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IFAS

Cooperative Efforts in Managing Whitefly Resistance to the Neo-nicotinoid Chemistry in Florida

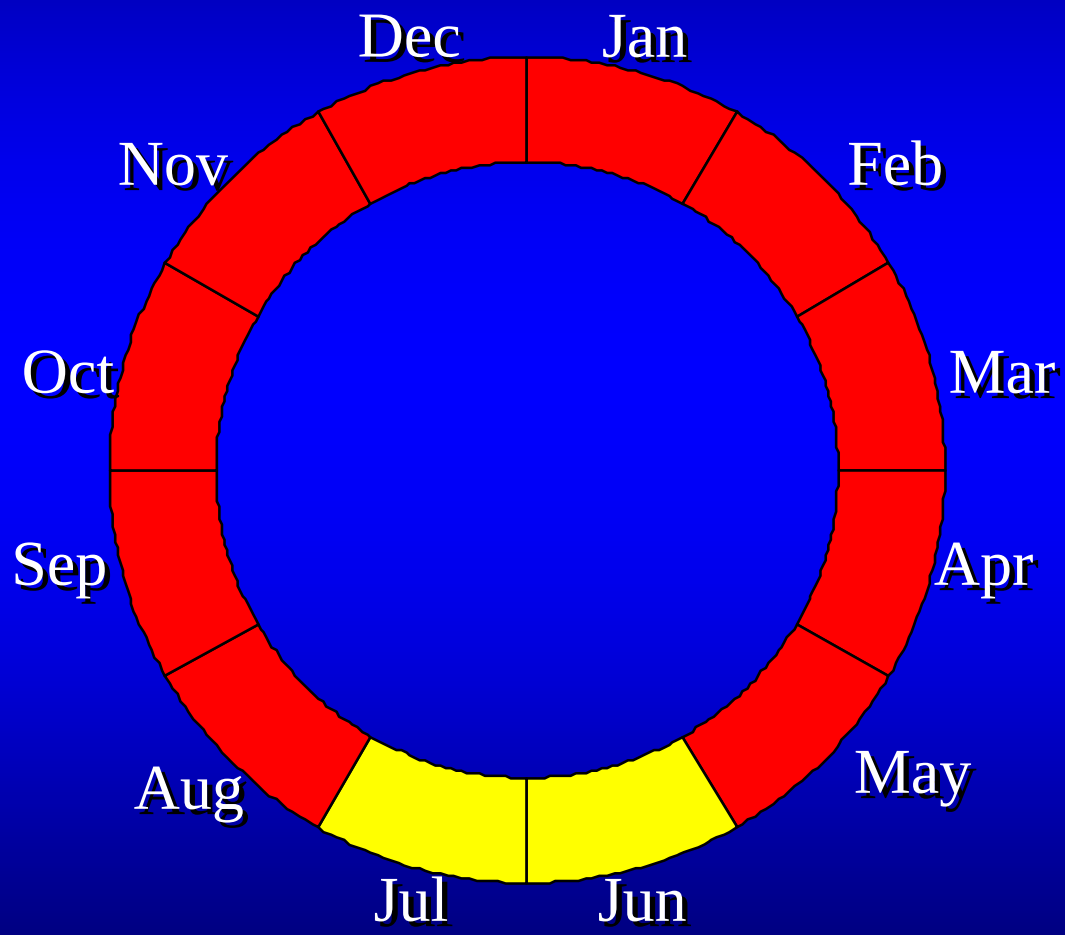
David J. Schuster

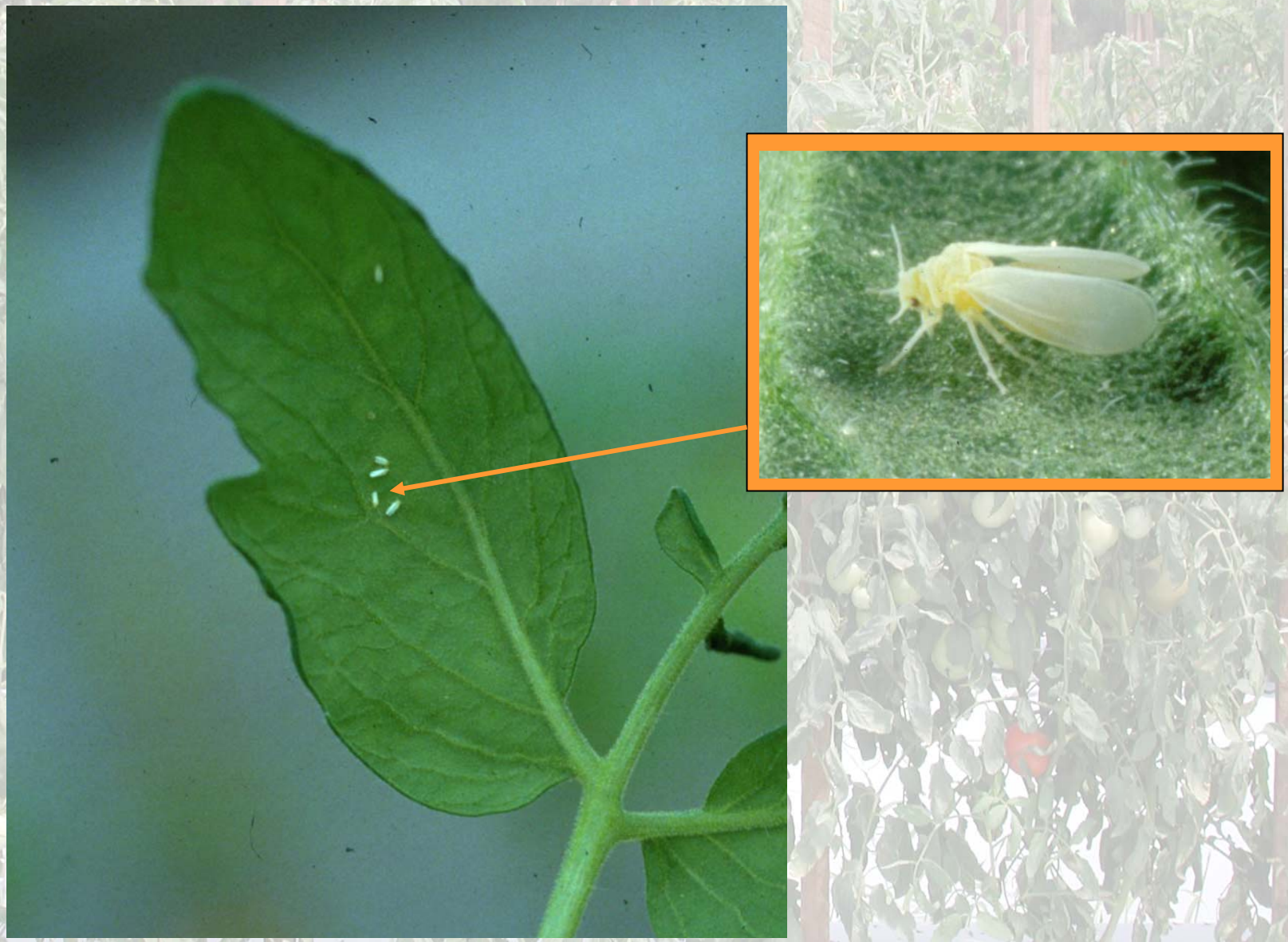
University of Florida, IFAS

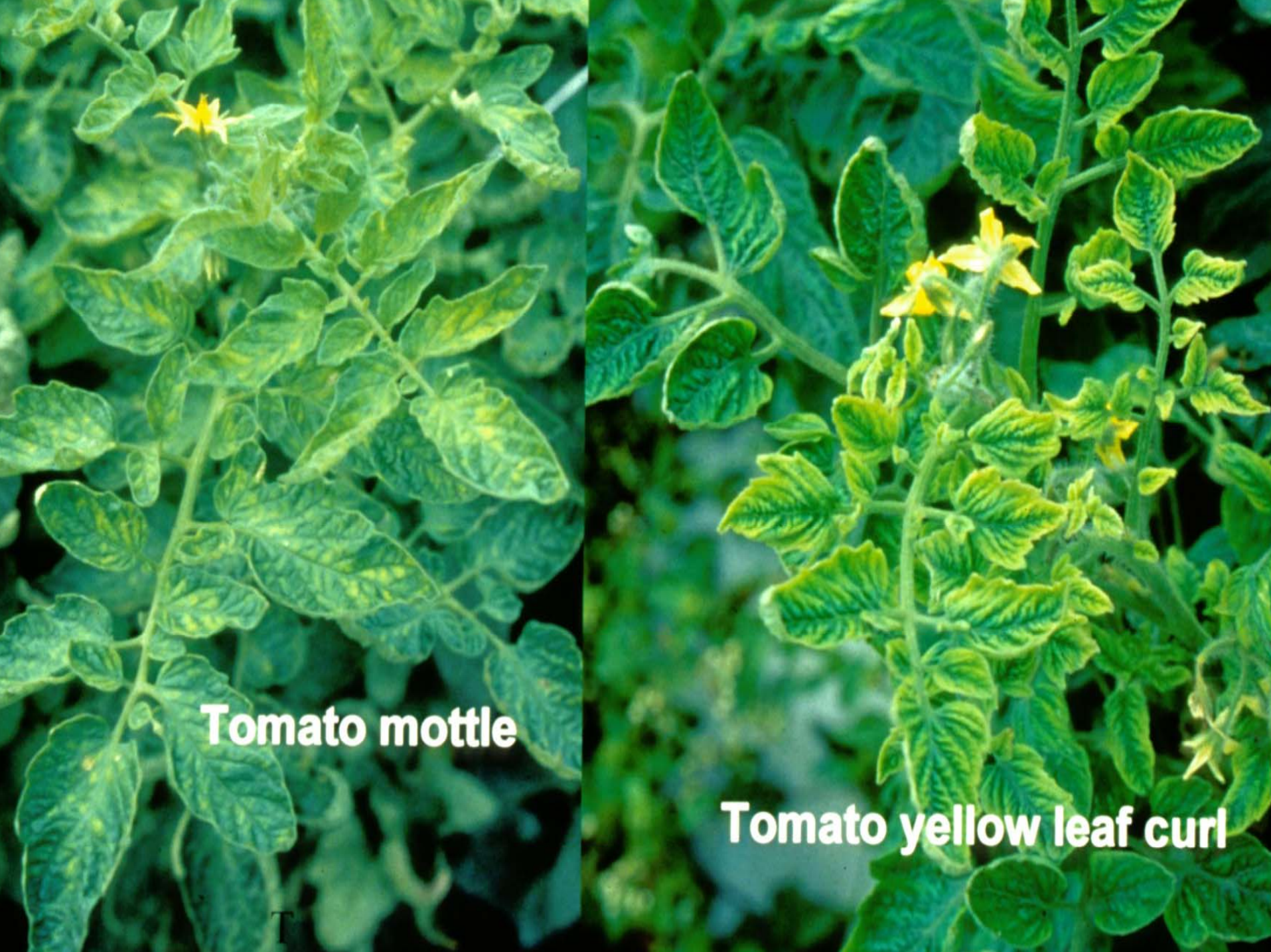
Gulf Coast Research & Education Center

Wimauma, FL

Generalized Production Cycle for Tomato in Southern Florida






Tomato mottle
Tomato yellow leaf curl

Nicotinoid Insecticides for Tomatoes

