Q-Biotype Whitefly: Strategies for Prevention and Management

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1) QTAC committee, Lance Osborne, Cindy McKenzie

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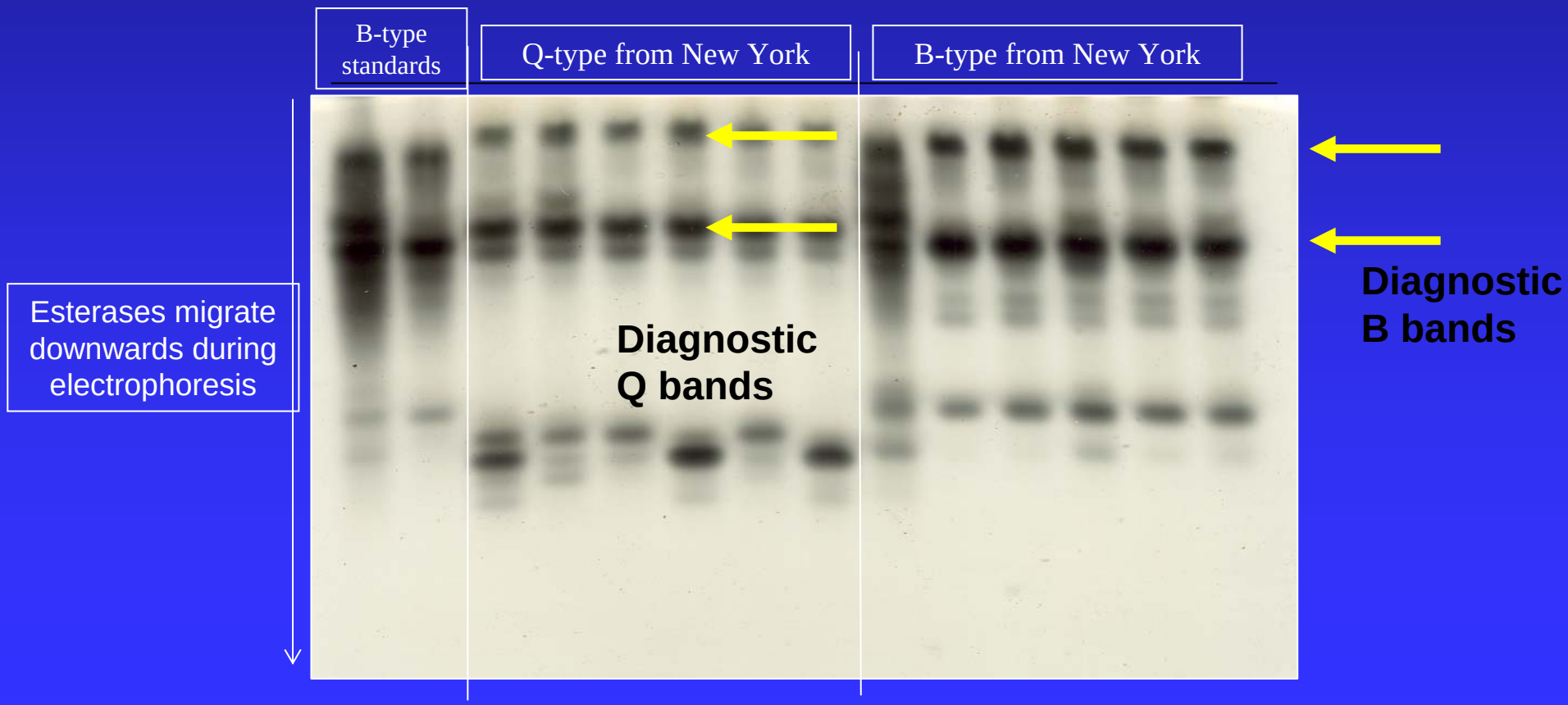
4) Dr. Frank Byrne

Q biotype *Bemisia* are distinguished from B biotype insects based on banding patterns of esterases

