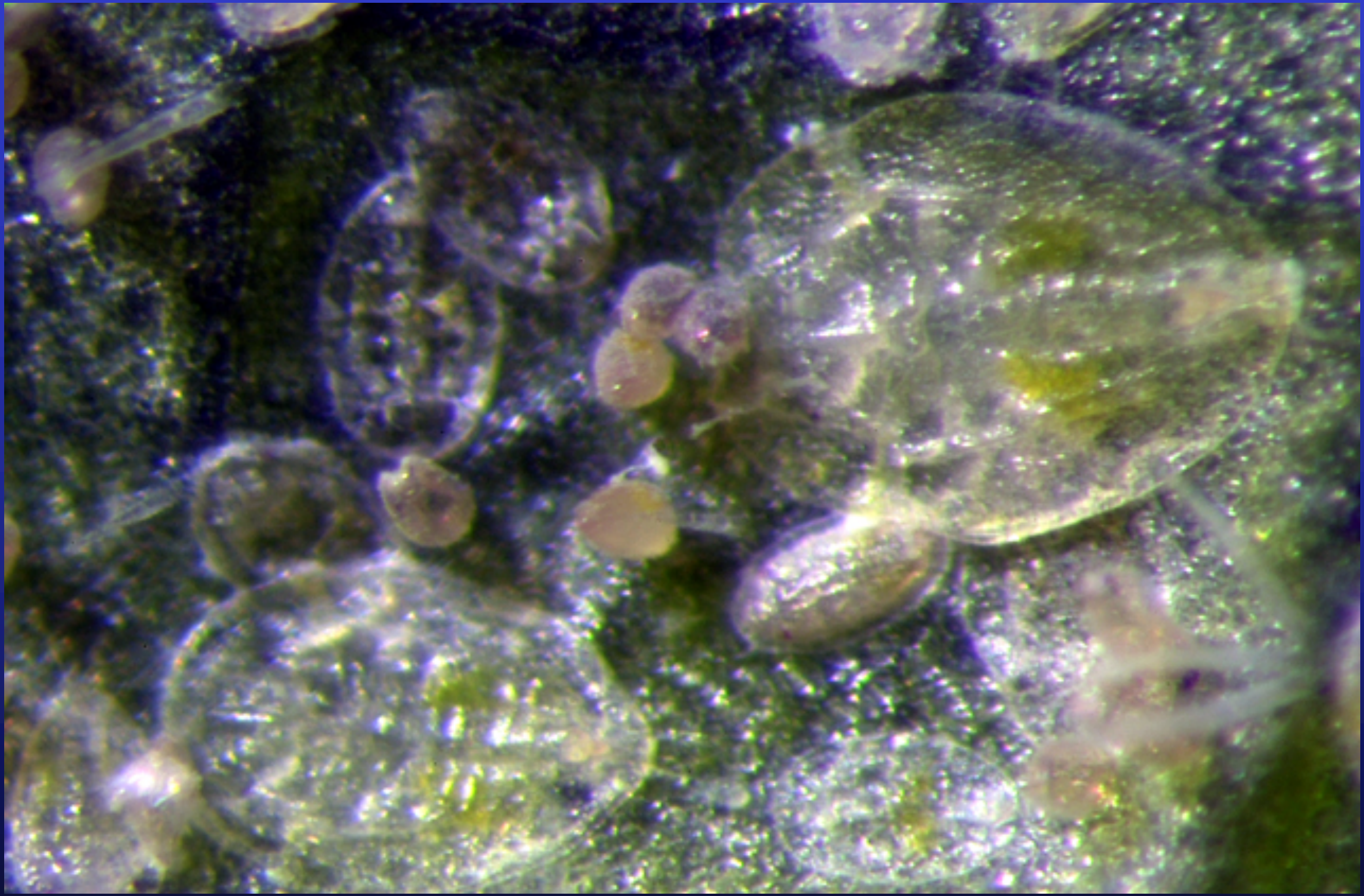
4th International *Bemisia* Workshop
December 3-6, 2006

Lance S. Osborne

December 4, 2006

- **Building a Knowledge Base for Global Action** (August 2005). Edited by: Pamela K. Anderson and Francisco J. Morales.
- **Crop Protection** 20(9): 707-869. November 2001
  - **Special Issue: Challenges and opportunities for pest management of *Bemisia tabaci* in the new century.** Steven E. Naranjo and Peter C. Ellsworth
  - **History, current status, and collaborative research projects for *Bemisia tabaci*.** M. R. V. Oliveira, T. J. Henneberry and P. Anderson

IPM 1985



Invasion

Whitefly History

- Whiteflies from the genus *Bemisia:*
  - have caused problems since at least 1929
  - form a complex of species and/or biotypes
  - The most common and invasive whitefly is *Bemisia tabaci* (B-biotype) = *B. argentifolii* (silverleaf whitefly)

Bemisia tabaci

- 1889 Tobacco in Greece
- 1897 Sweetpotato in U.S. Florida-Type Specimen
- 1928 *Euphorbia hirtella* in Brazil
- 1950s Cotton in Sudan & Iran
- 1961 El Salvador
- 1962 Mexico
- 1968 Brazil
- 1974 Turkey
- 1976 Israel
- 1978 Thailand
- 1981 Arizona & California
- 1984 Ethiopia
- 1985 Hibiscus in Apopka, Florida B-biotype

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)