Common name	Product name(s)	Application	Registration
Imidacloprid	Admire/Provado	Soil/Foliar	1994
Thiamethoxam	Platinum	Soil	2001
Acetamiprid	Assail	Foliar	2002
Dinotefuran	Venom	Soil/Foliar	2005

Properties: Group 4A Insecticides

Systemic/translaminar

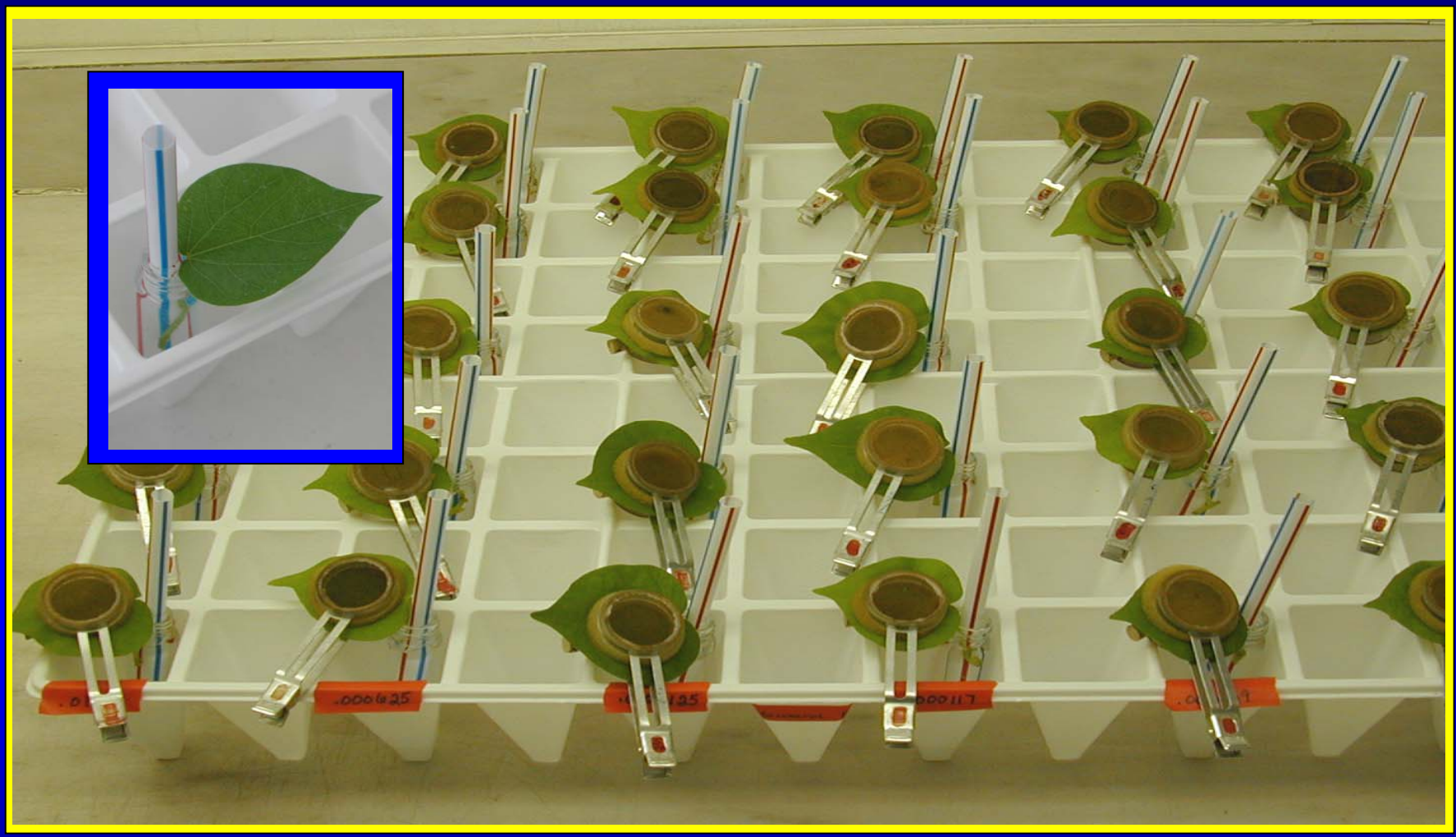
Interfere with nicotinic acetylcholine receptor (death in 2 - 48 hrs)

Contact and ingestion activity

Control aphids, whiteflies, some beetles

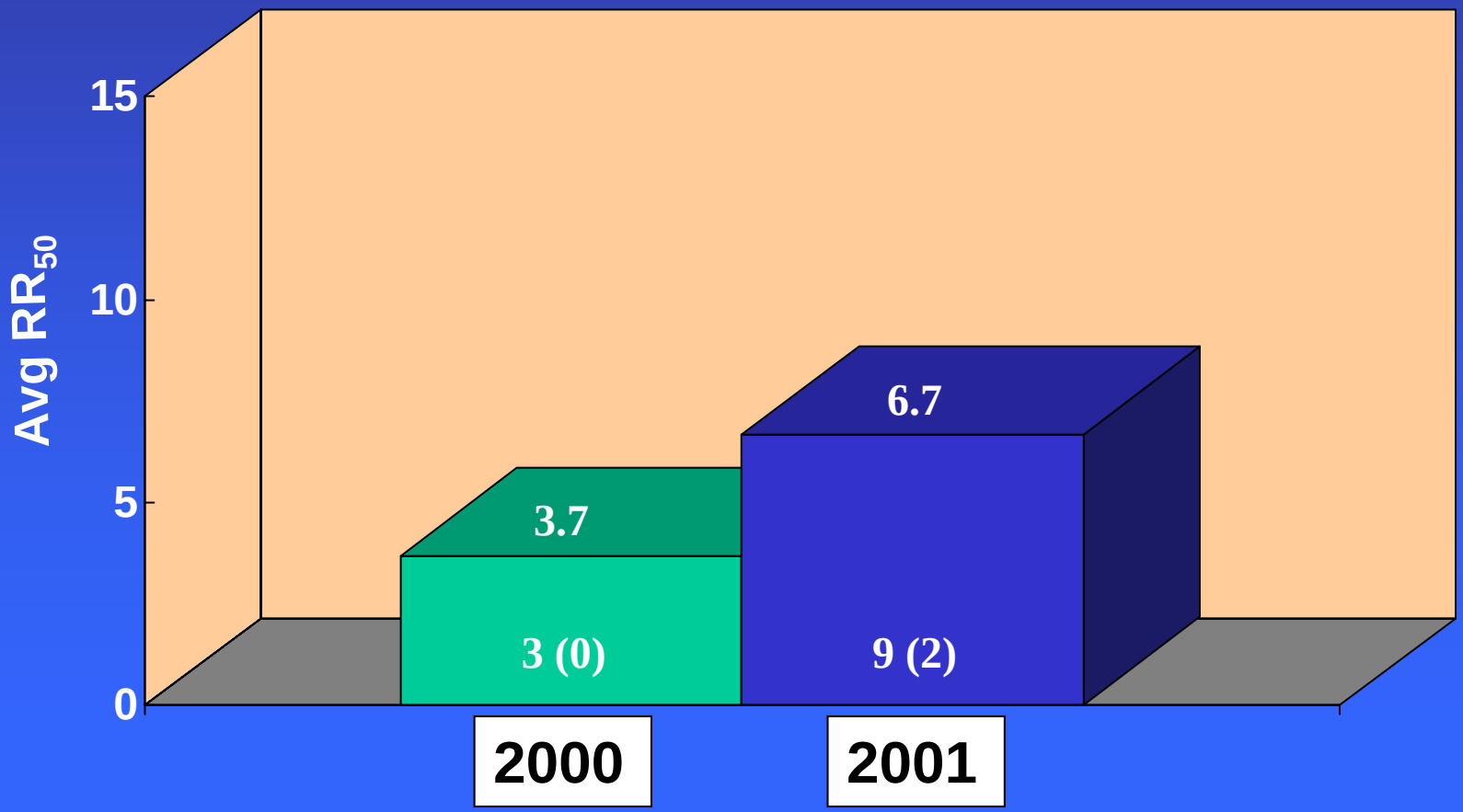
Monitoring for Resistance to Nicotinoids

