Lesson Plan

An Entomological Perspective For Emergency Agricultural Response



SART Training Media

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Lesson Plan

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SART Training Media are available for download from the Florida SART web site at www.flsart.org.

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About Florida SART

SART, the Florida State Agricultural Response Team, is a multi-agency coordinating group consisting of governmental and private entities dedicated to all-hazard disaster preparedness, planning, response and recovery for the animal and agriculture sectors in Florida.

SART operates at the local level through county SART organizations.

SART utilizes the skills and resources of many agencies, organizations and individuals with its multi-agency coordination group structure.

SART supports the county, regional and state emergency management efforts and incident management teams.

SART Mission

- Empower Floridians with training and resources to enhance animal and agricultural disaster response.

SART Goals

- Promote the establishment of a coordinator in each county responsible for all agriculturally related incidents.
- Provide assistance in the development and writing of ESF 17 plans.
- Promote the establishment of a county SART in each county to serve as a multi-agency group to support emergency management and incident management teams.
- Provide annual training for all SART and agriculturally related personnel.
- Identify county resources available for an emergency or disaster.
- Promote county cooperation at a regional level for mutual aid.

SUBJECT:	The entomological basis for actual and potential agricultural emergencies threatening Florida
GOAL:	Introduce participants to the variety of entomological pests now present in Florida, those that may appear in the future and their actual and potential for agricultural harm

INTRODUCTION

This lesson plan and workbook are designed to be part of the SART training module on entomology issues: *An Entomological Perspective for Emergency Agricultural Response*. This lesson plan gives the instructor direction for delivering the educational portion of the workshop. The mechanics of planning, organizing and publicizing the entire training event are covered in the companion piece, *Toolkit for Planning a Community-Based SART Training Event*. For information on obtaining this publication, please refer to the resources section.

This lesson plan is developed to help the instructor present information about entomological (insect) issues that affect or may affect Florida agriculture.

A PowerPoint presentation has been created to accompany this lesson. Throughout the lesson plan, box-like symbols have been placed in the margins to indicate that a PowerPoint slide is available for that section.

Approximately one hour should be allocated for this program.

SESSION OUTLINE

Part 1: Beginning the Workshop	5 minutes
Part 2: Bugs Rule! The Wide World of Arthropods	15 minutes
Part 3: The "Sentinel State" and How It Responds	10 minutes
Part 4: Emergencies, Interceptions and Discoveries	10 minutes
Part 5: Truly Bad Bugs That Are Not Here Yet	5 minutes
Part 6: Highlight Key Resources	5 minutes
Part 7: Summary & Wrap-Up	10 minutes
Total	60 minutes

SPECIFIC LEARNING OBJECTIVES

At the end of this training module, participants will be able to:

1. Identify some of the exotic insect pests currently present and those which pose a significant potential threat to Florida

2. Discuss the nature of the threat associated with exotic pests and the consequences of unchecked spread

3. Identify steps being taken to ameliorate the effects of current exotic insect pest infestation and to prevent the introduction of additional threats

4. Identify key resources that participants can easily access for further information and assistance

LEARNING ENVIRONMENT AND LEARNING AIDS

To complete this lesson plan, you will need:

- The PowerPoint Presentation *An Entomological Perspective For Emergency Agricultural Response.* Optional – a companion publication, *An Entomological Perspective For Emergency Agricultural Response: Participant Workbook*, is available with the PowerPoint slides and resource information.
- A companion publication (T-1) *Toolkit for Implementing a Community-Based SART Training Event* is available to help you organize, plan and present an entire SART training event with multiple training modules
  (See the Resources section at the end of this publication to find out more about any of these materials.)

To conduct this training unit, you will need:

- A means to show the PowerPoint Presentation: a computer with a projector. (Note: Master black and white copies of the slides are included at the end of this manual if you prefer to use an overhead projector.)
- Sufficient seating for all participants.

Each participant will need:

- A pen or pencil.
- Participant workbook or paper for notes.

BEFORE THE WORKSHOP

On the day of the workshop, check that all equipment needed is in place. Double-check that electronic media works on the equipment you have. Also, make certain that any materials such as paper, workbooks and pens or pencils for participants, are available in sufficient numbers to cover all participants.

PART 1: BEGINNING THE WORKSHOP

Time: 5 minutes

Focus: Explain purpose of workshop – Expand participants' knowledge of exotic entomology affecting Florida

Once all participants have taken their seats and have settled down, welcome them to the *An Entomological Perspective For Emergency Agricultural Response* workshop. Thank them for attending and congratulate them on taking the time to learn about this important issue. Remind them that the best way to respond to and recover from an emergency situation is to have a foundation of knowledge about available resources.

During this introduction, you may choose to distribute the Pre-Test included in the Resources section of this manual. The Pre-Test is a good way to determine the knowledge your audience currently possesses about invasive exotic insect threats in Florida. Make sure to communicate to the participants that their Pre-Test answers, right or wrong, are only meant to guide them through this learning experience. (Note: By design, the Pre-Test and Post-Test are the same.)

Slides 1–6

This lesson plan can be used with agricultural and non-agricultural audiences. At the end of this training module, participants will be able to identify some of the exotic insect pests currently present and those which pose a significant potential threat to Florida; discuss the nature of the threats associated with these exotic pests and the consequences of their unchecked spread; identify some of the steps being taken to ameliorate the effects of current exotic insect pest infestation and to prevent the introduction of additional threats; and identify key resources that participants can easily access for additional information and assistance.