Gel Electrophoresis - PCR - Gene sequencing



Q-Biotype Strains used in Efficacy Trials at UC Riverside

- **Poinsettia '04 - Dr. Tim Dennehy's colony from the Univ of Arizona held in quarantine at UC Riverside**
  - **Biotyped by Dr. Frank Byrne as 100% Q-Biotype**
  - **Trials completed in quarantine**
- **CASLO1 '05 - a population collected from gerbera daisy in a greenhouse in San Luis Obispo County (SLO), California (CA) in 2005**
  - **Biotyped by Dr. Frank Byrne as 97% Q-Biotype**
  - **Trials conducted in commercial and university greenhouses**

Field and Lab Trial Methodology

- 9 Trials
  - 3 field - 2 points, 1- gerbera
  - 5 greenhouse on points
  - 1 lab
- Whiteflies are biotyped
  - Population CASLO1 '05
- Poinsettias in 4-6" pots
- 5-6 single replicate blocks
- 15-20 Q adults clipcaged for 48 hours for oviposition
- Treatments applied to first and second instars, and efficacy was determined from the percentage of immatures completing development to adult

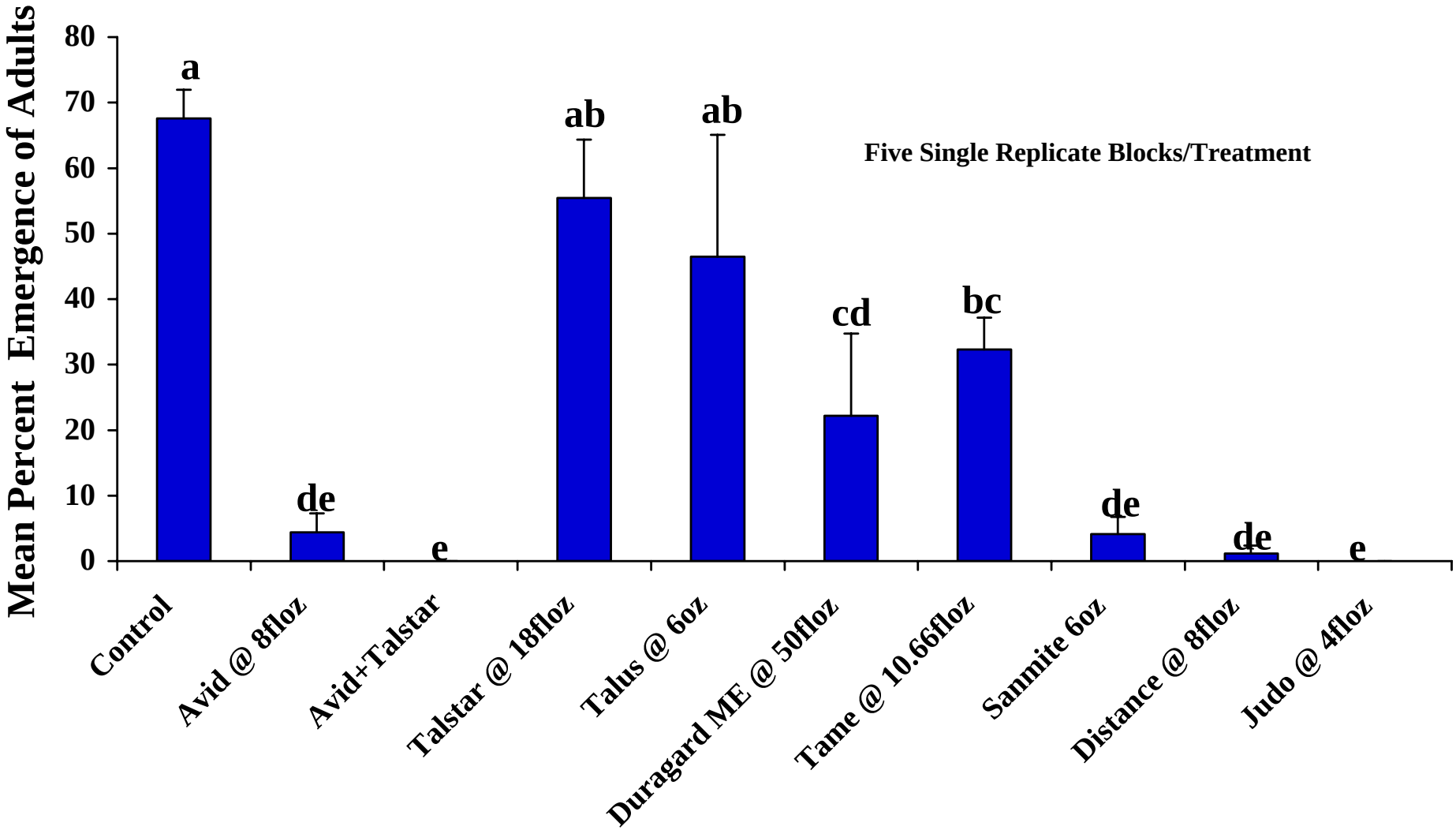
Pesticides in Trial

Trade Name	Formulation	Common Name	Rate/100 gal	Company
Aria	50%	Flonicamid	4.3oz	FMC
Avid	0.15EC	Abamectin	8floz	Syngenta
Avid+Talstar	0.15EC + NF	Abamectin+Bifenthrin	8floz + 18floz	Syngenta+FMC
Distance	IGR	Pyriproxifen	8floz	Valent
Dursban	ME	Chlorpyrifos	50floz	Dow Agrosciences
Discus	2.94 + 0.7%	Imidacloprid+Cyfluthrin	25floz	Olympic Horticultur
Endeavor	50WG	Pymetrozine	5oz	Syngenta
Enstar	II	S-Kinoprene	10floz	Wellmark
Judo	4lb/gal	Spiromesifen	4floz	Olympic Horticultur
MilStop	85%	Potassium Bicarbonate	2.5lb	BioWorks
Orthene	TT&O	Acephate	4oz	Valent
Sanmite	75WP	Pyridaben	6oz	Scotts
Talstar	NF	Bifenthrin	18floz	FMC
Talus	IGR	Buprofizen	6oz	SePro
Tame	2.4EC	Fenpropathrin	16floz	Valent