- Bioassay developed in 1999
- Monitoring began in 2000
- Funding provided by industry
  - Florida Tomato Committee
  - Bayer CropScience



LC_{50} values estimated and RR_{50} value calculated

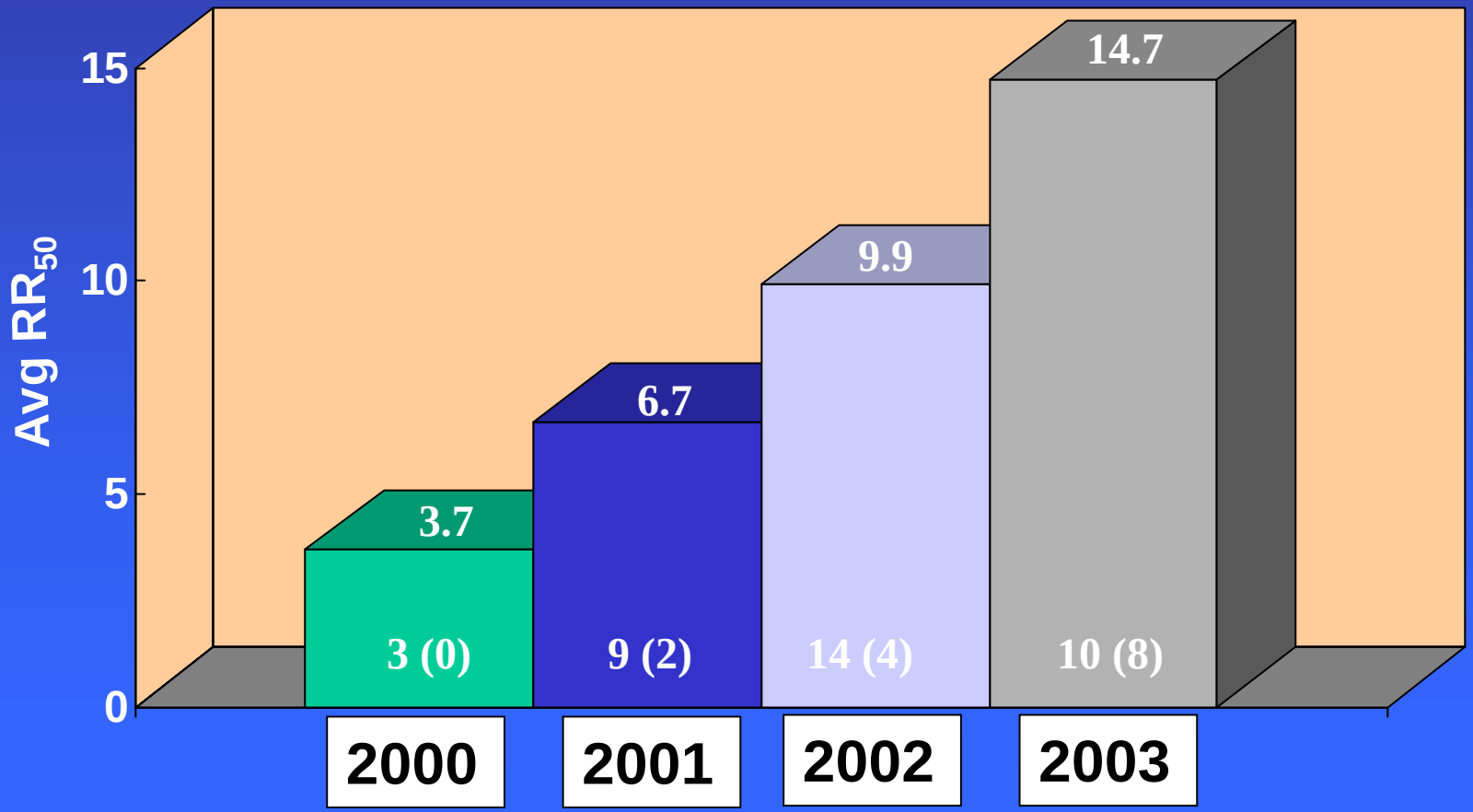
Monitoring Susceptibility (RR_{50}) of Whitefly Adults from Nicotinoid-Treated Tomato Fields to Imidacloprid Using a Laboratory Bioassay



Resistance Management Program Initiated

- Resistance management recommendations formulated
  - Insecticide program recommendations
  - Cultural manipulation recommendations
- Recommendations presented at grower meetings

Monitoring Susceptibility (RR_{50}) of Whitefly Adults from Nicotinoid-Treated Tomato Fields to Imidacloprid Using a Laboratory Bioassay



Ad Hoc Resistance Management Working Group

- University of Florida – research & county extension personnel
- Chemical industry representatives – Bayer CropScience, Cerexagri & Syngenta Crop Protection
- Crop consultants – Glades Crop Care & KAC Agricultural Research
- Grower group representative - FFVA

Ad Hoc Resistance Management Working Group Activities

- Revise the existing resistance management recommendations
- Expand and intensify the extension of these recommendations to growers
- Establish an area-wide demonstration of recommendations in southwest Florida

Nicotinoid Resistance Management Recommendations

Use Proper Insecticide Program

Do not use Admire Pro on transplants or use only once

Use Admire Pro (7ozs) or Platinum (8ozs) at transplanting

Do not split applications of Admire Pro or Platinum

Never follow a nicotinoid application with another nicotinoid application

Save nicotinoids for crops without virus or disorders

Nicotinoid Resistance Management Recommendations

Cultural Manipulations

Observe two-month tomato-free summer period

Nicotinoid Resistance Management Recommendations

Cultural Manipulations

Observe two-month tomato-free summer period

Use a correct crop destruction technique

- **Destroy crop promptly and efficiently between seasons**
- **Use oil with burn-down herbicide to kill whiteflies**
- **Time burn-down sprays to avoid windy periods**
- **Destroy crop block by block as harvest is completed**

Nicotinoid Resistance Management Recommendations

Cultural Manipulations

Observe two-month tomato-free summer period

Use a correct crop destruction technique

Other cultural practices to reduce SLWF

- **Plant whitefly-free and virus-free transplants**
- **Delay planting new crops as long as possible**
- **Destroy old crops immediately after harvest**
- **Manage whitefly infested host plants**
- **Manage weeds within crop**
- **Avoid u-pick or post harvest pin-hooking**

Nicotinoid Resistance Management Recommendations

Cultural Manipulations

- Observe two-month tomato-free summer period
- Use a correct crop destruction technique
- Other cultural practices to reduce SLWF
- Do unto your neighbor as you would have him do unto you
  - Keep abreast of neighboring operations
  - Participate in regional, cooperative effort

Expanded and Intensified Grower Education Activities

- Presentations at meetings
  - UF/IFAS sponsored statewide and regional grower meetings
  - UF/IFAS Extension in-service training
  - Agrichemical industry sponsored local and statewide grower meetings
  - Agrichemical industry sales staff meetings

Recommendations for Management of Neonicotinoid Resistance for Florida Tomato Production

(Neonicotinoids include Admire, Platinum, Provado, and Assail)

1. **Observe a minimum two-month crop free period from mid-June to mid-August.**

2. **Use a correct crop destruction technique which includes destruction of existing whitefly populations in addition to the physical destruction of the crop.**

    a. Prompt and efficient crop destruction between fall and spring crops to maximally decrease whitefly numbers and sources of TYLCV.

    b. Use a burn down herbicide such as Paraquat or Diquat in conjunction with a heavy application of oil (2-4 % solution) to quickly kill whiteflies.

    c. Time burn down sprays to avoid crop destruction during windy periods, especially when prevailing winds are blowing whiteflies toward adjacent plantings.

    d. Destroy crops block by block as harvest is completed rather than waiting and destroying the entire field at one time.

3. **Reduce overall whitefly populations by strictly adhering to cultural practices including:**

    a. Plant whitefly-free transplants.

    b. Delay planting new fall crops as long as possible and destroy old crops immediately after harvest to create or lengthen a tomato free period.

    c. Control whitefly infested weeds, abandoned crops, and volunteer plants.

    d. Control whitefly weed host reservoirs on field edges and ditch banks.

    e. Manage weeds within crops to minimize interference with spraying.

    f. Avoid u-pick or pin-hooking operations unless effective whitefly control measures are continued.

4. **Use a proper whitefly spray program. *Follow the label!***

    a. On transplants, either do not use a neonicotinoid or apply *once* 7 days before shipping; use products in other chemical classes, including Fulfill, before this time.

    b. Use a neonicotinoid Admire (16 ozs/acre) or Platinum (8ozs/acre), at transplanting. Use products of other chemical classes as the control from the neonicotinoid diminishes.

    c. Do not use Admire at less than 16 oz/a or Platinum at less than 8 oz/acre.

    d. Do not use a split application of Admire or Platinum (i.e. do not apply at transplanting and then again later).

    e. Never follow a soil or foliar application of a neonicotinoid with another soil or foliar application of the same or different neonicotinoid on the same crop or in the same field within the same season (i.e. do not treat a double crop with a neonicotinoid if the main crop had been treated previously, unless the double crop is planted at least 60 days after the main crop).