Remind attendees that the reason they are attending the workshop (and the training event if applicable) is because they realize the value of "understanding the enemy." This understanding is the basis for

developing and implementing an emergency or disaster plan. They will carry the results of the workshop and training event with them everywhere.

This introduction should not exceed five minutes unless the Pre-Test is to be completed, in which case another few minutes may be required. This is a time when the participants are getting comfortable with the workshop they have decided to attend, their surroundings and you as the presenter. Simultaneously, you are becoming comfortable with the participants, the material you are presenting, and with being a presenter.

Pay attention to time as participants will want to learn what you have to present AND will want to depart on time. If you find that you are nervous when you start, understand that this is a natural response to public speaking. These "nerves" can make people ramble, talk faster or talk slower than normal, or even forget the time altogether. Nevertheless, even if participants enjoy what you are presenting, they will appreciate your discipline when the workshop ends on time.

PART 2: BUGS RULE! THE WIDE WORLD OF ARTHROPODS

Time: 15 minutes

Focus: Explain the breadth and importance of arthropods in the world

Arthropods are a group of invertebrate animals with hard exoskeletons – skeletons outside their body – made of a tough carbohydrate called *chitin*. They have segmented bodies and jointed limbs. Insects, arachnids, crustaceans and others are arthropods. In other words, lady bugs, spiders, bees, cockroaches, butterflies ….

Slides 7-10

While there is one species of human and there may be 40,000 species of mammals (warm blooded, hairy animals), there are almost 1,000,000 species of bugs described and the oldest was alive 350 million years ago. It may be comforting to know that they pestered T-Rex picnics as much as they do our own.

A Pennsylvania study demonstrated that in the healthy forest, one could find almost 10,000 arthropods per square foot or an astounding 425 million individual animals per acre.

A Louisiana study estimated there are as many as 25 million insects per cubic mile above the surface of the earth. This study was

conducted by flying grids over selected areas and collecting insects in fine-mesh screens.

Think about this. A famous estimate of fly reproductive ability ran from April to August. Beginning with one pair, if none died, the final number would be approximately (191 million) x (1 trillion) flies!

The arthropod world is numerous and fertile; its members are hardy and they can be terrifyingly powerful. In the 1930s, a swarm of locusts in the United States moving at 5 miles per hour was estimated 100 miles wide, 300 miles long and more than ½-mile high … and individual locusts were found at more than one mile high.

Beneficial vs. Non-Beneficial

One way to think about bugs is to divide them into beneficial and harmful categories. Not every member of the arthropod phylum is a biting, blood-sucking horror. Indeed, many bugs have beneficial qualities. Honeybees sting, but they also pollinate. Ladybugs eat aphids, scale and mites. Night crawlers are powerful soil engineers. Crickets are edible: 100 grams contain 121 calories and 13 grams of protein.

Of course, many insects are not beneficial and Floridians know some of them only too well: mosquitoes, ticks, fire ants, yellow flies and no-see-ums. Many that we hear about in the news are recent migrants, "killer bees," for example.

There are plenty of insects that we do not know very well, however, bugs that do not receive the publicity of those that can kill, that are nevertheless a terrible threat to our agricultural economy. Many varieties of exotic thrips and beetles and whiteflies have recently found a home in Florida … or could potentially end up here as a result of accident, a thoughtless selfish act or even an intentional act of agro-terrorism. To protect ourselves, our agricultural economy and our way of life, it is important that we understand these bugs and make an effort to know the difference between what is beneficial and what is harmful. We can then translate information and awareness into power.

Slide 11

Major Groups of Arthropod Pests (supplemented with additional presenter information)

As we have noted, many insects in Florida are beneficial while others are not. Here are the major insect pest categories: scales, mealybugs, aphids, whiteflies, spider mites, borers, beetles, caterpillars and thrips.

Scales & Mealybugs

Scale insects are divided into three major groups: (1) armored, (2) soft and (3) mealybugs.

Armored scales secrete a waxy covering resembling a plate of armor. It is not an integral part of the insect's body; the scale lives and feeds beneath it. These insects vary from 1/16- to 1/8-inch long and can be almost any color or shape: circular, oval, oblong, thread-like or even pear-shaped. About 175 of America's 350 species are present in Florida.

Slide 12

Soft scales also secrete a waxy covering, but it is an integral part of their body. Soft scales, too, vary widely in color, size and shape, from 1/8- to ½-inch and may be nearly flat to almost spherical. Eighty-five species of soft scales occur in the United States, 60 of them in Florida.

Mealybugs, a form of plant scale insect, get their name because the white wax on their bodies makes them look like they were rolled in flour. Infested plants exhibit the white "fluff" mealybugs produce as protection from heat and moisture loss. They are common pests of greenhouse and stored plants, feeding on plants by inserting long, straw-like mouthparts (called *stylets*) deep into plant tissue. Mealybugs also secrete a sticky honeydew that adheres to leaf surfaces and attracts dust and molds.

In low numbers, mealybugs do not cause plants significant injury. However, in large numbers, they cause leaf yellowing, leaf curling, and/or leaf drop. They are difficult to eradicate because crawlers wedge themselves in plant roots, crotches and leaf folds where pesticides cannot reach. Infested plants do not always show obvious signs of infestation until the infestation is too advanced to use a biological control.