Factors Contributing to the Invasiveness of B-biotype

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

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

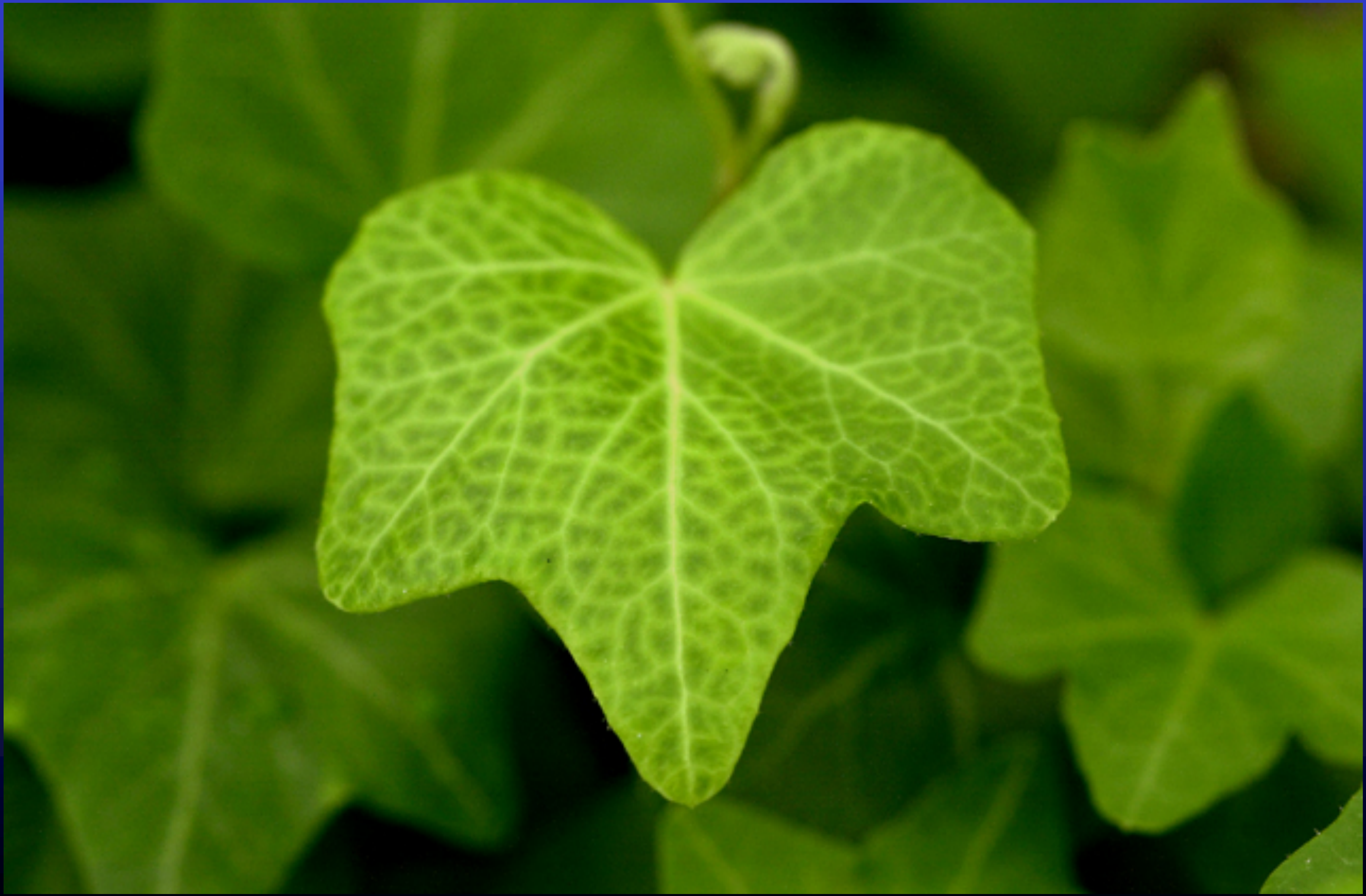
Damage

Honey Dew

Sooty Mold

Sooty Mold

Physiological Disorders



Physiological Disorders

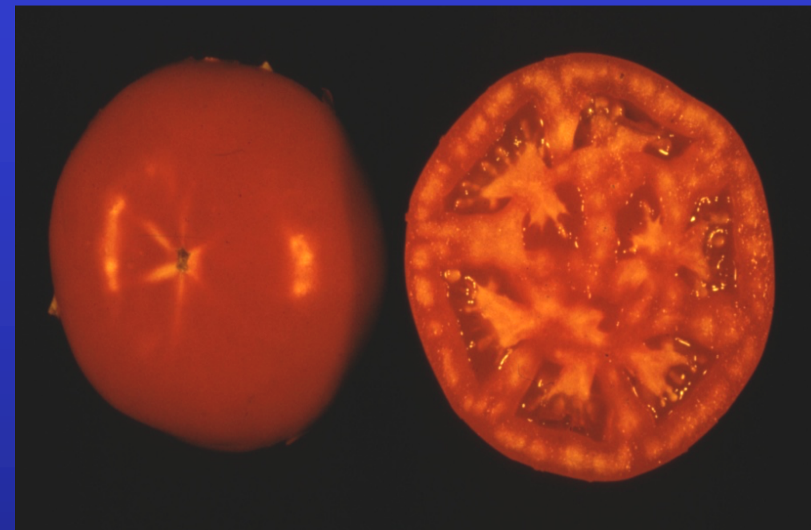
B-biotype

Q-biotype

Rose & Flower
Insect Killer
READY-TO-USE
Kills on contact
NET CONTENTS 24 FL OZ (709mL)

Internal symptoms

IRREGULAR RIPENING



External symptoms

Photos: Dr. David J. Schuster

Virus Transmission

"Whiteflies and the viruses they carry comprise two of the worst crop pests of all times. Devastating in their effects, particularly for resource-poor farmers, these pests are found throughout the tropics and subtropics….."

Building a Knowledge Base for Global Action (August 2005). Edited by: Pamela K. Anderson and Francisco J. Morales.

“Their control presents such major challenges that many nations, which otherwise do not regulate agriculture, have instigated legal measures.”

Building a Knowledge Base for Global Action (August 2005). Edited by: Pamela K. Anderson and Francisco J. Morales.

African cassava mosaic virus

FAO Photo

Tomato yellow leaf curl virus (TYLCV)

Cabbage leaf curl virus CLCV

Squash vein yellowing virus

Dr. Susan E. Webb

Impact

AFRICA

- **Losses due to Cassava Mosaic Disease (CMD)**

  12 - 23 million tons annually which would amount to approximately $1,200 - $2,300 million.

AUSTRALIA

- DESCRIBED 1959
- ECONOMIC PROBLEM COTTON- 1994
- Impact – not given

Brazil

- 1995-2001 ACCUMULATED LOSSES EXCEEDED 5 BILLION
  - Beans
  - Tomatoes
  - Cotton
  - Melons
  - Watermelons
  - Okra
  - Cabbage
  - Numerous others

CARIBBEAN & CENTRAL AMERICA

EXTENSIVE LOSSES TO:

- Tomato
- Okra
- Cotton
- Tobacco
- Melon

Impact – not given

Guatemala

- Costs increased 30-50% (melon, tomato, pepper)
- 1998-99 melon losses reported to have exceeded 40% (sooty mold and geminiviruses)