5. **Do unto your neighbor as you would have him do unto you.**

    Looking out for your neighbor's welfare may be a strange or unwelcome concept in the highly competitive vegetable industry but it is your best interest to do just that. Growers need to remember that should the whiteflies develop full-blown resistance to the neonicotinoids, it's not just the other guy that will be hurt---everybody will feel the pain! This is why the Resistance Management Working Group has focused on *encouraging region-wide cooperation in this effort.*

    Knowing what is going on in the neighbor's fields is important. Growers should try to keep abreast of operations in upwind fields, especially harvesting and crop destruction, which both disturb the foliage and cause the whitefly to fly. Now that peppers have been added to the list of TYLCV hosts, growers will need to keep in touch with events in that crop as well.

For additional information:

IRAC (Insecticide Resistance Action Committee) Website – http://www.irac-online.org

More suggestions for breaking the whitefly/TYLCV cycle can be found in an article by Dr. Jane Polston in Sept. 2003 Proceedings of the Tomato Institute, available online at the SWFREC website: http://www.imok.ufl.edu/veghort/docs/tom_inst_2002_091202.pdf

Insecticide Resistance: Causes and Action

A joint effort between the Southern Region Integrated Pest Management Center and the Insecticide Resistance Action Committee

Mode of Action (MOA) Initiative

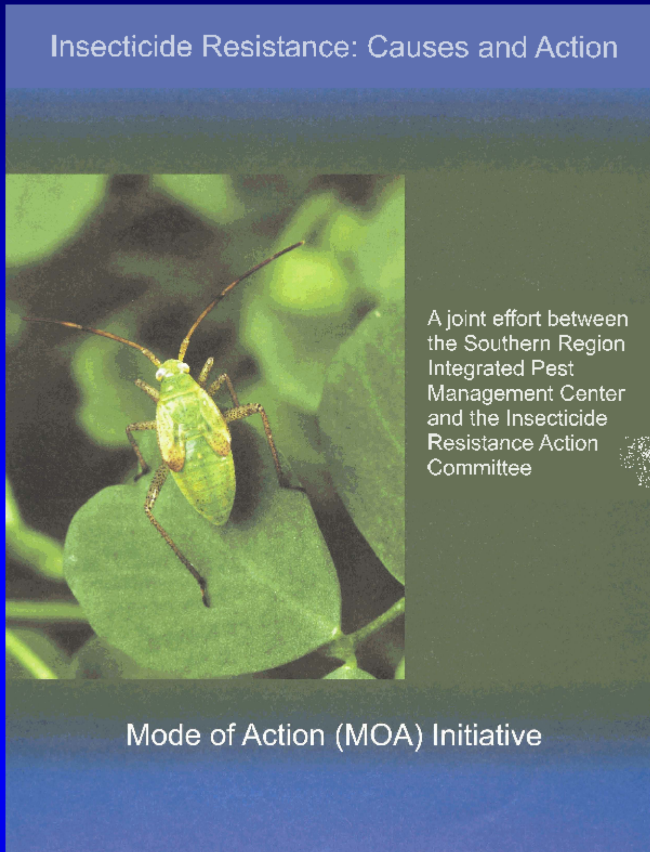
What Can You Do About Insecticide Resistance?

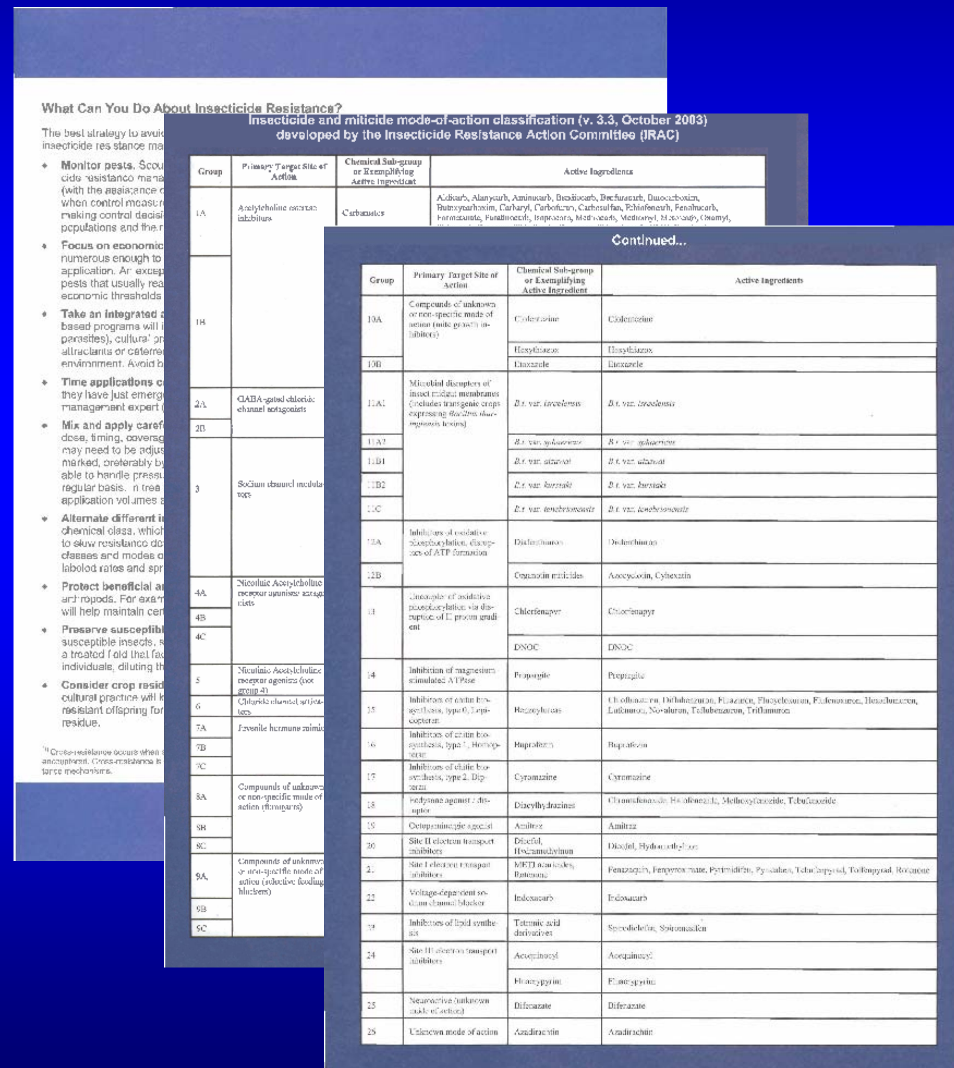
The best strategy to avoid insecticide resistance is *prevention*. More and more pest management specialists recommend insecticide resistance management programs as one part of a larger integrated pest management (IPM) approach.

Corn Earworm (Corn Bollworm)

- **Monitor pests.** Scouting is one of the key activities in the implementation of an insecticide resistance management strategy. Monitor insect population development in fields (with the assistance of a crop consultant or advisor if necessary) to determine if and when control measures are warranted. Monitor and consider natural enemies when making control decisions. After treatment, continue monitoring to assess pest populations and their control.
- **Focus on economic thresholds.** Insecticides should be used only if insects are numerous enough to cause economic losses that exceed the cost of the insecticide plus application. An exception would be in-furrow, at-planting treatments for early season pests that usually reach damaging levels each year. Consult local crop advisors about economic thresholds for target pests in your area.
- **Take an integrated approach to managing pests.** Use as many different control measures as possible. Effective IPM-based programs will include the use of synthetic insecticides, biological insecticides, beneficial arthropods (predators and parasites), cultural practices, transgenic plant varieties, crop rotation, pest-resistant crop varieties and chemical attractants or deterrents. Select insecticides with care and consider the impact on future pest populations and the environment. Avoid broad-spectrum insecticides when a narrow-spectrum or more specific insecticide will work.
- **Time applications correctly.** Apply insecticides when the pests are most vulnerable. For many insects this may be when they have just emerged. Use application rates and intervals recommended by the manufacturer or a local pest management expert (i.e., university insect management specialist, county Extension agent, or crop consultant).
- **Mix and apply carefully.** As the potential for resistance increases, the accuracy of insecticide applications in terms of dose, timing, coverage, etc. assumes greater importance. The pH of water used to dilute some insecticides in tank mixes may need to be adjusted to the product manufacturer's specifications. In aerial application, the swath widths should be marked, preferably by permanent markers. Sprayer nozzles should be checked for blockage and wear, and should be able to handle pressure adequate for good coverage. Spray equipment should be properly calibrated and checked on a regular basis. In tree fruits, proper and intense pruning will allow better canopy penetration and tree coverage. Use application volumes and techniques recommended by the manufacturers and local crop advisors.
- **Alternate different insecticide classes.** Avoid the repeated use of the same insecticide or insecticides in the same chemical class, which can lead to resistance and/or cross-resistance[1]. Rotate insecticides across all available classes to slow resistance development. In addition, do not tank-mix products from the same insecticide class. Rotate insecticide classes and modes of action (see Insert(s)), consider the impact of pesticides on beneficial insects, and use products at labeled rates and spray intervals.
- **Protect beneficial arthropods.** Select insecticides in a manner that is the least damaging to populations of beneficial arthropods. For example, applying insecticides in-furrow at planting or in a band over the row rather than broadcasting will help maintain certain natural enemies.
- **Preserve susceptible genes.** Preserve susceptible individuals within the target population by providing a haven for susceptible insects, such as unsprayed areas within treated fields, adjacent "refuge" fields, or habits; attractions within a treated field that facilitate immigration. These susceptible individuals may outcompete and interbreed with resistant individuals, diluting the resistant genes and therefore the impact of resistance.
- **Consider crop residue options.** Destroying crop residue can deprive insects of food and overwintering sites. This cultural practice will kill insecticide-resistant pests (as well as susceptible ones) and prevent them from producing resistant offspring for the next season. However, review your soil conservation requirements before removing crop residue.