Aphids & Whiteflies

Slide 13

Aphids, or plant lice, are small, soft-bodied insects which are common pests of nearly all ornamental plants, indoor and outdoor, as well as vegetables, field crops and fruit trees. There are thousands of different species of aphids, some of which attack only one host plant, while others attack numerous hosts. Most aphids are about 1/10 inch long, and though commonly green and black, may also be gray, brown, pink, red, yellow or lavender. A characteristic common to most species is the presence of two tubes, called *siphunculi*, on the back ends of their bodies. These *siphunculi* secrete defensive substances.

Aphids feed in clusters and generally prefer new, succulent shoots or young leaves. They suck plant juices through a food channel in their beaks while injecting saliva into the host.

Light infestations are usually not harmful, but higher populations cause leaf curl, wilting, stunting of shoot growth, and delay in production of flowers and fruit, as well as a general decline in plant vigor. Some aphids are also important vectors of plant diseases, transmitting pathogens, particularly viruses, in the feeding process.

Whiteflies are tiny, snow-white insect pests resembling moths. Without magnification, they look like flying dandruff! Although they might resemble moths, they are actually more related to and are often confused with scale insects. Both adult and nymph stages feed by sucking plant juices. Heavy feeding gives plants a mottled look, causing yellowing and eventually death. Like aphids and mealybugs, whiteflies excrete sticky honeydew, which permits the development of black sooty mold fungus. Besides being unattractive, sooty mold interferes with photosynthesis, which retards plant growth and often causes leaf drop.

The most common and perhaps most difficult to control insect pests in greenhouses and interior landscapes are whiteflies. Three common species of whiteflies – the greenhouse, sweet potato and banded wing – attack a wide range of plants including bedding plants, cotton, strawberries, vegetables and poinsettias. In addition, whiteflies are difficult to control. Immature stages are small and difficult to detect. Growers often buy plants, unaware of whitefly infestations.

Once adults develop and emerge, they quickly become distributed over an entire crop or infest other available plants. Chemical control programs often have limited success. Whitefly egg and pupa are tolerant of most insecticides. Control is also complicated by insects clinging on to the underside of leaves, making them difficult to reach with chemical or oil sprays.

Spider Mites

Slide 14

There are three major groups of mites that attack woody ornamental plants. These are the spider mites, the false spider (or flat mites) and the gall or eriophyid mites. Mites are not technically insects, but are more closely related to spiders and ticks. The body of a spider mite or false spider mite is separated into two distinct parts, the gnathosoma (mouth parts) and the idiosoma (the remainder of the body which parallels the head, thorax and abdomen of insects).

Spider mites are the most common mites attacking woody plants. False spider mites and eriophyid mites are less common. Eriophyid mites exhibit great modification of body structure. They have only two pair of legs, as the four rear legs are absent. They are microscopic, elongate, spindle-shaped and translucent.

Some of the more common woody plants attacked by mites include azalea, camellia, citrus, silver thorn, hibiscus, ligustrum, photinia, pyracantha, rose, viburnum, juniper, arborvitae, holly, pittosporum, wax myrtle, and croton. Eriophyid mites attack a wide range of plants including black olive, camellia, juniper, podocarpus, boxwood, maple and citrus.

All mites have needle-like piercing-sucking mouthparts. Spider mites feed by penetrating the plant tissue with their mouthparts and are found primarily on the underside of the leaf. All spin fine strands of webbing on the host plant, hence their name. For instance, when two-spotted spider mites remove the sap, the mesophyll tissue collapses and a small chlorotic spot forms at each feeding site. It is estimated that 18 to 22 cells are destroyed per minute. Continued feeding causes a stippled-bleached effect and later the leaves turn yellow, gray or bronze. Complete defoliation may occur if the mites are not controlled. A common control is the release of predatory mites.

Beetles & Borers

Diverse and abundant is the world of beetles. A beetle is an insect with a biting mouthparts and front wings modified to form horny covers overlying the membranous rear wings.

Beetles are everywhere and destructive pests are as numerous as those, which are innocuous. As if our European honeybees, for instance, were not under sufficient attack from various exotic mites and from the Africanized honeybee, the *Aethina tumida* or small hive beetle has recently been found in colonies in southeast Florida. These beetles enjoy the honey and combs as much as humans, but their presence can ultimately destroy colony structure.

Another example of a destructive beetle is the southern pine beetle or SPB, *Dendroctonus frontalis*. SPB is the most aggressive and destructive of the five bark beetle species commonly infesting pines in the southern United States. In recent years outbreaks in north Florida have increased in frequency and severity owing to the increased acreage, density and maturity of loblolly pine, the beetle's favorite host.

Slide 15

Insect borers are aesthetic, economic and structural pests of trees and shrubs because tunneling damages wood, creates "hazard" trees, and lowers the wood's value for lumber. Infested nursery stock has poor form, reduced growth rates, and may be difficult to sell.

Borer larvae and adults tunnel in woody plants of all ages and sizes. Eggs are laid on or in the bark, and larvae chew into the plant tissue. Most borers are larvae of beetles or moths, but some are wasps or flies. They are considered "secondary pests," attacking after a plant has been weakened by another stress. A few are "primary pests" though and will attack healthy trees and shrubs. Knowing whether insects are primary or secondary pests is critical to assessing and treating plant problems.