CHINA

- Severe outbreaks
  – Taiwan - 1953
  – Yunnan - 1972

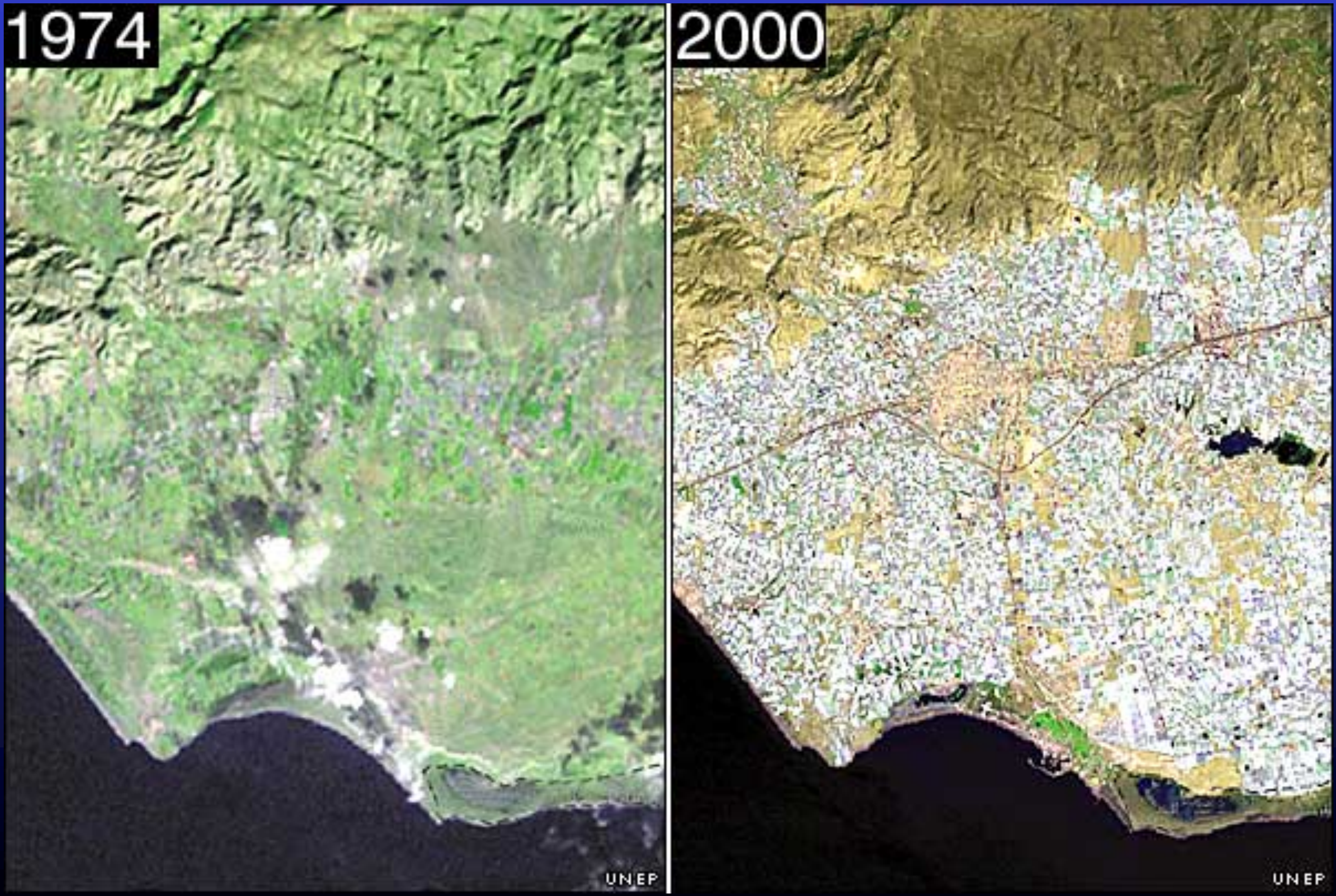
Impact – not given

MEDITERRANEAN BASIN

- SEVERE INFESTATIONS BEGAN IN 1974
- ITALY & SOUTHERN France
  - Major damage to tomato & poinsettia

Impact – not given

Agricultural Expansion in Almeria
Q-Biotype

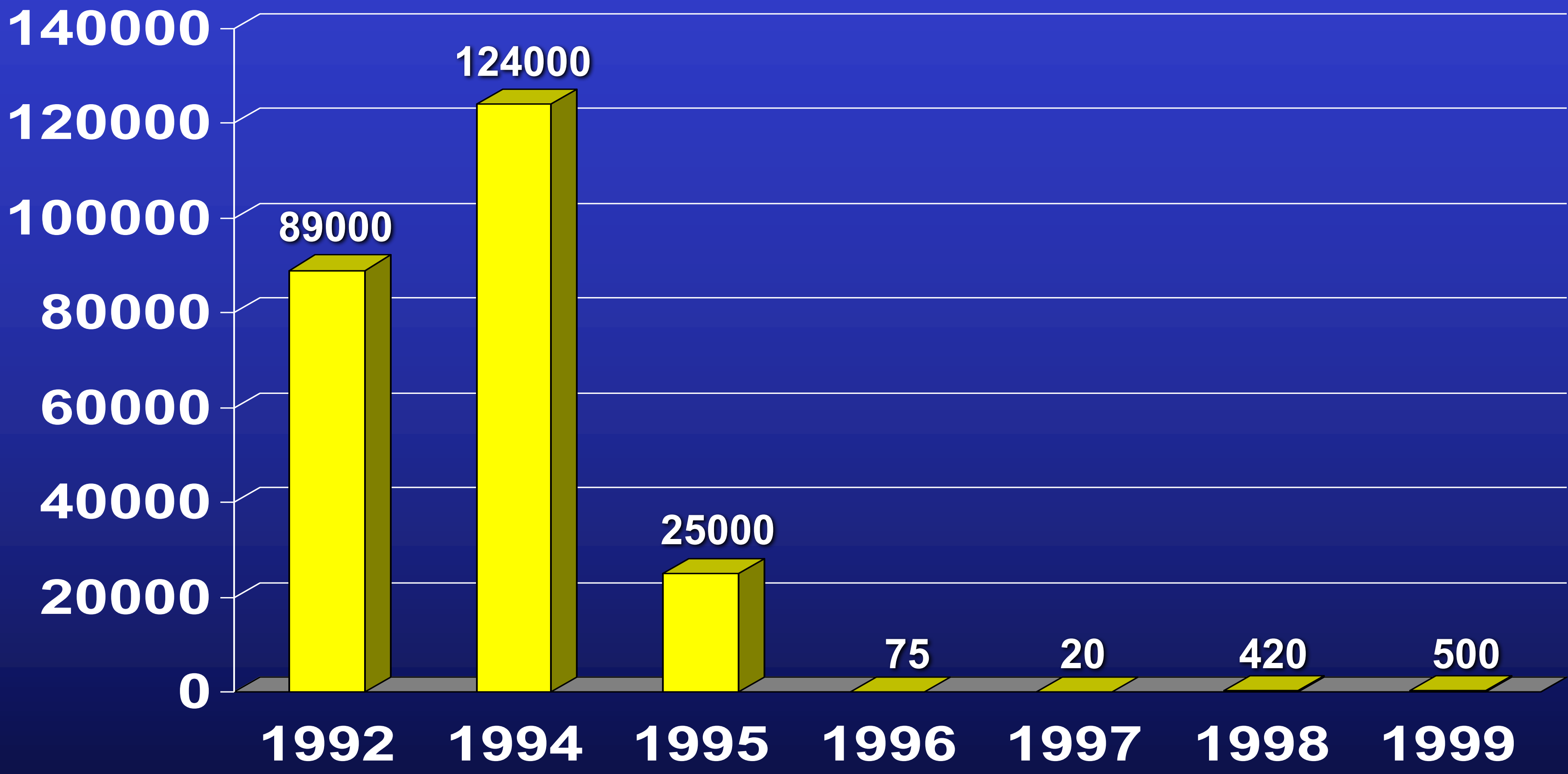


MEXICO
(Mexicali Valley)

1991-1992 LOSSES EXCEEDING 33 M

- MELON
- WATERMELONS
- SESAME
- COTTON
  - MEXICALI PRODUCTION REDUCED FROM 39, 415 ha in 1991 TO 653 ha in 1992 =98% REDUCTION
  - SONORA 1995 & 1996 REDUCED 65%

MEXICO
(Sonora)
Soybean acreage (ha)



Costs of control were $120/ha but not considered particularly effective. Reductions weren't all whitefly related.