[1] Cross-resistance occurs when a population of insects that has developed resistance to one insecticide exhibits resistance to one or more insecticide(s) it has never encountered. Cross-resistance is different from multiple resistance, which occurs when insects develop resistance to several compounds by expressing multiple resistance mechanisms.





Group	Primary Target Site of Action	Chemical Sub-group or Exemplifying Active Ingredient	Active Ingredients
10A	Compounds of unknown or non-specific mode of action (mite growth inhibitors)	Clofentezine	Clofentezine
		Hexythiazox	Hexythiazox
10B		Etoxazole	Etoxazole
11A1	Microbial disruptors of insect midgut membranes (includes transgenic crops expressing *Bacillus thuringiensis* toxins)	*B.t.* var. *israelensis*	*B.t.* var. *israelensis*
11A2		*B.t.* var. *sphaericus*	*B.t.* var. *sphaericus*
11B1		*B.t.* var. *aizawai*	*B.t.* var. *aizawai*
11B2		*B.t.* var. *kurstaki*	*B.t.* var. *kurstaki*
11C		*B.t.* var. *tenebrionensis*	*B.t.* var. *tenebrionensis*
12A	Inhibitors of oxidative phosphorylation, disruptors of ATP formation	Diafenthiuron	Diafenthiuron
12B		Organotin miticides	Azocyclotin, Cyhexatin
13	Uncoupler of oxidative phosphorylation via disruption of H proton gradient	Chlorfenapyr	Chlorfenapyr
		DNOC	DNOC
14	Inhibition of magnesium stimulated ATPase	Propargite	Propargite
15	Inhibitors of chitin biosynthesis, type 0, Lepidopteran	Benzoylureas	Chlofluazuron, Diflubenzuron, Fluazuron, Flucycloxuron, Flufenoxuron, Hexaflumuron, Lufenuron, Novaluron, Teflubenzuron, Triflumuron
16	Inhibitors of chitin biosynthesis, type 1, Homopteran	Buprofezin	Buprofezin
17	Inhibitors of chitin biosynthesis, type 2, Dipteran	Cyromazine	Cyromazine
18	Ecdysone agonist / disruptor	Diacylhydrazines	Chromafenozide, Halofenozide, Methoxyfenozide, Tebufenozide
19	Octopaminergic agonist	Amitraz	Amitraz
20	Site II electron transport inhibitors	Dicofol, Hydramethylnon	Dicofol, Hydramethylnon
21	Site I electron transport inhibitors	METI acaricides, Rotenone	Fenazaquin, Fenpyroximate, Pyrimidifen, Pyridaben, Tebufenpyrad, Tolfenpyrad, Rotenone
22	Voltage-dependent sodium channel blocker	Indoxacarb	Indoxacarb
23	Inhibitors of lipid synthesis	Tetronic acid derivatives	Spirodiclofen, Spiromesifen
24	Site III electron transport inhibitors	Acequinocyl	Acequinocyl
		Fluacrypyrim	Fluacrypyrim
25	Neuroactive (unknown mode of action)	Difenazate	Difenazate
25	Unknown mode of action	Azadirachtin	Azadirachtin

Expanded and Intensified Grower Education Activities

- Presentations at meetings
- Written Communications


PRO 518
2001
Florida Tomato
Institute
PROCEEDINGS
SEPTEMBER 5, 2001
Citrus & Vegetable
UNIVERSITY OF FLORIDA
Compiled by:
Phyllis Gilreath, Extension Agent, Manatee County, University of Florida and
C.S. Vavrina, Professor/Interim District Director, University of Florida, SWFREC, Immokalee
PRO 519
2002
Florida Tomato
Institute
4, 2002
PRO 520
FLORIDA
TOMATO
INSTITUTE
PROCEEDINGS
September 3, 2003
Compiled by:
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UNIVERSITY OF FLORIDA
EXTENSION
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Vance
PRO 521
FLORIDA
TOMATO INSTITUTE
PROCEEDINGS
September 8, 2004
Compiled by:
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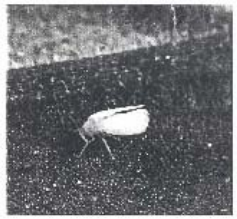
Whitefly Management Update



Compiled by Phyllis Gilreath and Dave Schuster

As we recover from a somewhat disappointing spring season, growers are of necessity turning their attention to fall and the question keeps coming up: "What can we do about all these whiteflies?"

Numbers of silverleaf whitefly (SWF) were unusually high toward the end of last season, with populations exploding seemingly overnight. Chemical controls seemed to have little impact. Because of this situation, Dave Schuster, professor at the Gulf Coast Research and Education Center (GCREC) in Bradenton, has continued estimating the susceptibility to Admire of adults reared from nymph-infested, field-collected foliage and comparing the results with the susceptibility of a laboratory colony that has never been exposed to Admire.

Populations from nine farms in the Manatee/Ruskin region have been tested. Only two fall into what Schuster says is an acceptable range in terms of susceptibility. Not all of these fields were treated with Admire at transplanting; some were treated with Platinum.

All fields were sampled at the end of the season, initially after last harvest, when the length of exposure to either Admire or Platinum would have been the greatest and when inter-regional "mixing" of adult populations could have occurred. Regardless, this is not a positive trend and growers should redouble their efforts in resistance management, as discussed below. (For results of past studies, see the 2002 Tomato Institute Proceedings at www.imok.ufl.edu/veghort/docs/toro_inst_2002_091202.pdf.) More information from these tests will be presented at the Tomato Institute in September.

Growers are now wondering what to do to prepare for fall and minimize the impact from SWF. In addition to chemical controls, there are a number of other control measures a grower can incorporate into a SWF/TYLCV management program, many of which will also improve control of other pests.

1. Sanitation – First and foremost is prompt crop destruction at season's end. The life cycle of the SWF is about two to four weeks, depending on temperature, with higher temperatures decreasing the time required for development. Since SWF do not pass the virus on to their progeny, destruction of infected crops and other plant hosts will reduce carry-over to the fall crop. The longer this host-free period, the better, so delaying planting the fall crop as long as possible will also help.

Part of the problem last season was overwintering of the virus on crops with longer harvest seasons, such as cherry and grape tomatoes. Overwintering can also be a problem, but rain should help somewhat in reducing populations.

Questions also arise regarding spraying field perimeters during the off season to try and reduce the number of SWF in weeds and borders. This is not a very efficient practice and with conventional sprayers, you will not reach far enough into the perimeter to do much good. In addition, there are beneficials harbored in unsprayed perimeters which may have some impact on SWF populations as populations are reduced due to reduction in hosts and summer rains. In addition, natural enemies of other pests, especially leafminers, reside in weeds and may be negatively impacted by sprays targeting whiteflies.

2. In the transplant house – Use of Admire as a soil drench one week before transplanting to the field will provide protection during the first few weeks in the field while Admire or Platinum applied at transplanting are being taken up by young plants. The use of Fulfill has shown to inhibit feeding.

Since the SWF must actually feed for 15 to 20 minutes to acquire the virus (i.e. just probing will not result in transmission), anything that acts as a feeding inhibitor or repellent should be beneficial. Past work has indicated that oil applied at 0.25 percent also provided a limited amount of repellency and reduced virus transmission on tomato seedlings. Some new products are currently being tested that may play a role here in the future.

3. UV reflective mulches – The theory behind these products is that they reflect a particular spectrum of light wavelengths that tend to disorient adult SWF, aphids and thrips as they fly over your fields. If you can keep them from landing, this may reduce the severity of viral infections.

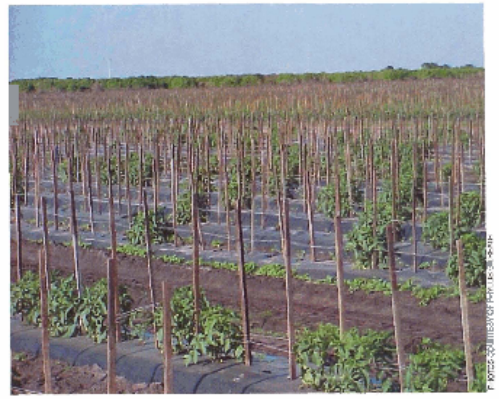
Keep in mind that there is a difference between the gray or silver mulch and the UV reflective or metalized mulch. Research with the metalized mulch has shown the most positive effects on both plant growth and virus reduction.

Growers in the Quincy area rely heavily on reflective mulch for help in controlling tomato spotted wilt (TSW) virus. Some manufacturers claim as high as 95 percent reflectance, but most is probably closer to 50 percent. With very high reflectance, field workers will actually need sunglasses for protection.

TYLCV: Pogo Was Right

By Phyllis Gilreath, Dave Schuster, Jane Polston and Jay Scott

This season, in spite of low silverleaf whitefly (SWF) numbers, there has been an unusually high incidence of Tomato Yellow Leaf Curl Virus (TYLCV) in many Central Florida tomato fields.



Tomato that requires the TYLCV and root

At a recent grower meeting in Bradenton, participants heard a review of the current situation, received a primer on virus epidemiology and whitefly biology, and were reminded of resistance management guidelines that must be followed in order to minimize future problems. The take-home message many received is that the problem is not SWF adults picking up the virus from weeds in woods or pastures surrounding tomato farms, but from tomato fields themselves. In other words, to sum it up in a quote from the 1950's comic strip, Pogo: "We have met the enemy and he is us."