Borers are hard to detect until plants are damaged or die. Sawdust-like frass (excrement) may appear around a hole or in a pile on the ground. Sap may ooze from the wound site. Round, oval, or D-shaped holes may be randomly located on the plant. (Insect exit holes can be distinguished from woodpecker holes by the presence or absence of frass.) The chewing of some species may even be heard by standing near the tree.

The severity of damage depends on the number and location of insects. Phloem feeders destroy tissues that transport food and produce new wood and bark. Feeding by a few individuals may produce necrotic lesions, whereas feeding that encircles the stem may kill the entire tree. Xylem borers drill into the sapwood and disrupt the flow of nutrients and water as well as structurally weakening the plant. Twig and shoot borers decrease fruit, nut and seed production by causing branch dieback. Borers may also feed in the succulent callus tissue around grafts, thus preventing the connection of scion and stock. Dead branches, pitch masses, and wood and bark riddled with holes decrease the aesthetic value of plants.

Caterpillars and Thrips

Caterpillars eventually become moths and butterflies. In doing so, however, they pass through a “very hungry” stage and while some members of this immense and diverse group are eventually beneficial, many, if not most, are not.

The oleander caterpillar, *Syntomeida epilais* is one of hundreds of damaging caterpillars. A bright orange caterpillar with tufts of long black hairs, it is common on oleanders in Florida and south Georgia.

Slide 16

In south Florida, oleander caterpillars cause considerable defoliation. It is the only caterpillar pest of concern on this hardy ornamental plant. Early infestation is easy to recognize. The young, gregariously feeding larvae turn new oleander shoots light brown due to their skeletonizing feeding (leaving the major and minor leaf veins untouched while eating the tissue in between). Examination of the underneath surface of these brown leaves or those leaves slightly below the damaged foliage reveal small larvae.

At this stage the insect is easy to control. If caterpillars are allowed to grow beyond the small, gregarious stage, they can inflict a lot of unsightly defoliation on the oleander unless nature or human intervention stops them. Total defoliation will not kill the plant but, if it occurs repeatedly year after year, the plant may be more susceptible to other pests such as scale insects.

Birds do not feed on this abundant resource because of the caterpillar's poisonous diet. Several insect species however do eat oleander caterpillars: predatory stink bugs, parasitic tachinid flies and wasps, and the ever-voracious red imported fire ant.

A thrip is a small sucking insect. Some species are wingless, but most have four narrow feathery wings fringed with hairs. They feed on plant sap and many are destructive as individuals and, when attacking plants in hordes, can be deadly. Thrips have piercing-and-sucking mouthparts and cup-shaped feet from which bladder-like adhesive organs may be extended. Metamorphosis is gradual, and some thrips reproduce by *parthenogenesis*, a form of reproduction in which the ovum develops into a new individual without fertilization.

A few species prey on mites and small insects. Others, however, the onion, pear, greenhouse and grass thrips, feed on the foliage and flowers of plants to which they may transmit virus diseases.

PART 3: THE "SENTINEL STATE" AND HOW IT RESPONDS

Time: 10 minutes

Focus: Why Florida's unique position is conducive to exotic pests, how it responds, and the major groups of arthropods in Florida

Slides 17-18

Florida's unique geographic position, sub-tropical climate, extraordinarily long coastline and growing, affluent population render it susceptible to invasion by exotic plants, animals and insects.

The Sunshine State peninsula points like a finger from the mainland of North America into the Caribbean and hundreds of tropical islands to the south. In addition, its deep-water ports are open to shipping from around the world.

For all of these reasons, Florida is considered a "sentinel state;" it is on the *front line* for exotic invasions of the American mainland … sometimes in time to take effective action.

Management Strategies: Eradication vs. Management

Two essential strategies have been adopted for dealing with invasive species, eradication and management.

Slide 19

Eradication of exotic species, and certainly those which have the ability to cause significant harm in the Florida agricultural and natural ecosystems, is the preferred solution. Unfortunately, it is not always possible. To be eligible for complete eradication, we need to be able to isolate species; the species needs to be fairly limited in distribution; and/or it has to respond to a known bait.

If eradication is not deemed possible, perhaps because a species becomes too widely distributed before the threat is discovered, then a management strategy is prepared. This means that barring unforeseen circumstances, we have to learn to live with a new neighbor.

Eradication Example: The 1997-98 Mediterranean Fruit Fly Emergency

The Mediterranean fruit fly or "medfly," *Ceratitis capitata*, is one of the world's most destructive fruit pests. The species originated in sub-Saharan Africa. It is not known to be permanently established in the United States. When it has been detected in Florida and California, especially in recent years, each infestation caused intensive and massive detection and eradication procedures so that the pest did not become established.

Slides 20-27

Female flies bore holes in citrus fruit and lay eggs inside. Once hatched, the larvae consume the fruit from the inside-out, leaving a stinking inedible mass.

In areas with permanent medfly infestation – and these flies are known to attack more than 260 varieties of fruit and flower – fruit must be picked early or else production literally falls to zero.

Once established, the continuing eradication effort involves hand sorting and inspecting. The process is time-consuming and, ultimately, prohibitively expensive.