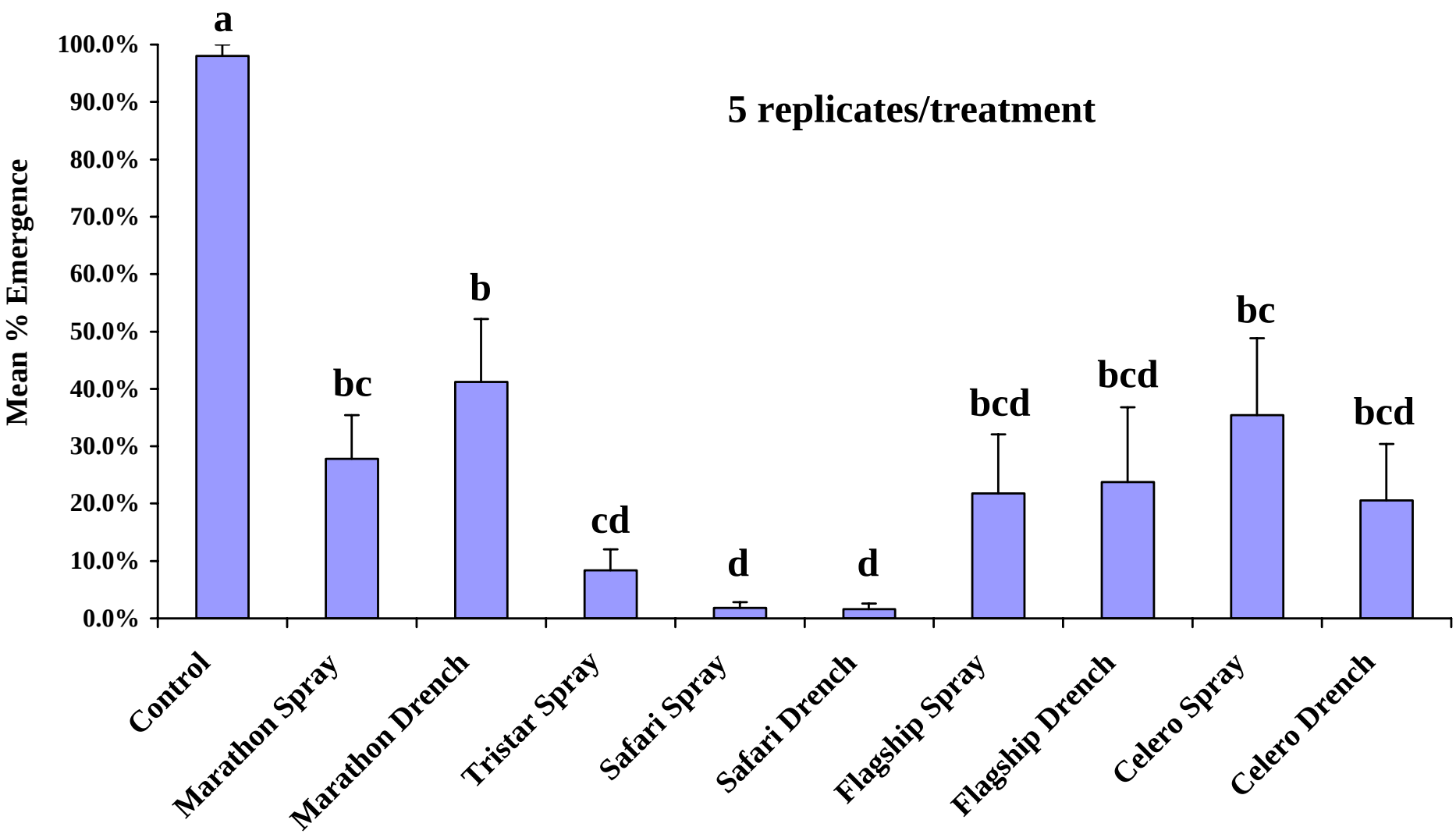
Pesticides in Trial

Foliar Applications	Formulation	Common Name	Rate per 100 gallons	Company
Celero	16 WSG	Clothianidin	4oz	Arysta Life Science
Flagship	25 WG	Thiamethoxam	4oz	Syngenta
Marathon	II	Imidacloprid	1.7floz	Olympic Horticulture
Safari	20 SG	Dinotefuran	8oz	Valent
Tristar	70WSP	Acetamiprid	4 packet = 2.2 oz	Clearys
Drench Applications	**Formulation**	**Common Name**	**Amount of Product/pot**	**Company**
Celero	16 WSG	Clothianidin	4oz of product/2000 6" pots	Arysta Life Science
Flagship	25 WG	Thiamethoxam	4oz /100gal use 1/3 pot volume	Syngenta
Marathon	II	Imidacloprid	1.7 oz/1000 6" pots	Olympic Horticulture
Safari	20 SG	Dinotefuran	24oz/100 gal - 4oz fin solu/pot	Valent

Mean Percent Emergence of Q-Biotype CASLO1 Treated With the Highest Recommended Rate of Selected Insecticides on Poinsettia



Mean Percent Emergence of Q-Biotype CASLO1 Population Treated with the Neonicotinoids on Poinsettia