TYLCV Resistant Varieties

Currently available 'resistant' tomato varieties are not immune to TYLCV. The virus can be present in the variety if fed upon by a viruliferous whitefly adult and can be a source of virus in grower fields.

Although 'resistant' varieties do not show symptoms of the virus and will produce a marketable crop, whitefly adults can still spread the virus from an infected 'resistant' variety to a healthy 'susceptible' variety. Even when older 'susceptible' plants are infected late in the season and virus is only faintly evident in the very top of the bush, the entire plant is infected and still attractive to SWF.

Thus, growers need to maintain control of SWF then and during harvest, even when resistant varieties are used, in order to prevent virus spread and to prevent the development of irregular ripening of fruit.

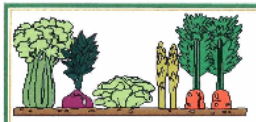
Summer conditions are not conducive to producing crops that can compete with more northerly regions, where tomatoes are produced during the summer.

Prompt crop destruction as soon as possible in each block is imperative to provide as long a crop-free period as possible. Tomato-free periods, especially for two months in the summer, are extremely important in managing both whiteflies and TYLCV.

There is also concern that availability of the new heat-tolerant tomato 'Solar Fire' will permit summer tomato production in Florida, which could make the crop-free period nonexistent. This was never the intent of the release.

Summer conditions are not conducive to producing crops that can compete with more northerly regions, where tomatoes are produced during the summer. The improved heat-tolerant fruit setting of 'Solar Fire' will improve yields of crops planted in the fall.

It will also allow for delaying fall plantings and, due to increased fruit setting, will allow for early harvests equal to less heat-tolerant varieties



VEGETARIAN NEWSLETTER

A Vegetable Crops Extension Publication
Vegetarian 03-05
May 2003

University of Florida
Institute of Food and Agricultural Sciences
Cooperative Extension Service

Vegetarian Index

Print Version

COMMERCIAL VEGETABLES

List of Extension Vegetable Crops Specialists

******* UPCOMING EVENTS CALENDAR ******

Various Extension Events in South Florida. Contact Gene McAvoy at 674-4092

116th Florida State Horticultural Society. Sheraton World Resort Hotel International Drive - Orlando, Fla. June 8-10, 2003. (Press release)

Methyl Bromide Alternatives Field Day. NFREC-Suwannee Valley, Live Oak, FL. May 8, 2003 - 9am-11am. For more information, contact Karen Hancock at 386-362-1725 or KHancock@ifas.ufl.edu.

Twilight Field Day. NFREC-Suwannee Valley, Live Oak, FL. May 29, 2003. For more information, contact Karen Hancock at 386-362-1725 or KHancock@ifas.ufl.edu .

CEU Day at Florida State Horticultural Society. - June 9, 2003, 7:30 am - 4:30 pm

71st Annual Meeting and Convention of the Florida Seed Association. Don CeSar Resort and Spa, St. Petersburg, FL. June 18-20, 2003. For more information, contact Jack Oswald at 850-482-8241and for Hotel Reservations, call the hotel at 727-360-1881. Also visit www.floridaseed.org .

49th Conference of the InterAmerican Society for Tropical Horticulture. Fortaleza, Brazil, Aug. 31- Sept. 5, 2003.

ISHS International Symposium on Protected Culture in a Mild-Winter Climate. Renaissance WorldGate Hotel - Kissimmee, Fla. March 23-27, 2004. Contact: Daniel Cantliffe at djc@mail.ifas.ufl.edu

UNIVERSITY OF FLORIDA | Cooperative Extension Service
Institute of Food and Agricultural Sciences

Manatee Vegetable Newsletter

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May/June 2004

Calendar:

June 6-8 **Florida State Horticultural Society Meeting.** Sheraton World Resort, Orlando. For more details, visit the website at http://www.fshs.org

June 10 **Nutrient Management and Soil/Water Management CCA Seminar.** 8 am - 5 pm. UF/IFAS - SW Florida Research and Education Center, Hwy 29 N. Immokalee. Earn 8 CCA CEUs Cost is $80. To register, contact Mary Hartney at 863-293-4827 or e-mail: mhartney@ifas.org To see an agenda, visit the SWFREC website at http://www.imok.ufl.edu/

June 15 **General Standards (CORE)/Private Applicator Ag Pesticide License Exam Preparation Class.** 9-11 am. Manatee County Extension Service. Exams given immediately following class. 2 CORE CEUs approved for licensed applicators

June 21-24 **1st International Symposium on Tomato Diseases and 19th Annual Tomato Disease Workshop.** Grosvenor Resort at Walt Disney World Orlando. Contact: Tim Momol at 850-875-7154 or E-mail: Tmomol@ifas.ufl.edu or visit the website http://plantdoctor.ifas.ufl.edu/istd.html

TBA **S.O.D. (Sudden Oak Death) Workshop.** Manatee County Extension Service, Palmetto. This workshop is tentatively scheduled for late June or early July. Please call 722-4524 for additional information.

A pat on the back, though only a few vertebrae removed from a kick in the pants, is miles ahead in results. (*Bennett Cerf*)

UNIVERSITY OF FLORIDA | EXTENSION
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SOUTH FLORIDA VEGETABLE PEST AND DISEASE HOTLINE

December 6, 2005

Cooler temperatures have prevailed across south Florida as typical late fall/winter weather patterns ha become established dropping temperatures to more seasonable norms. The arrival of weekly cold fronts accompanied by showers and unsettled conditions have also bought significant rainfall to most of the region over the past few weeks.

Daytime highs were mainly in the 70s with a few days reaching the low 80s. Cooler temperatures at nig brought lows into the 40s and 50s. Rainfall was variable across the area with Fort Pierce reporting 3.73 in and Homestead coming in at the bottom of the list with only 0.31 inches for the period.

Mostly clear weather allowed fieldwork to progress on schedule as south Florida growers continue recovery effort following Wilma. Growers remain busy cleaning up and replanting fields destroyed or damaged by Wilma in addition to nursing along those crops that survived the storm.

FAWN Weather Summary*

Date	Air Temp (°F) Min	Air Temp (°F) Max	Rainfall (Inches)	Hours Below Certain Temperature (hours) 40°F	45°F	50°F	55°F	60°F	65°F	70°F
Bradenton 11/10 – 12/6/05										
Ft Lauderdale 11/10 – 12/6/05	50.1	84.1	2.70	0.0	0.0	0.0	1.6	17.5	9.7	2.0
Fort Pierce 11/10 – 12/6/05	42.9	82.2	3.73	0.0	1.3	4.3	13.0	19.9	1.3	1
Homestead 11/10 – 12/6/05	44.6	84.2	0.31	0.0	0.5	10.2	20.3	39.7	22.2	3
Immokalee 11/10 – 12/6/05	43.9	84.5	1.48	0.0	3.7	3.1	6.5	30.9	23.8	

* Note – FAWN system weather info for Bradenton is not available at this time – rainfall total in others is no

As fall crops come off, it is important to practice good sanitation to avoid movement of whiteflies into later plantings and a buildup in populations that carry over to the spring crop.

Growers are urged to continue to practice the following recommendations
Nicotinoid Resistance Management Recommendations

- Reduce overall whitefly populations by strictly adhering to cultural practices including:
  - Plant whitefly-free transplants
  - Delay planting new crops as long as possible and destroy old crops immediately after harvest to create or lengthen a tomato free period
  - Do not plant new crops near or adjacent to infested weeds or crops, abandoned fields awaiting destruction or areas with volunteer plants
  - Use UV-reflective (aluminum) plastic soil mulch
  - Control weeds on field edges if scouting indicates whiteflies are present and natural enemies are absent
  - Manage weeds within crops to minimize interference with spraying;
  - Avoid u-pick or pin-hooking operations unless effective control measures are continued
- Do not use a nicotinoid like Admire on transplants or apply only once 7-10 days before transplanting; use other products in other chemical classes, including Fulfill, before this time;
- Apply a nicotinoid like Admire (16 ozs/acre) or Platinum (8ozs/acre) at transplanting and use products of other chemical classes (such as the insect growth regulators Courier® or Knack® as the control with the nicotinoid diminishes. Note: Courier and Applaud are the same active: buprofezin. Courier is labeled for whitefly on tomato and snap bean. The mode of action is chitinase inhibitor. Dimilin and Knack are juvenile hormone mimics labeled for whitefly control on fruiting vegetables.
- Never follow an application (soil or foliar) of a nicotinoid with another application (soil or foliar) of the same or different nicotinoid on the same crop or in the same field within the same season (i.e. do not treat a double crop with a nicotinoid if the main crop had been treated previously);
- Save applications of nicotinoids for crops threatened by whitefly-transmitted plant viruses or whitefly-inflicted disorders (i.e. tomato, beans or squash) and consider the use of chemicals of other classes for whitefly control on other crops.

Worms

Scouts in Homestead report problems with a fairly large fall armyworm hatch over the past week or so, and note that they are still seeing occasional problems with wireworm, cutworm, and lesser corn stalk borer on young corn. A range of worms including beet armyworm, southern armyworm and tomato fruit worm are present in eggplant, pepper and tomato and growers report problems with melon worms and pickleworms on cucumbers and squash.

Growers and scouts in the Glades indicate that fall armyworm pressure is high in recent days. Reports indicate hatch-outs of up to 80% on young corn, with many surrounding blocks near the same age ranging anywhere from 30-65% infestation.

Reports from Manatee County indicate that worms still around in moderate numbers and note some problems with diamondback moths in cabbage.

Around southwest Florida, growers and scouts indicate that pressure is starting to pickup with mainly beet and southern armyworms. Melonworms are reported to moderate to heavy in cucurbits in some places.