Of course, the medfly target is one of the state's most significant agricultural commodities. Florida produces 80 percent of all citrus grown in the United States; its citrus production is second in the world, following only Brazil. Thus, millions of dollars and thousands of livelihoods are at stake, not to mention millions of dollars in taxes at all government levels.

An eradication effort is built on three phases: survey, organize and regulate, and control or action.

In the survey effort, researchers move into citrus groves and even the yards of homes that have citrus trees, to chart the distribution or spread of the infestation. The results give a picture of the scale of the emergency and clues to effective control measures.

The second step in eradication is to organize and regulate so that the invasion can be countered. This step involves agencies of the Department of Agriculture and the Florida Department of Agriculture and Consumer Services. It may involve other states and multiple state and local agencies.

Part of the 1997-98 medfly outbreak control effort in Florida – and Florida has been battling medfly epidemics since the 1920s – involved regulating the transport of fruit, establishing quarantine zones and inspecting fruit. The Tampa area and its busy, international port were major centers of activity.

The third phase of an eradication effort is a boots-on-the-ground action phase. Groves may be sprayed from the air; individual trees are sprayed from the ground; infected fruit is disposed-of. This phase may also involve a biological as well as a chemical control, the release of sterile flies, which has been shown to have some limited effect in both Florida and in Chile.

Slides 28-29

Throughout the program, communication and education with the public is paramount. The public and the news media are sensitive about pesticides as well as exotic insect pests; airborne spraying and invasion of personal space and private property. Thus, it is necessary to communicate effectively and cooperatively with the media. It is essential to give the public accurate information in a timely manner.

And, just as errors and accountability need to be acknowledged and freely discussed, successes – such as apparent eradication of the 1997-98 medfly outbreak – should be also be publicized.

Management Example: Pink hibiscus mealybug

The pink hibiscus mealybug, *Maconellicoccus hirsutus*, is a serious pest of many plants in tropical and subtropical regions, including Africa, Asia and Australia. This pest has two common names (pink mealybug and hibiscus mealybug), but there is an effort to standardize the common name by calling the pest "pink hibiscus mealybug," even though it attacks many plant species, including citrus.

Slides 30-32

This bug was found for the first time in the Caribbean in 1994. Subsequently, it was discovered in Broward County, Florida on June 13, 2002 … then in Dade County … and has continued to spread. Because it would be difficult to impossible to eradicate, a management strategy has been developed to limit its spread and impact.

The pink hibiscus mealybug is expected to attack many Florida crops including citrus, avocado, carambola, fig, guava, mango, soursop (or guanábana, a distant relative of the paw paw), and sugarcane; vegetable crops including asparagus, beans, beets, cabbage, peanuts, pigeon pea, cucumber, lettuce, pepper, pumpkin, and tomato; forest trees, and many species of ornamental plants including allamanda, angelica, anthurium, bougainvillea, croton, ginger lily, heliconia, ixora, hibiscus, palm, and oleander.

Crop production costs will increase if growers attempt to manage mealybug populations by pesticide applications. Pesticides disrupt the effective natural enemies of other crop pests, such as mites, scale insects and whiteflies. This, in turn, leads to the application of additional pesticides to control these pests. Additional pesticide applications can contaminate food, water and farm workers.

Around the yard and home, insecticide use will probably increase due to the bug's damaging effects on ornamental plants, particularly hibiscus.

PART 4: EMERGENCIES, INTERCEPTIONS, DISCOVERIES

Time: 10 minutes

Focus: Florida's position as a sentinel state requires that it deal with entomological emergencies now and in the future

Slide 33

Because of its position as a "sentinel state," Florida has and will continue to have biological emergencies. Some dangerous pests will be intercepted and turned back at ports of entry; a few will be disposed-of by already-established insects with which they cannot compete; others will slip through the net and become a recurring part of our environment.

Two Current Entomological Emergencies

We have heard of "killer bees" for years in films and on television, and the Africanized honeybee is now present in Florida. Taken from Africa to Brazil in the 1950s, they eventually swarmed through Central America and are now found throughout the southern regions of the United States and especially the southwest.

Slide 34

The Africanized bee is a significant threat to current European honeybees, which are used both for honey production and as America's pollinators. Africanized bees have the following undesirable characteristics:

- Highly aggressive to humans and to the milder European honeybees
- Relatively poor pollinators
- Relatively skimpy honey producers

This species should be considered established in America and possibly in Florida. Hive removal and destruction is an on-going process.

Although it does not receive the public attention of the so-called "killer bees," citrus greening or *huanglongbing* is a terrible and destructive threat to the future of citrus growing in Florida. It is found in Brazil, and in many countries in Asia and Africa. Citrus greening is caused by bacteria, which is spread by the invasive Asian citrus psyllid. Symptoms of greening include blotchy matter on the leaves, yellowing on trees and bitter, misshapen fruit. This exotic disease is potentially devastating to Florida's $9.13 billion citrus industry. The presence of the psyllid may be detected by notched or folded leaves.

Recent Interceptions

Slides 35-36

- The bark beetle *Chlorophorus strobilicola* was found in packages of scented pine cones from India, which were sold through mass merchants in December 2003. The USDA and Florida Department of Agriculture and Consumer Services (FDACS) issued a recall for all such infected product. The beetle is not yet known to be established here.