Bemisia tabaci Gennadius, Q-Biotype

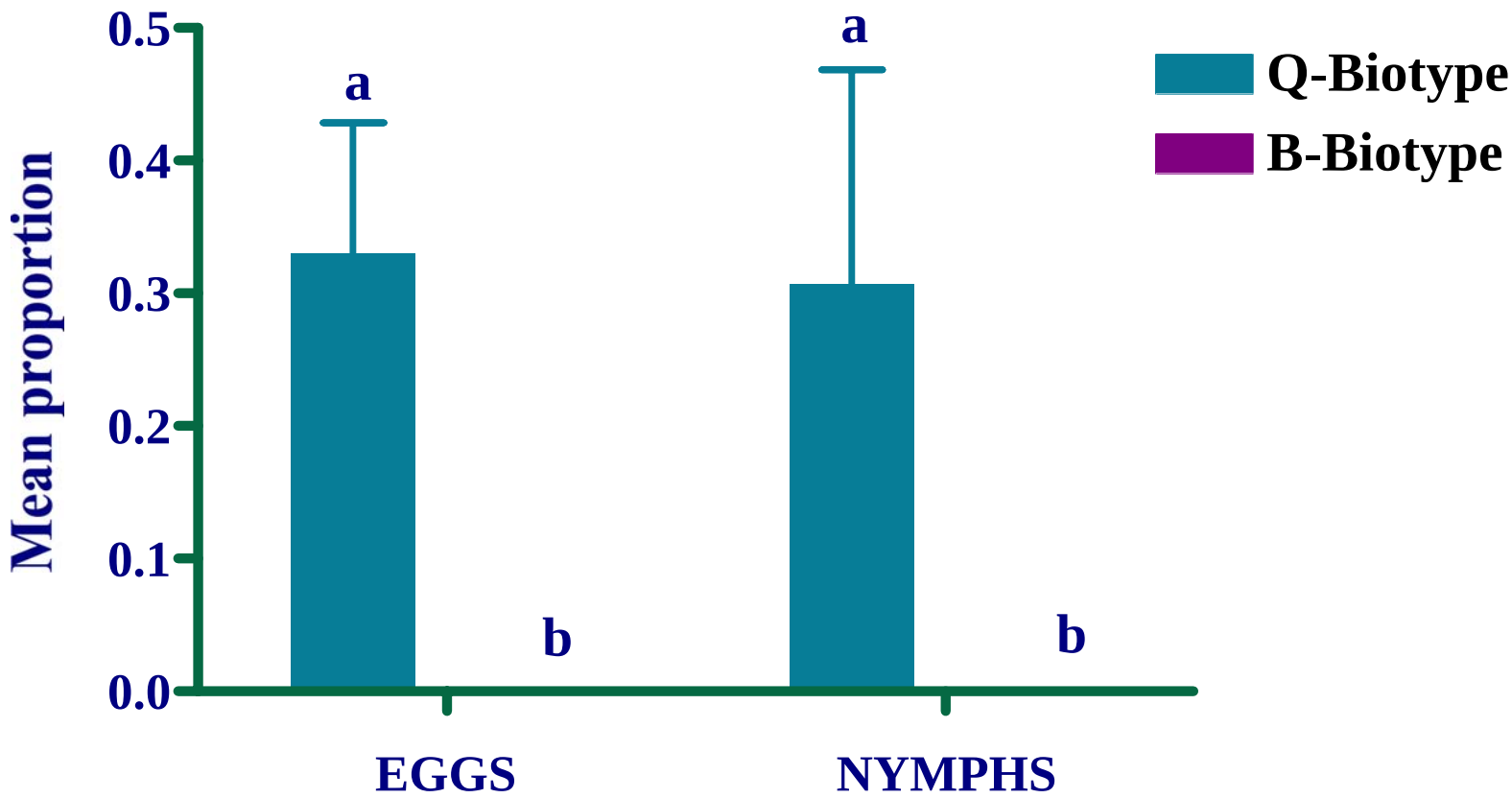
Conclusions: First 5 Trials

Pesticide	Formulation - v/vAI - %AI	Rate per 100 gallons	Relative Efficacy in Trials
Avid +Talstar*	0.15EC + NF	8oz + 18oz	100%
Avid*	0.15EC - 0.15lbAI/gal - 2%AI	8oz	>95%
Celero	16 WSG - 0.16lbAI/lb - 16%	4oz	70-80%
Distance	IGR - 0.86lbsAI/gal - 11.23% AI	8oz	>95%
Duragard	ME - 20% AI	50oz	80%
Flagship*	25 WG - 0.25lbAI/lb - 25%	4oz	80-100%
Judo*	4 lbs/gallon - 45.2% AI	4oz	100%
Marathon	II - 2 lbs/gallon -21.4%AI	1.7oz	70-80%
Safari*	20 SG - 0.2lbAI/lb - 20%	8oz	95-100%
Sanmite*	75WP -0.75lbAI/lb - 75%AI	6oz	>95%
Talstar	NF - 0.67lbs/gal - 7.9% AI	18oz	50%
Talus	IGR - 0.7lbsAI/lb - 70% AI	6oz	60%
Tame	2.4EC - 2.4lbsAI/gal - 30.9%	16oz	70%
Tristar*	70WSP - 0.7lbAI/lb - 70%AI	4 packet = 2.7 oz	>90%