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IFAS EXTENSION

Fact Sheet MCV 03-01
Phyllis Gilreath, Manatee County Extension Service
Davic Schuster, GCREC

Whitefly Management Update

As we recover from a somewhat disappointing spring season, growers are of necessity turning t
to fall and the question keeps coming up - what can we do about all these whiteflies! Numbers
whitefly (SWF) were unusually high toward the end of last season, with populations exploding
overnight. Chemical controls seemed to have little impact. Because of this situation, Dr. Dav
continued estimating the susceptibility to Admire of adults reared from nymph-infested, field-c
and comparing the results with the susceptibility of a laboratory colony that has never been e
Admire. Populations from nine farms scattered across the Manatee/Ruskin production regio
tested. Of these nine, only two fall into what Dave feels is an acceptable range in terms of
Not all of these fields were treated with Admire at transplanting; some were treated with Pla
were sampled at the end of the season, usually after last harvest, when the length of expos
Admire or Platinum would have been the greatest and when inter-regional 'mixing" of adul
have occurred. Regardless, this is not a positive trend and growers should re-double their
resistance management as discussed below. (For results of past studies, see the 2002
Proceedings at http://www.imok.ufl.edu/veghortdocs/tom_insr_2002_091202.pdf) More
these tests will be presented at the Tomato Institute in September.

Growers are now wondering what to do to prepare for fall and minimize the impact from
chemical controls, there are a number of other control measures a grower can incorpo
SWF/TYLCV management program, many of which will also improve control of other

1. **Sanitation** - First and foremost is prompt crop destruction at season's end. The
about 2 to 4 weeks, depending on temperature, with higher temperatures decreasin
development. Since SWF do NOT pass the virus on to their progeny, destruction o
weed hosts will reduce carry-over to the fall crop. The longer this host free period, t
planting the fall crop as long as possible will also help. Part of the problem this las
overwintering of the virus on crops with longer harvest seasons such as cherry and
Oversummering can also be a problem, although rain should help somewhat in r
Questions also arise regarding spraying field perimeters during the off season to
of SWF in weeds and borders. This is not a very efficient practice and with conv
not reach far enough into the perimeter to do much good. In addition, there are
unsprayed perimeters which may have some impact on SWF populations as po
reduction in hosts and summer rains. In addition, natural enemies of other pes
reside in weeds and may be negatively impacted by sprays targeting whiteflies

2. **In the transplant house** - use of Admire as a soil drench one week before
Provide protection during the first couple of weeks in the field while Admire or
transplanting are being taken up by young plants. Also, the use of Fulfill has
Since the SWF must actually feed for 15 to 20 minutes to acquire the virus (
transmission), anything that acts as a feeding inhibitor or repellent should b
indicated that oil applied at 0.25% also provided a limited amount of repelle
transmission of tomato seedlings. Some new products are currently being
the future.

3. **UV reflective mulches** - The theory behind these products is that they reflect a particular spectrum of light wavelengths that tend to disorient adult SWF, aphids and thrips as they fly over your fields. If you can keep them from landing, this may reduce the severity of viral infections. Keep in mind that there is a difference between the gray or silver mulch and the UV-reflective or metalized mulch. Research with the metalized mulch has shown the most positive effects on both plant growth and virus reduction. Growers in the Quincy area rely heavily on reflective mulch for help in controlling tomato spotted wilt (TSW) virus. Some manufacturers claim as high as 95% reflectance but most is probably closer to 50%. With very high reflectance, field workers will actually need sunglasses for protection. In a fall 2002 stand establishment trial in Quincy, soil temperatures were significantly cooler under the metallized mulch compared to white/black. A somewhat surprising result was the difference in number of missing plants, which averaged 2% for the metallized mulch compared to 30% with the white/black. Some growers have expressed concern that air temperature would be increased from the increased reflectance. In this particular trial, plants were transplanted on July 15, or under similar conditions to what we face in Central Florida. Growers may consider using metallized mulch in early plantings or in areas known to be hotspots for SWF and virus. There are also questions regarding the new metalized 'flattering strips' which are attached to tomato stakes and supposedly also discrient flying SWF, aphids and thrips. Although grower use in Quincy is being reported, I am not aware of any trials that have been conducted in Florida to verify efficacy. Large scale trials would be necessary to limit interference from adjoining plots or treatments.

4. **Sticky traps** - Growers have asked about the benefits of the yellow sticky traps to help monitor SWF populations as we plant new fields. Yellow sticky traps placed vertically on small stakes around the perimeter of a field can help assess numbers of SWF in the vicinity. Sticky traps are also helpful during the season. Vertical orientation helps monitor what is moving within the crop, while horizontal orientation on top of stakes, etc. can help monitor what is coming into the field from outside. Traps should be checked and replaced at least weekly.

5. **Use of Resistant Cultivars** - This may be a key cultural practice in coming years. The IFAS tomato breeding program as well as a number of commercial companies are hard at work developing TYLCV resistant cultivars. Some of the cultivars tried in recent years gave good results in some seasons, but did not hold up well under our typical rainy, fall conditions. Use of resistant cultivars may be a tool for early plantings where SWF and/or virus pressure will be heaviest. Again, keep in mind that these cultivars are typically 'tolerant' of the virus. This means that, while they do not show symptoms or yield affects, they still acquire it and can serve as a host for non-resistant cultivars.

6. **During the season** - A number of practices can be followed to minimize the impact. You have heard and seen these before but they are worth reviewing briefly. These include:

- Never follow an application (soil or foliar) of a nicotinoid with another application (soil or foliar) of the same or different nicotinoid on the same crop or in the same field within the same season (i.e. do not treat a double crop with a nicotinoid if the primary crop was treated previously). This practice of applying different formulations of nicotinoids within the same crop may be one reason we are seeing increased tolerance to these products. Additionally, grower and scout observations indicate these products did not improve SWF control or TYLCV incidence compared to other chemicals.
- Manage weeds within the crop so they do not interfere with crop spray coverage.
- Control weeds or field edges if scouting indicates whiteflies are present and natural enemies are absent; however, this situation generally has not occurred since the initial whitefly outbreak in the late 1980s and early 1990s.
- Save applications of nicotinoids for crops threatened by whitefly-transmitted plant viruses or whitefly-inflicted disorders (i.e. tomato, bean or squash) and consider the use of other chemical classes for other crops.
- Rogue infected plants as soon as infections are identified in the field. As plants get older with multiple ties, many growers just clip the plant at the soil and leave it in place.
- Continue chemical controls throughout the season, including during pinhooking and u-picking, even if only using oil or soap products.

(Information from Drs. Dave Schuster, Steve Olson, Joe Funderburk and Jane Polston, July 2003)

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IFAS EXTENSION

ENY681

Monitoring Susceptibility of Whiteflies to Imidacloprid and Resistance Management for Nicotinoid Insecticides[1]

David J. Schuster, Sandra Thompson, and Roy F. Morris II[2]

Imidacloprid a nicotinoid insecticide that is applied at transplanting or within two to three weeks after transplanting to nearly 100% of the tomato acreage in Florida for control of the silverleaf whitefly (SLWF), *Bemisia argentifolii* Bellows & Perring, and the geminiviruses it transmits, primarily tomato yellow leaf curl virus (TYLCV). A cut leaf petiole (CLP) method using cotton seedlings was used to develop the baseline level of susceptibility of whitefly adults from a laboratory colony to imidacloprid. The CLP method was easy and quick and was used to estimate the susceptibility of whitefly populations from three imidacloprid-treated tomato fields in the spring of 2000, nine in the spring of 2001, two in the fall of 2001, and 13 in the spring of 2002 using adults reared from field-collected nymphs. Standard probit analyses were used to estimate the LC_{50} values (the concentration estimated to kill 50% of the population) for the laboratory colony and for each field population. LC_{50} values of field populations ranged from about 2 to 35 times that of the highly susceptible laboratory colony. Values on the high side of the range were found at two sites in 2001 and two other sites in 2002. Two sites that had high values in 2001 did not have high values in 2002. In addition, SLWF populations were not reported by growers to be out of control at any of the sites, and in-field evaluations of imidacloprid efficacy in 2002 indicated expected levels of control of SLWF nymphs, even at the site that had an LC_{50} value 35 times the laboratory colony. Growers are encouraged to implement a resistance management program for nicotinoids by reducing overall whitefly populations and by rotating nicotinoids with insecticides of other chemistries.