- The Mexican fruit fly *Anastrepha ludens* was found in Pinellas County in May 2004 lurking in Mexican Manzano peppers. This potentially

serious pest of citrus is not yet established in Florida. There are no known lures for baits and traps.

Recent Discoveries

- The brown citrus aphid carries a disease caused by citrus *tristeza* virus. Widespread around the world, it is blamed for the largest citrus emergency ever, when more than 16 million trees were destroyed in Brazil and Argentina in the '70s. It was originally found in Florida in November 1995 and is now known to be established.
- Originally a serious African pest, *Dieuches armatipes* feeds on peanuts, especially during the harvesting phase. It has been in Florida for nearly 10 years and has been found as far north as Alachua County. At this time, its distribution in Florida is not known.

Slides 37-44

- The cactus moth may have been in Florida for 15 years, spread north by hurricanes from the Caribbean where it is locally established. Because one of its primary foods is prickly pear, the moth is considered serious and threatens America's $70 million industry in ornamental cactus. It is spread via imported plants.
- *Myllocerus undatus* is an Asian gray weevil, probably native to Sri Lanka. Found established in September 2000, it preys on a variety of plants: sea grape, Turk's cap, upland cotton, hibiscus, crepe myrtle, peach, live oak and some palms.
- *Paratachardina lobata* was first reported in Florida in August 1999 on hibiscus and is considered established in south Florida. This polyphagous scale could be a serious problem for native woody plants. A sign of possible infestation is the presence of black sooty mold.
- The Mexican red rump tarantula is aggressive – or at least skittish. It was found in a Ft. Pierce citrus grove in 1996, probably discarded as an unwanted pet. Eradication efforts have so far failed and this tarantula is now considered locally established.

PART 5: TRULY BAD BUGS THAT ARE NOT HERE … YET!

Time: 5 minutes

Focus: Pests that affect other tropical and sub-tropical regions of the world

Sometimes it seems that Florida is overrun with exotic pests and indeed, it has its share. Nevertheless, here are the nine that we do not want!

- Suni Bug: *Eurygaster integriceps* may absolutely be the world's worst agricultural pest. It is astonishingly destructive of wheat, arguably the world's most important food crop. It is unlikely to be a problem in Florida even if it does make its way to the United States. Still, an insect of this genus has been intercepted in Florida on European tile.

- Soybean Aphid: *Aphis glycines* is an aphid species that was found in Minnesota in 2000. Since then it has been discovered as far south as Georgia. Florida's farmers plant about 20,000 acres in soybeans and it is a $3 million cash crop.

Slides 45-57

- Asian foxglove aphid: *Aulacorthum solani* is one aphid that is not yet found in the Western Hemisphere. It colonizes soybeans and many ornamentals, causing visible bright yellow damage. The aphid carries soybean dwarf virus, a persistent legume virus. Nursery plants and cut flowers may be hosts.

- Cottonseed bug: *Oxycarenus hyalinipennis*, a widespread Old World bug, is now established in the Caribbean.

- Potato psyllid: *Russelliana solanicola* is believed to serve as vector for a virus that has had serious effects in Peru. There, outbreaks cause severely crinkled leaves and weak, stunted plants, cutting the harvest by 60 percent.

- Asian longhorned beetle: *Anoplophora glabripennis* threatens a wide variety of hardwood trees (maple, elm, horsechestnut, ash, birch, poplar, willow and many more) in North America. Adults are large (0.75 - 1.50 inches long) with very long black and white banded antennae. The body is glossy black with irregular white spots. The beetle was introduced into New York City, Chicago and New Jersey, and is a very serious pest of hardwood trees. Adults can be seen from late spring to fall depending on the climate. Eradication involves quarantines, and cutting and burning large numbers of affected trees.

- Citrus longhorned beetle: One of the worst exotic wood-boring pests to enter the United States from Asia, *Anoplophora chinensis* has been found on bonsai trees for sale in Georgia and in Washington State. Host plants are numerous hardwoods and citrus, hibiscus, ficus, sycamore, willow, pear, oak, maple and Japanese red cedar. This beetle has no natural enemies in the Americas.

- African citrus psyllid: *Troiza erytreae Del Guercio* is one of the vectors for the bacteria that cause citrus greening and could have a potentially devastating effect on the Florida citrus industry.

- Sweet potato whitefly: *Bemisia tabachi* (Biotype Q), a small sap sucking insect in the same biological family as aphids, this whitefly specializes

in transmitting a virus to sweet potatoes and other vegetables, while others related to it are destructive in cotton. Occasional outbreaks have been reported in the Unite States since the 1800s and the bug is apparently increasingly resistant to pesticides. This whitefly biotype has now been reported from many of our southern states, but there are (as of 2006) no confirmed infestations in Florida.

Part 6: KEY RESOURCES

Time: 5 minutes

Focus: Identify key resources participants can easily access for additional information

This publication and other materials for SART training programs are available on the World Wide Web at www.flsart.org, the Web site of the Florida State Agricultural Response Team. Note: As new modules become available, they will be posted on the Web site.