NEAR EAST

- Vegetables & Ornamentals outdoors and in protected culture
- Citrus & Cotton in Pakistan & Israel
- Olives & pears in Morocco
- Watermelon crops devastated since 1989 in Yemen

Impact – not given

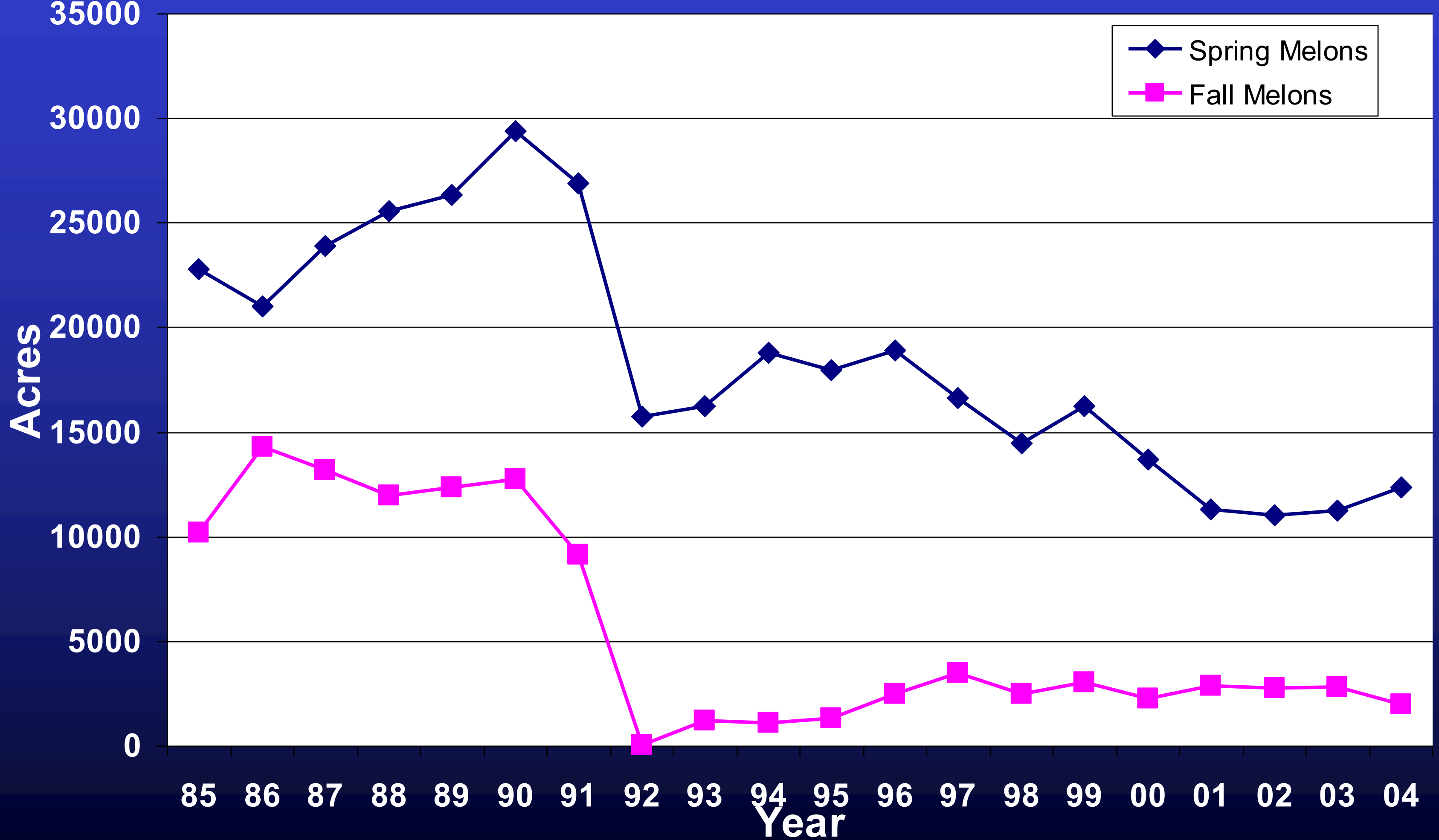
United States

- 1991-92 **$200-500** million (multiple commodities)
- Imperial Valley, CA 1991-95 **$100** million annually
- Arizona, California & Texas 1994-98 **$153.9** million spent to prevent sticky cotton
- Gonzalez (1992) for every **$1 million** dollars of primary-induced crop loss **$1.2** million in lost personal income as well as the elimination of 42 jobs