Greenhouse Trial using Distance

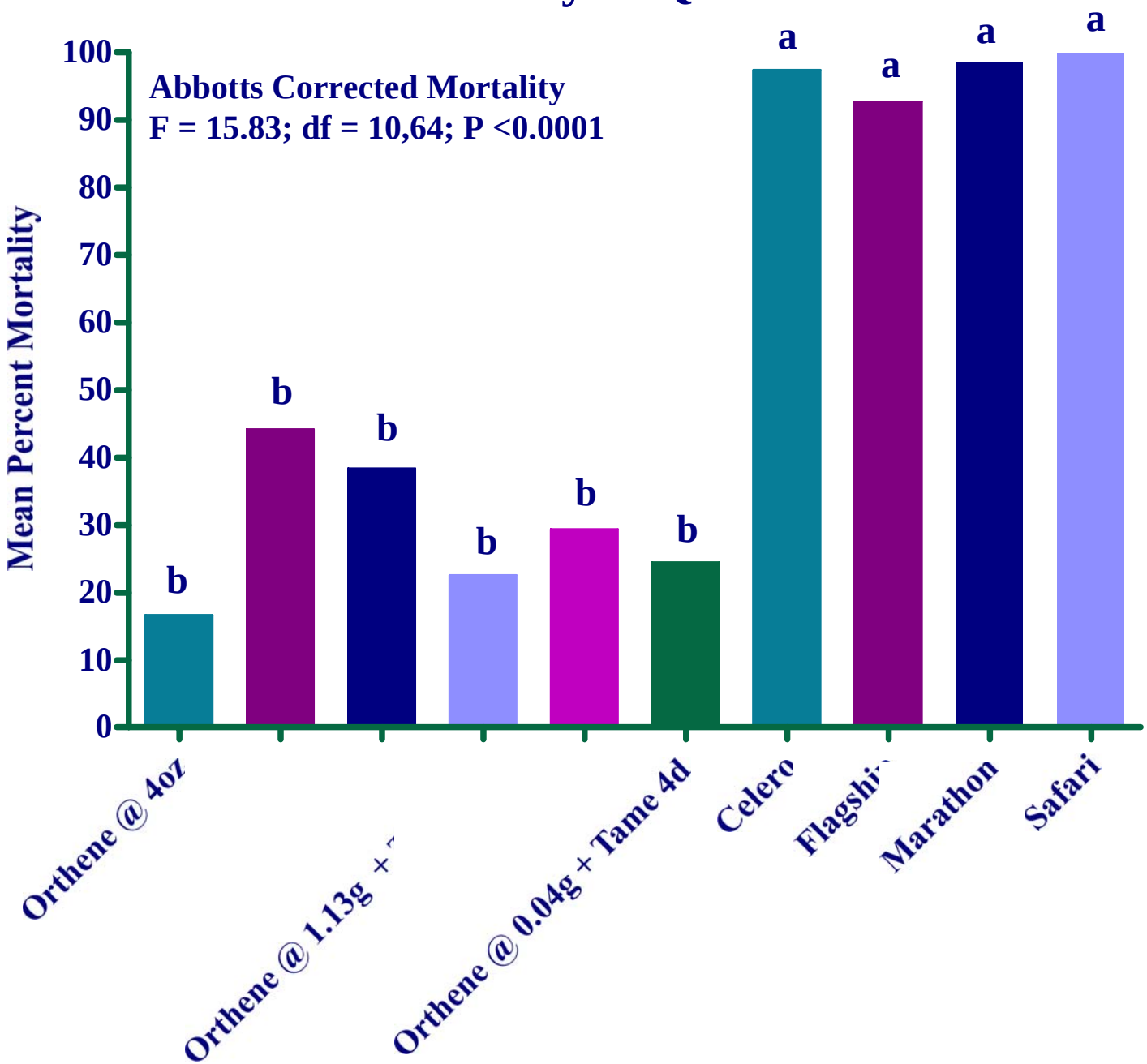
- B (Commercial Nursery) and Q (CASLO1 '05) were caged on opposite sides of the same poinsettia leaf and allowed to oviposit, one time to obtain eggs a second time on a different leaf to obtain nymphs.
- Two leaves were used per plant for both eggs and nymphs on three plants per treatment.
- Plants were treated with the highest recommended rate of Distance (pyriproxifen)
- The percent hatch and percent emergence was determined for treated eggs and nymphs of both Q and B biotypes.