United States Department of Agriculture (USDA) (www.usda.gov)
USDA, Animal and Plant Health Inspection Service, National Center for Import and Export (www.aphis.usda.gov/vs/ncie/)

Florida Department of Agriculture and Consumer Services (FDACS) (www.doacs.state.fl.us)
FDACS-Division of Plant Industry (www.doacs.state.fl.us/pi/)
FDACS Division of Animal Industry (www.doacs.state.fl.us/ai/)

Slides 58-59

Florida Agriculture Statistical Directory 2004 (www.florida-agriculture.com/pubs/pubform/pdf/Florida_Agriculture_Statistical_Directory_2004.pdf)

Bemesia pest alert issues by FDACS-DPI (www.doacs.state.fl.us/pi/enpp/ento/b.tabaci.html)

Florida Department of Agriculture Annual Report 2004 (www.florida-agriculture.com/pubs/puform/pdf/FDACS_Annual_Report_2004.pdf)

FDACS' Division of Marketing and Development Internet site provides information to agribusinesses and the general public about Florida agriculture (www.florida-agriculture.com)

Integrated Pest Management, IFAS Extension, University of Florida (http://ipm.ufl.edu/)

PART 7: SUMMARY, DISCUSSION & WRAP-UP

Time: 5 - 10 minutes

Focus: Review the learning objectives and encourage a commitment to SART

Slides 60-61

You and your audience have had a stimulating and practical 50 minutes, but your time together is almost over. Prior to answering any audience questions or comments, provide a summary to the participants of what they just learned:

1. Identification of some of the exotic insect pests currently present and those which pose a significant potential threat to Florida
2. The nature of the threat associated with exotic pests and the consequences of unchecked spread
3. Steps taken to ameliorate the effects of current exotic insect pest infestations and to prevent the introduction of additional threats
4. About key resources that can easily be accessed for additional information and assistance

Thank the audience for their attention and participation. Congratulate them for their commitment to the SART endeavor and on their desire to be part of the solution to entomological emergencies.

At this point, you may elect to have the participants take the Post-Test provided in the Resources section of this manual. Remember to review the answers to the test questions after all participants complete the test.

A content-specific Evaluation is provided in the Resources section of the manual. The generic Evaluation available in the *Toolkit for Implementing a Community-Based SART Training Event* can be utilized as well. As the presenter, you should decide which evaluation best meets the needs of your situation. Please have participants complete an evaluation at the conclusion of this module. Encourage participants to be as honest and forthright as possible as it helps you, the presenter, make adjustments as necessary for future presentations, which in turn benefits future participants.

PARTICIPANT EVALUATION

An Entomological Perspective for Emergency Agricultural Response

Please circle the number that best expresses your opinions about the following statements.

		Fully Disagree	Disagree	Neutral	Agree	Fully Agree
1.	The training unit's format was appropriate.	1	2	3	4	5
2.	The information presented is useful to me.	1	2	3	4	5
3.	The time it took to complete this module was acceptable.	1	2	3	4	5
4.	The reason Florida is considered a "sentinel state" are clear.	1	2	3	4	5
5.	The reasons that invasive insects can pose risks to agriculture were explained.	1	2	3	4	5
6.	The types of exotic insects – those present in Florida now, those intercepted at ports of entry and those that could pose an invasive threat – were adequately presented.	1	2	3	4	5
7.	The two basic types of response to invasive insects, eradication and management, were explained and an example given.	1	2	3	4	5
8.	What you should do or who you should contact if you recognize an unusual insect or plant damage that seems extra-ordinary was explained.	1	2	3	4	5
9.	Available up-to-date resources were clearly outlined.	1	2	3	4	5

We welcome your comments about this program:

Please use the back of this sheet for any further comments.
Thank you for your time.

PARTICIPANT PRE-TEST/POST-TEST

1. (True/False) Florida "SART" is a rescue team of trained dog handlers and crime scene investigators on-call following an emergency.

Slides 62-64

2. You might say that insects and man have a love-hate relationship – even though bugs may not be capable of feeling those emotions. Nevertheless, which of the following activities is actually beneficial to man?

a. pollination of plants
b. nature's recyclers
c. used in medical research
d. predation on other insects
e. all of the above are beneficial

3. Because of its sub-tropical climate, unusual geography as a peninsula pointing 300 miles from the mainland of North America to the heart of the tropics and accessibility for exotic imports, Florida is considered a "_____ State."

4. (True/False) The major source of new plant pests is from movement of plants by people.

5. An invasive plant pest such as the Africanized honeybee or pink hibiscus mealybug will be met with one of two control strategies. Can you name these two threat responses?

6. The on-going phase of an eradication effort aimed at an invasive exotic species, the continuing public effort before, during and following A. Survey, B. Organize-Regulate and C. Control is considered the _____.

7. Two current invasive threats that have potentially deadly and/or devastating consequences in Florida are _____ and _____.

8. Which of the following has not been identified yet in Florida?

a. Mexican fruit fly
b. Suni bug
c. Onion thrips
d. Mediterranean fruit fly

9. If you recognize an unusual insect or plant damage that seems extra-ordinary you should notify:

a. nobody – you're not an expert, so meddling will only take up the time of people who are doing serious work eliminating exotic pests
b. Ghost Busters
c. your County Agricultural Extension Service

d. the Department of Agriculture and Consumer Services consumer *Help Line* 888-397-1517.

10. Approximately how many described species of arthropods (insects, spiders, crustaceans, etc.) are there on earth? _____

TEST ANSWER KEY

1. False

Slide 65

2. (d) all of the above

3. A "Sentinel State"

4. True

5. Eradication or management

6. Public Relations

7. Africanized honeybees and citrus greening

8. Suni bug

9. c. or d. – your County Agricultural Extension Service or the DACS *Help Line* [1-888-397-1517] are acceptable.