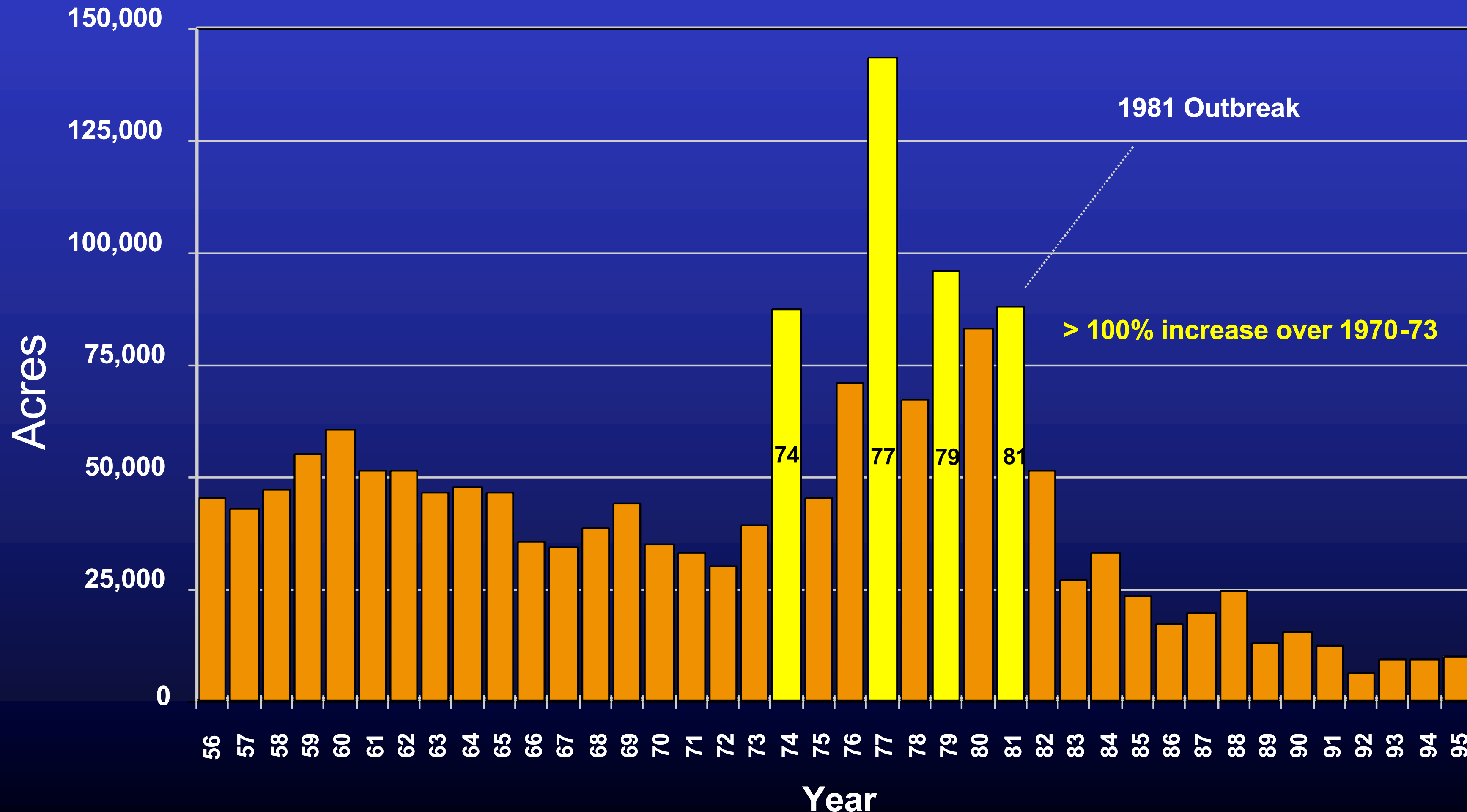
Imperial Valley

- mid -1970s to mid-1980s **300 fold increases**
- mid -1970s to mid-1990s **1,600 fold increases**

Melon Acreage in the Imperial Valley

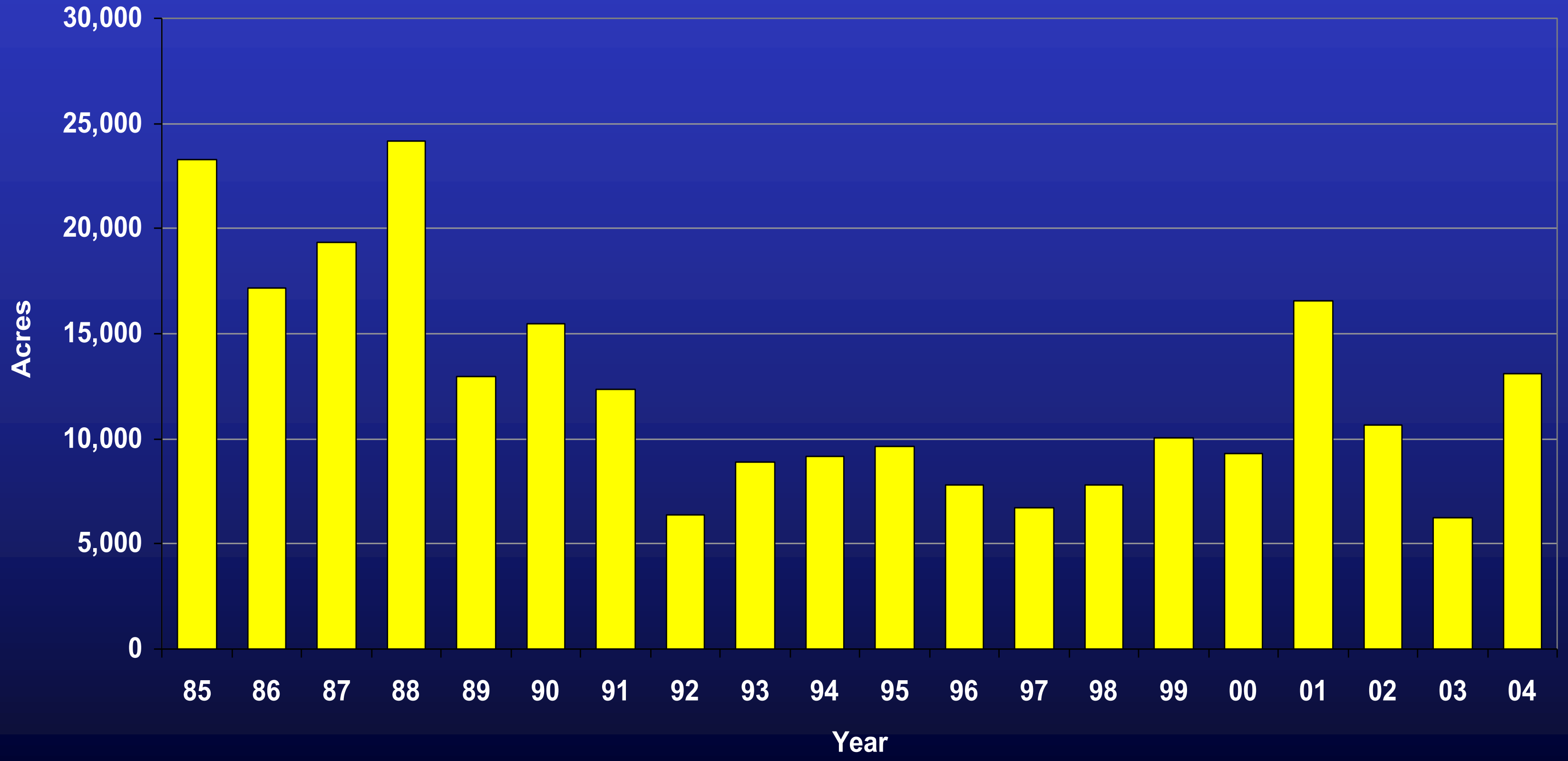


Imperial Valley Cotton Acreage in Perspective



Dr. Peter Ellsworth

Cotton Acreage in Imperial Valley



PEST OF ORNAMENTALS
B-biotype (plant abnormalities)

• Hibiscus in Apopka, Florida	Dec. 2, 1985
• Crossandra in Apopka	June 25, 1986
• Gerbera in Apopka	Oct. 18, 1986
• Poinsettia in Apopka	Nov. 3 1986

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.

Significance?