Mean proportion of emergence when eggs or nymphs of B and Q biotype whiteflies are treated with Distance

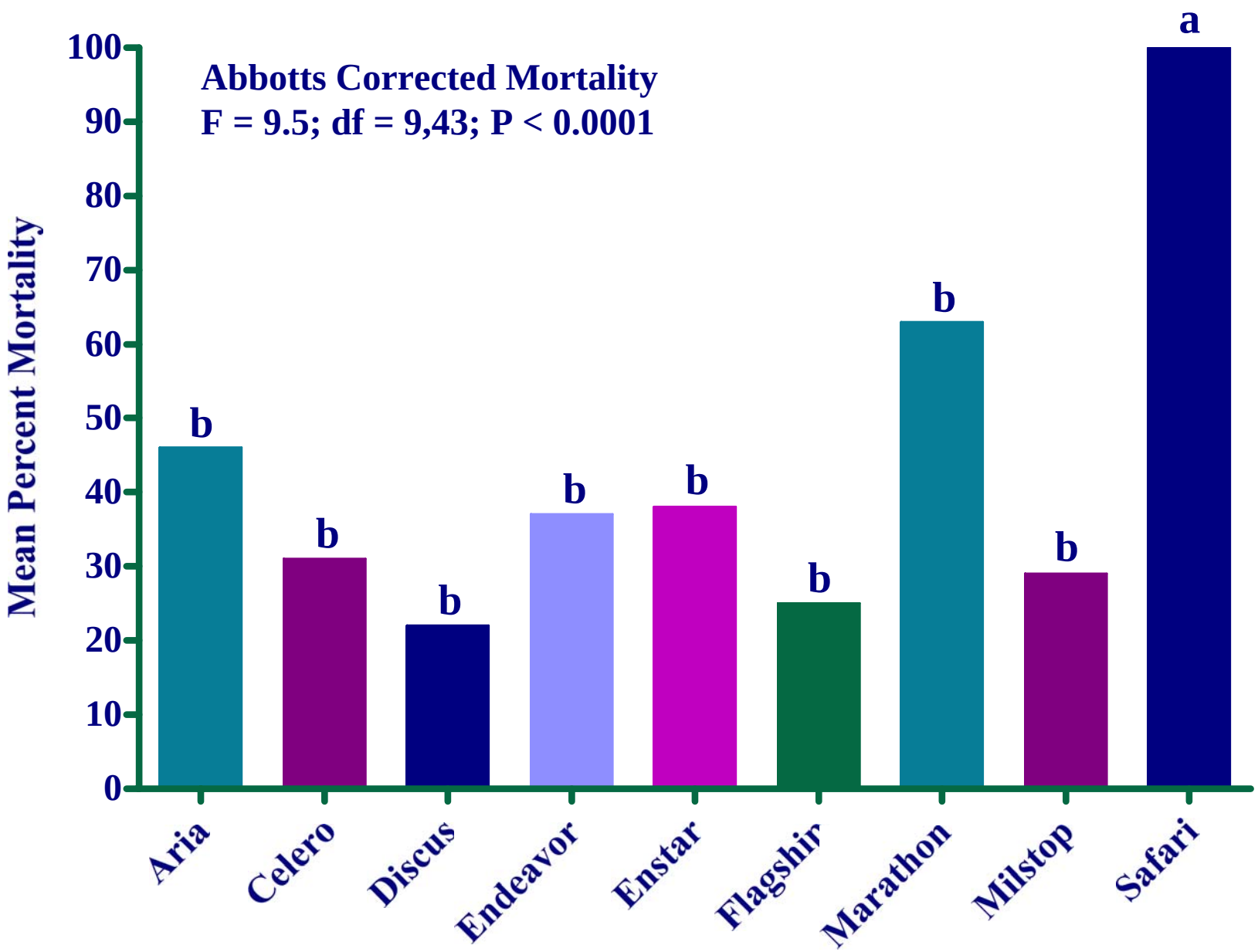


Trials at Eckes

Mean Percent Mortality of Q on 4" Potted Poinsettia



Mean Percent Mortality of Q on 6" Potted Poinsettia



Trials in Georgia and New York

Three trials in Georgia

- All trials were conducted at the Georgia Mountain Research and Education Center
- Whiteflies were identified by Frank Byrne as the 'Q' strain of *Bemisia*
- Treatments applied twice as a foliar spray at approx 14 days (*Beauveria* 4X at 4-5 days)
- > 90% mortality: Tristar, Safari, Judo, Naturalis and Botanigard, Sanmite, and Avid

Two trials in NY

- Evaluated three foliar sprays against immature populations on Poinsettia's
- Results determined six weeks following the first treatment.
- Acceptable population reductions for Judo and Safari.