Introduction

Nicotinoids (also known as neonicotinoids, chloronicotinyls, nitroguanidines and nitromethylenes) are a relatively new class of insecticides that are structured after naturally occurring nicotine compounds and act similarly on the central nervous system. They are translaminar

1. This document is ENY681, a publication of the Entomology and Nematology Sciences Department, Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida. Publication Date: September 2003. Please visit the ENS Website at http://edis.ifas.ufl.edu.
2. David J. Schuster, professor, Gulf Coast Research and Education Center, University of Florida/IFAS, Gulf Coast Research & Education Center - Bradenton; Sandra Thompson, technical assistant, Gulf Coast Research and Education Center- Bradenton, Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida, Gainesville, FL 32611. Roy F. Morris II, Technical Sales Specialist, Bayer CropScience, 2635 Ewell Rd., Lakeland, FL 33811

UNIVERSITY OF FLORIDA
IFAS EXTENSION

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David J. Schuster, Sandra Thompson, and Roy F. Morris II[2]

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ENY684

UNIVERSITY OF FLORIDA
IFAS EXTENSION

Biorational Insecticides for Integrated Pest Management in Tomatoes[1]

David J. Schuster and Phillip A. Stansly[2]

IPM and Biorational Insecticides

Integrated pest management (IPM) can be defined as the use of all available means to maintain pest populations below levels that would cause economic loss while minimally impacting the environment. The tactics utilized in IPM programs include chemical, cultural, physical, and biological control. Most management programs rely heavily upon the use of insecticides applied when periodic scouting indicates that pests have exceeded a pre-determined threshold. Insecticides provide quick control of pests but often require repeated applications to provide long term management. It has long been recognized by researchers and, more recently, by IPM practitioners that the integration of biological control (mortality induced by natural enemies including parasites, predators, and pathogens) into IPM programs is essential for long term, stable management of pests. Repeated applications of insecticides can lead to the development of resistance in the target pest and can reduce the natural enemy populations, leading to resurgence of the target pest(s) and outbreaks of secondary pests, i.e. those normally kept under control by their natural enemies. Therefore,

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is essential.
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1. This is document ENY681, one of a series of the Entomology and Nematology Department, Flori
Agricultural Sciences, University of Florida. Please visit the EDIS Website at http://edis.ifas.ufl
2. David J. Schuster, professor, Entomology and Nematology Department, Gulf Coast Research and
professor Entomology and Nematology Department, Southwest Florida Research and Educatio
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ENY-685

UNIVERSITY OF FLORIDA
IFAS EXTENSION

Scouting for Insects, Use of Thresholds and Conservation of Beneficial Insects on Tomatoes[1]

David J. Schuster[2]

Integrated pest management (IPM
defined as the utilization of all availab
managing pests such that economic lo
and environmental impact minimized.
cornerstone of IPM is a knowledge of
attacking a crop and an understanding
relationship of density of those pests t
Therefore, every IPM program is depe
periodic scouting to ascertain pest den
establishment of densities when treatm
warranted, i.e. thresholds. Although th
upon the economics of the crop and up
treatment have been developed for son
vegetables, these "economic" threshol
have not been used because of the vari
unpredictability of the ultimate market
winter vegetables. Therefore, action th
been utilized. Action thresholds can be
those levels of pest density or damage
consistently (statistically) measurable
quantity or quality. What follows is a
the rationale of scouting methodology,
thresholds, and pesticide selection crit
tomatoes.

1. This document ENY-685, one of a series of the
Sciences, University of Florida. Reviewed: Marc
2. David J. Schuster, professor, Gulf Coast Research
Agricultural Sciences, University of Florida, Gai

ENY705

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IFAS EXTENSION

A Threshold for Timing Applications of IGRs to Manage the Silverleaf Whitefly and Irregular Ripening on Tomato[1]

David J. Schuster[2]

The silverleaf whitefly, *Bemisia argentifolii* Bellows & Perring, has been the major pest of tomatoes in South Florida since 1988 (Schuster et al. 1989). The insect causes losses indirectly through the transmission of plant viruses, including *Tomato mottle virus* and *Tomato yellow leaf curl virus* in Florida (Simone et al. 1990, Polston et al. 1999). Feeding, primarily by nymphs, has been associated with an irregular ripening (IRR) disorder of fruit (Schuster et al. 1990, Schuster 2002). The disorder is characterized externally by inhibited or incomplete ripening of longitudinal sections of fruit and internally by an increase in the amount of white tissue. No foliar symptoms are apparent.

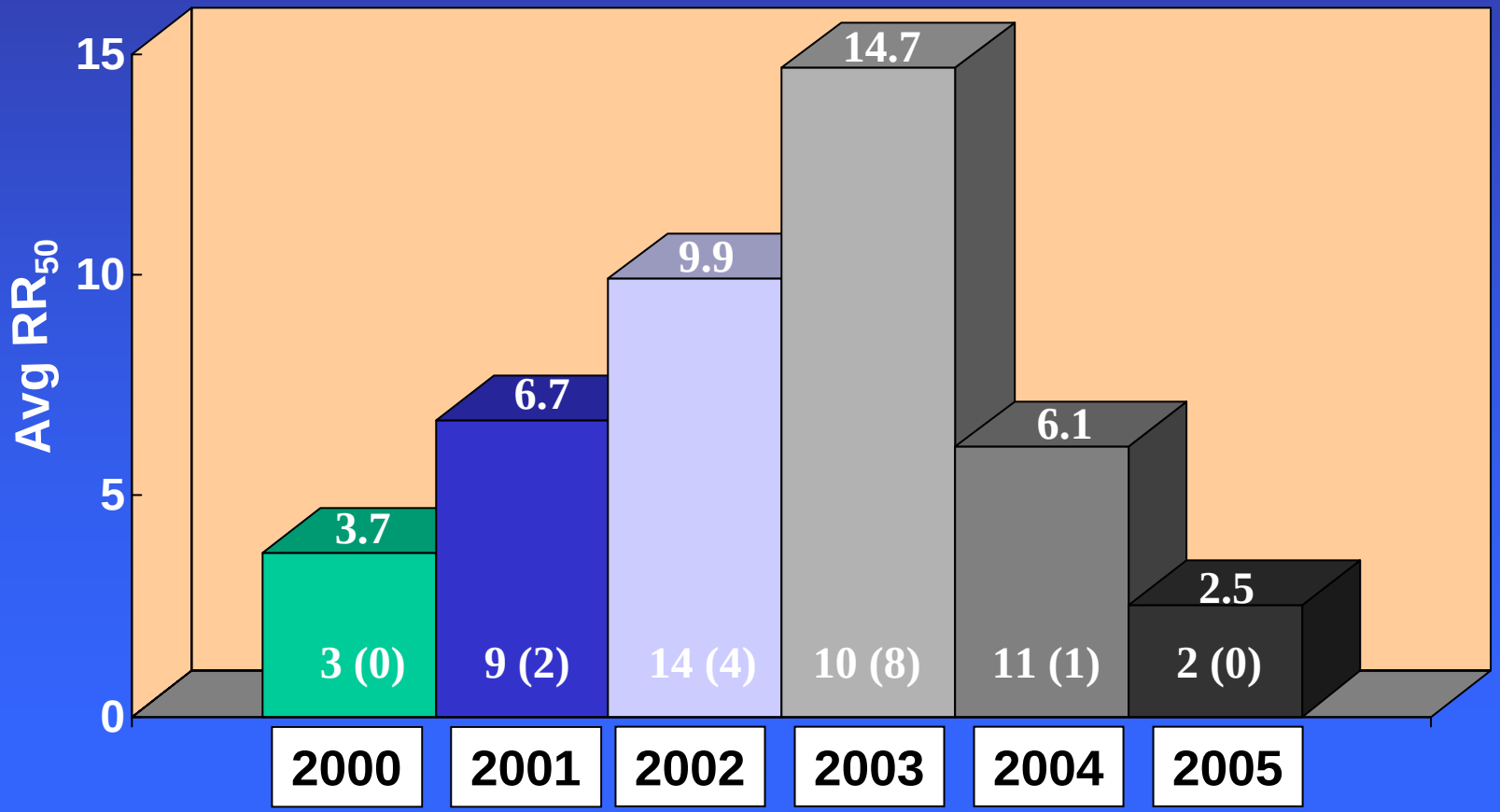
Management of the whitefly and associated diseases and disorders includes the rigid adherence to cultural practices supplemented with insecticidal applications (Schuster et al. 1993). The systemic, nicotinoid insecticide imidacloprid (Admire 2F, Bayer CropScience) is applied to seedlings 7-10 days prior to transplanting and is supplemented with a soil application of either imidacloprid or another nicotinoid insecticide, thiamethoxam (Platinum 2SC, Syngenta Crop Protection, Inc.), at transplanting. Insecticides of different chemical classes then are

applied as needed as the effects of imidacloprid and thiamethoxam diminish, usually after about 8 weeks. Two insect growth regulators (IGRs), buprofezin (Courier 70WP, Nichino America, Inc.) and pyriproxyfen (Knack 0.86EC, Valent Agricultural Products), have received authorization by the EPA for whitefly management on Florida tomatoes. Neither IGR kills adults; however, both sterilize eggs of treated adults, although the effect is much greater for pyriproxyfen. Buprofezin prevents successful molting at all nymphal stages while pyriproxyfen only prevents adult emergence following the last nymphal stage. Research was undertaken to identify the nymphal density at which these IGRs should be applied to avoid IRR.

Five experiments were conducted during the spring and fall of 1997 and 1998 and the spring of 1999 at the Gulf Coast Research & Education Center, Bradenton, FL. In each experiment, three row plots were established and were sprayed when predetermined thresholds of 5 to 20 sessile nymphs and pupae (2^{nd}-4^{th} instars) per 10 leaflets were reached. Nymphal counts were completed in the laboratory using dissecting microscopes on the terminal leaflet of the 7^{th} to 8^{th} leaf from the tops of

1. This document is ENY 705, a publication of the Entomology and Nematology Sciences Department, Florida Cooperative Extension Service, IFAS, University of Florida. Publication date: March 2004. Please visit the EDIS Website at http://edis.ifas.ufl.edu.
2. David J. Schuster, professor, Gulf Coast Research and Education Center, Cooperative Extension Service, IFAS, University of Florida, Gainesville, FL 32611.

Monitoring Relative Susceptibility (RR_{50}) of Whitefly Adults from Nicotinoid-Treated Tomato Fields to Imidacloprid Using a Laboratory Bioassay



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KAC Agricultural Research
Agricultural Crop Consulting, Inc.
Integrated Crop Management, Inc.
Agri-Tech Services, Inc.
Numerous cooperating tomato growers

University of Florida

Phyllis Gilreath
Gene McAvoy
Jane Polston
Phil Stansly & Jim Conner