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

Response

4th International Whitefly Workshop

&

International Whitefly Genomics Workshop

Research

Web of Knowledge Year to date: 11/30/06	259
Web of Knowledge Last five years:	1,081
Total Bibliography of *Bemisia tabaci/argentifolii* *	7,336

*Dr. Steve Naranjo through April, 2005

21st International Congress of Entomology

Brazil August, 2000

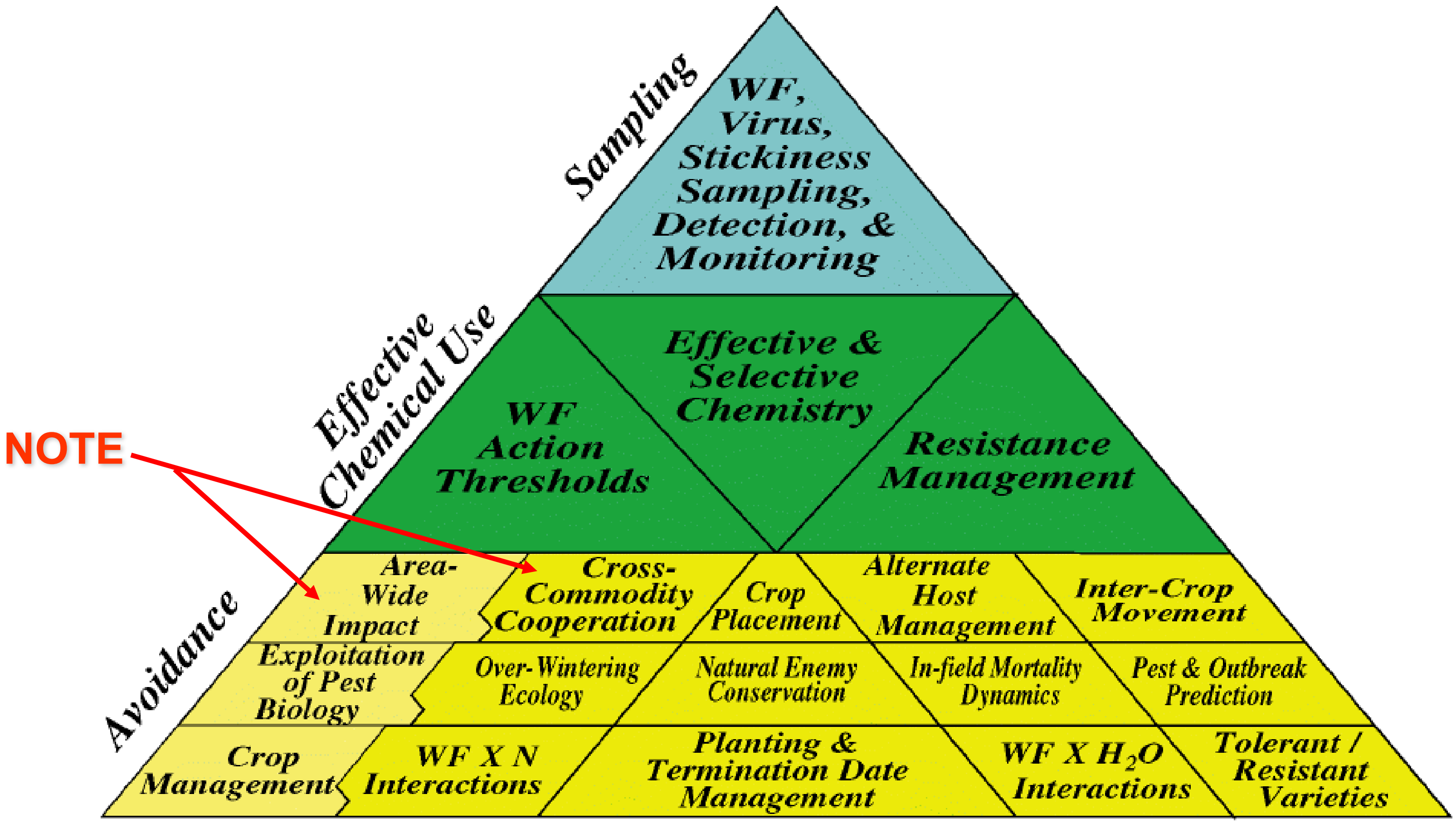
- Crop Protection 20(9): 707-869. November 2001