Conclusions

- Foliar applications of Pyriproxyfen against Q are not recommended
- Drench applications of neonicotinoids still need study. There was a difference between applications on 4” vs 6” pots.
  - Heavy peat media
  - Plants were watered differently
  - Different stage of bract formation
  - Difference in density and volume of foliage
- No new products to add to the list.
  - Botanigard
- Similar results from colleagues
- http://www.mrec.ifas.ufl.edu/LSO/bemisia/bemisia.htm

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	

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
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	
Pyrethroids + azadirachtin	3 + 26	

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

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).
Foliar Applications:			
Aria (flonicamid)	9C	Yes	
Avid (abamectin)	6	Yes	
Azadirachtin	23	No	
Beauveria bassiana	n/a	Yes	
Celero (clothianadin)	4	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		
TriStar (acetamiprid)	4	Yes	
Foggers and other products whose use is not restricted by the label	Many	No	

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

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. The neonicotinoid drenches have not been evaluated against the Q-biotype when plants are at this stage of crop production. 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).

Whitefly Resistance Management

The greater the number of whiteflies present when a pesticide application is made the greater the chance that at least one individual might possess the ability to survive the treatment.

The more frequently a given pesticide or mode of action is used, the greater the potential for developing a problem. Along those same lines, the longer the residual activity the greater the "selection" pressure on a resident whitefly population.
Older recommendations stated that "Insecticides should be applied a minimum of two times at a **five to seven day** interval to allow for egg hatch between applications so that both adults, nymphs and individuals that hatch from eggs are killed. This is not appropriate for many of the new pesticides that have residual activity of one week or greater. If the insecticide is properly applied and is not providing control, change to another material with a different mode of action because whitefly populations have the propensity to develop resistance. This is why scouting weekly and especially after a pesticide application is critical.

There are a number of ways to deal with this issue but the bottom line is the fewer applications one makes of materials with a similar mode of action, the smaller the potential for resistance developing. To that end, what can be done? First off, we recommend you develop a list of all the pesticides that are legal to use for whitefly control on the crop you are growing. Next, we suggest that each be evaluated under your particular situation for phytotoxicity. When you are finished you will have a list, hopefully not too short, from which you can develop a management program. The next problem is to review the labels to find restrictions/limitations on how often a material can be applied to a given crop. The plan you put together should be based on all of these points and the fact that growers will have to apply materials to manage other pests. We suggest you target those materials that have demonstrated the highest efficacy and use them during the most critical phases of the crop cycle. For example, treat newly obtained plant material as soon after receiving it as practical and then target the crop just prior to shipping so that you ship the cleanest plants as possible. Scouting is essential to the success of any pest management program and additional guidance will be placed on the Bemisia Website (www.mrec.ifas.ufl.edu/LSO/bemisia/bemisia.htm)

The Whitefly Management Program is our attempt to help with this process and includes many insecticides that are listed according to their IRAC (Insecticide Resistance Action Committee) mode of action classification. Growers must learn from experience which chemicals, when correctly applied, fail to give satisfactory control, and to then try other materials in a different classification. Most of us that have put this program together feel VERY STRONGLY that no more than 2-3 applications of materials should be applied during a given crop cycle. This would mean, for example, that one application of Chemical A from group 4, one of Chemical B from group 4 and one of Chemical C from group 4 would be the limit during the entire crop cycle in your nursery. There will probably be a need to apply other compounds for whiteflies or other pests. These materials should have a different mode of action. There will be times that you will use compounds that may not be as effective as you would like but their use is absolutely critical if you are going to effectively slow the development of resistance in your nursery.

Finally, we will also post on the website (listed above) the names and addresses of qualified entomologists who are willing to review your spray programs if you desire.

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.

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

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