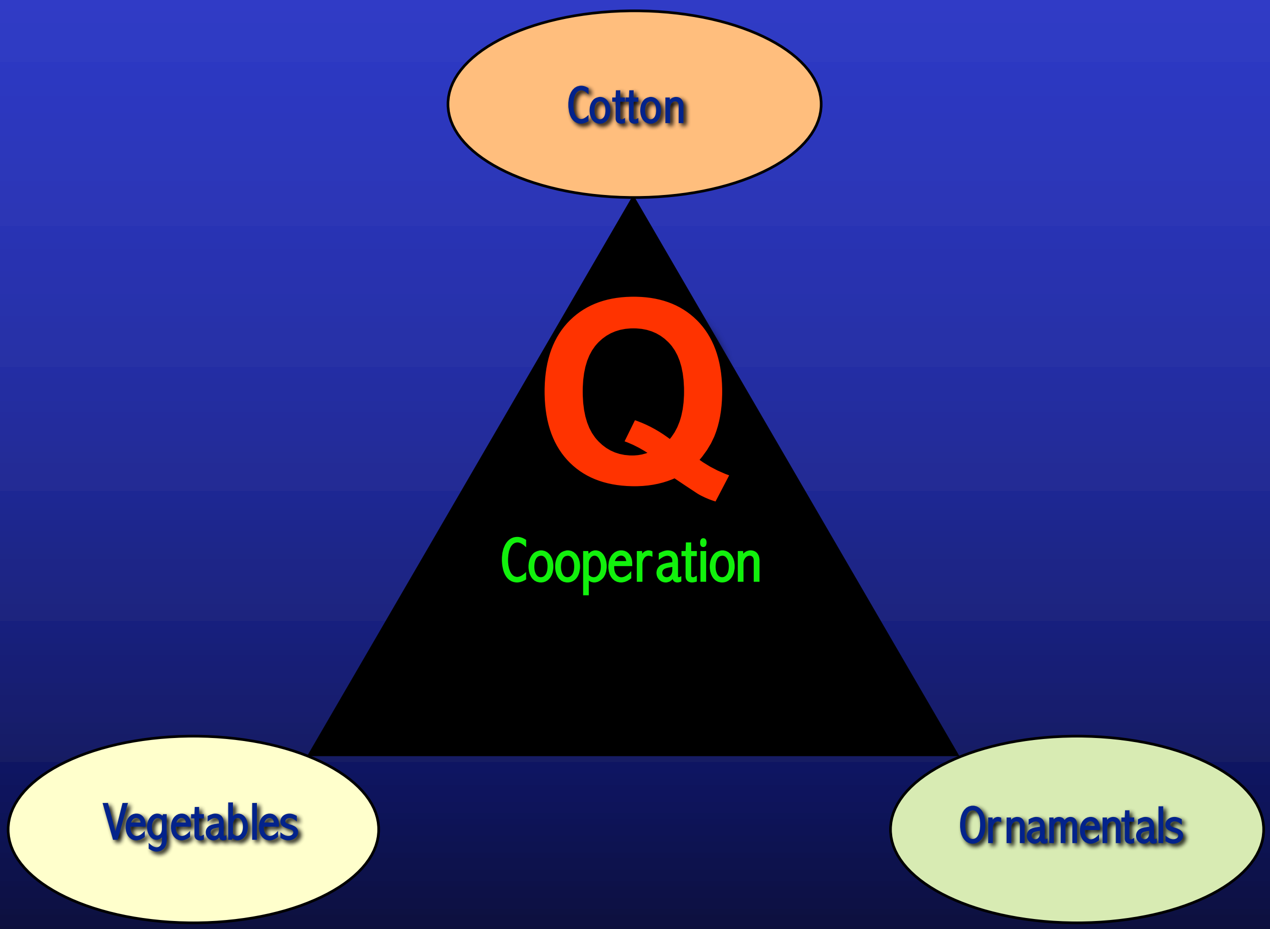
CGIAR
TWF-IPM Project

Consultative Group for International Agricultural Research

Building a Knowledge Base for Global Action (August 2005). Edited by: Pamela K. Anderson and Francisco J. Morales.

Conceptual diagram of Arizona whitefly IPM
(from Ellsworth & Martínez-Carrillo, 2001)




Cotton
Q
Cooperation
Vegetables
Ornamentals

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

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)

Cooperation

Just when we thought we were making significant progress ….

Regulatory Issues

TRADE


Beautiful
Flowers
from around
the World
3 for
$ 10.00
2/ $5.00
NEWITEM


Meet Agriculture's
Beagle Brigade!
JAMONES

What the…

Neo-Journalism
Fair and Balanced (Fox News)?

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.

M. CASTILLO/AP

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:

Each year, the US imports over 610 million ornamental cuttings worth $60.5 million

Multiplier – 10x
~$6 billion

CUTTINGS – imports

U.S. imports of "unrooted cuttings and slips"

- $60,405,000, up 10% from 2004, and quantities 872,415,500, up 14% from 2004 Over half of this is from Central America.

- $6,760,000 from EU, up 37% from 2004.

Cotton

- U.S. is a major exporting country -- projected exports are 16.2 million bales in 2006/07, about 39% of global cotton trade.

- U.S. exports were valued at $2.6 billion in 1998.

Fresh Fruits

- U.S. exported 2,829,357.6 metric tons ($2.7 billion) in 2005
- EU exports are down 18.6% to 137,209 metric tons ($154,255,000).

Fresh Vegetables

- U.S. exported 2,076,509.4 metric tons ($1.6 billion) in 2005.

- We are a net importer at $3.6 billion total from all world and $90 million from the EU (down 25% from 2005).

The Point Is?

If we want people to buy our commodities, we have to buy theirs.

This includes ornamental cuttings.

The Point Is?

If you want us to buy your commodities, you have to buy ours.

This includes ornamentals.

Trust

- We must be open and truthful about what pests we have in our countries.

This hasn’t always been the case and I fear it still isn’t!

World Trade

- Increasing pressure to accept more plant materials in a form that present greater risks.
  - We tried to fight this trend in the early 90s but LOST.

IT WILL HAPPEN!

The Systems that Safeguard our Agriculture are Broken!

Increased Regulation

- We regulate Exotic Arthropod Pests
- We currently DON’T regulate arthropod pests below the species level – Biotypes, resistant strains.

Technology?

- We have the ability to tell the difference between B and Q.
- The technology has not progressed to the point that it could be used in a timely fashion for regulatory purposes.

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

What is an acceptable level of risk?

What measures are you willing to go to in order to maintain the risk at that level?

Options?

- Impacted industries must do a better job.
- The Q-biotype actually allows us to validate control programs and track problems.
- New and quicker tools must be developed to identify threats!
- Pre-certification and BMP programs
  - If they can be developed for a plant pathogen why not an arthropod?

What is the impact of Bemisia Worldwide?

- Small world with interconnected agriculture.
- Trade will continue and so will movement of pests.
- Current systems in place to protect agriculture from the establishment of unwanted exotic pests are not working.
- New exotic species are important but so are strains of old, “common” pests.
  - Pesticide Resistant Vectors are extremely dangerous.

We Have an Opportunity...

Aphids

Mites

Scales

Thrips

Worms…

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

Thank you!

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 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 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 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

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

Contributors in alphabetical order:

James Bethke
Luis Canas
Joe Chamberlin
Ray Cloyd
Jeff Dobbs
Richard Fletcher
Dave Fujino
Dan Gilrein
Richard Lindquist
Scott Ludwig
Cindy McKenzie
Ron Oetting
Lance Osborne
Cristi Palmer
John Sanderson

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

"Far better, though, if the whitefly could indeed be kept out in the first place, however pretty its Trojan horses."

NATURE Vol. 443 NEWS FEATURE 26 October 2006

Invasive Species Management

As much about managing people as it is about managing pests!

MOST MAJOR PESTS

HAVE SIGNIFICANT HOST RANGES

THEY DON' T DISCRIMINATE BETWEEN

ORNAMENTALS & FOOD CROPS

Long-Term Solution

IPM

- BIOLOGICAL CONTROL
- CULTURAL
- PESTICIDES…

Immediate Solutions

- Cooperation
- Systems Approach
- Pesticides (IR-4)

An example of cooperation… efforts regarding

Bemisia tabaci – and the viruses it vectors

Invasion

Began in the 80s

Geographical Range

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

Whitefly History

- **Whiteflies from the genus *Bemisia:***
  - **have caused problems for more than a 100 years.**
  - **form a complex of species and/or biotypes .**

- **The most common whitefly is *Bemisia argentifolii* (silverleaf whitefly).**

- ***Bemisia argentifolii* = *Bemisia tabaci* (biotype B)**

Bemisia tabaci

1889	Tobacco	Greece	
1897	Sweetpotato	Florida	
1928	*Euphorbia hirtella*	Brazil	
1950s	Cotton	Sudan & Iran	
1961	“	El Salvador	
1962	“	Mexico	
1968	“	Brazil	
1974	“	Turkey	
1976	“	Israel	
1978	“	Thailand	
1981	“	Arizona & California	A-biotype
1984	“	Ethiopia	
1985	Hibiscus	Apopka, Florida	B-biotype
2004	Poinsettia	Arizona	Q-biotype

Factors Contributing to the Invasiveness of B-biotype

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

Impact of B-biotype

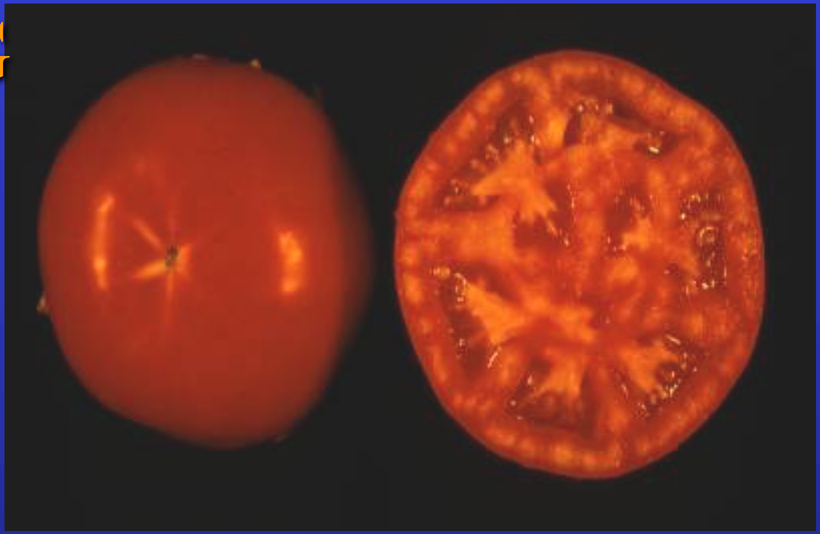
SINCE THE 1980s:

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)**

Physiological Disorders

IRREGULAR RIPENING

Internal symptoms



External symptoms

Virus Transmission

Tomato yellow leaf curl virus (TYLCV)

African cassava mosaic virus

FAO Photo

Ornamental Industry

Ornamental Industry

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.**

Significance?

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

B- biotype Managed!

- Biological Controls
- New effective pesticides (IR-4 again)
- Cultural controls
- Area wide systems for multiple commodities
  - Resistance Management Plans and MONITORING

Q

Q

- **Developed resistance in vegetable crops**
- **Spread on ornamentals**

ZERO TOLERANCE

- Growers can’t tell the difference between Q-biotype and B-biotype.
- Both transmit virus and cause aesthetic damage.

KILL THEM ALL

We don' t want resistant whiteflies no matter what biotype!

In fact, a resistant strain of the B-biotype could be more dangerous than the Q-biotype.

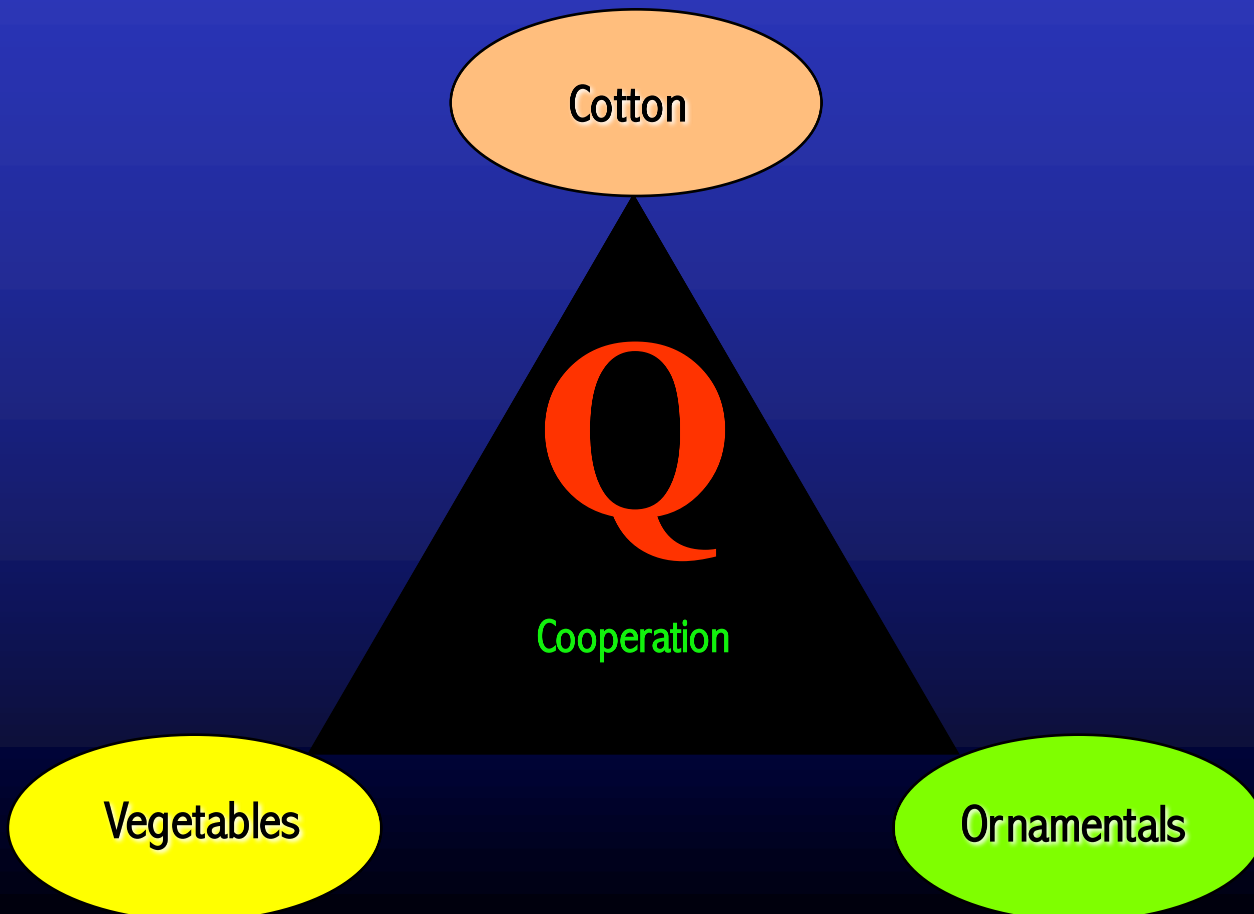
Response

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**

IRM

Only as good as the weakest link!



Pest Management Plans

Funded by:

- **IR-4**
- **USDA-Floral Initiative**
- **CSREES**

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	18	No
Beauveria bassiana	n/a	Yes
Distance (pyriproxyfen)	7C	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 + 18	No

link

2006

- Very few samples submitted.
- Good whitefly year.
- Why?
  - Growers using insecticides effective against Q?
  - Propagators not shipping whiteflies?

2007

- Whiteflies were detected in some rooted cuttings shipments.
- Initial fear that we were going to have another 2005.
- Task Force worked with SAF to conduct an educational blitz.
- Problem was Biotype B & Q.

2008??

It’s been too Quite!

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 and build better IRM programs
- Forced 3 commodities to start a dialogue

Suggestions for Future Directions

- Continued Support of Offshore Screening and Mitigation (Red Palm Mite)
- Coordinating Effort of Invasives
- Facilitate Discussion on the Establishment of Quarantine Center for Invasives
- Side-Effects on BC-Agents
- Resistance Management Programs

We need to protect the materials we have registered!!!

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

Thank You!

Questions