10. About 1,000,000 (one million)

GLOSSARY

Slides 66-68

Agroterrorism: when any person knowingly or maliciously uses biological or chemical agents as weapons against the agriculture industry and food supply. It may also be thought of as the malicious use of plant or animal pathogens to cause disease in the agricultural sector – plants or animals.

Arthropod: Any organism belonging to the phylum *Arthropoda*, characterized by a segmented body, jointed legs, a digestive tract and, in most cases, a *chitinous* shell that is periodically molted to allow growth. Modern-day arthropods include spiders, insects, crustaceans, scorpions and horseshoe crabs.

Chitin: The tough, horny protein material similar to fingernails, it is a nitrogenous polysaccharide, which forms the exoskeleton of an insect.

Entomology: The study of insects, their life cycles, behavior, ecology, diversity and control.

Exotic: Not native, introduced from abroad.

Killer bees (Africanized honeybees): A strain of honeybees that originated in Brazil in the 1950s as a cross between an aggressive African bee and a European honeybee. These bees retain most of the traits of the African bee: highly aggressive, relatively poor pollinators and relatively poor honey producers.

Mesophyll: The photosynthetic tissue of a leaf located between the two outer leaf tissues.

Phloem: The food-conducting tissue of a plant, the “inner bark,” made up of sieve tubes, companion cells, phloem parenchyma, and fibers.

SART: The Florida State Agricultural Response Team, is a multi-agency coordination group consisting of governmental and private entities dedicated to all-hazard disaster preparedness, planning, response and recovery for the animal and agriculture sectors in Florida.

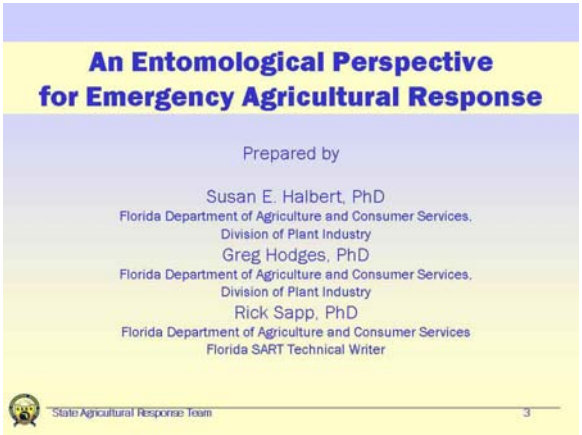
Siphunculi: A characteristic common to most aphids is the presence of two tubes, called *siphunculi*, on the back ends of their bodies. These *siphunculi* secrete defensive substances.

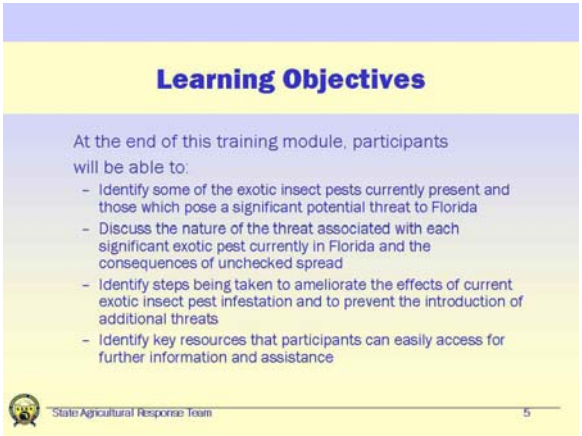
Stylets: Sharp appendages on an insect, used for piercing and sucking.

Xylem: The supporting layer of tissue in vascular plants that conducts water and nutrients from the roots to other parts of the plant.

PowerPoint Slides

Slides 1-6





PowerPoint Slides

Slides 7-12

Bugs Rule!
The Wide World of Arthropods

Insects, spiders, bees, cockroaches, butterflies .... Any invertebrate with a segmented body, jointed limbs and a mineralized shell covering

- Almost one million species
- Oldest was alive 350,000,000 years ago
- In the forest, almost 10,000/square foot or 425 million individual animals per acre
- Airborne collection has estimated 25 million per cubic mile
- Estimated of fly reproduction from one pair, April to August if none died = (191 million) x (1 trillion)
- A 5 mph locust swarm estimated 100 miles wide, 300 miles long, and more than ½-mile high

State Agricultural Response Team 7

Some are Beneficial to Man

- Beneficial
  - Honeybees and wild bees
  - Ladybug (larvae)
  - Praying mantis
  - Ambush bugs
  - Common lacewing (larvae)
  - Ground beetle
  - Robber flies
  - Predatory thrips
  - Tachinid flies
- Beneficial Activities
  - Decomposers/recyclers
  - Pollinators
  - Pest controllers
  - Food sources for other animals (or humans)
  - Products for humans
  - Medical research
  - Soil engineers

State Agricultural Response Team 8

Some are *NOT* Beneficial

- People pests
  Mosquitoes, fire ants, venomous spiders and hornets can injure and annoy people
- Plant pests
  Other insects threaten plants including plants that humans depend on for food

State Agricultural Response Team 9

Know the Difference

- It is critical to know the difference between beneficial insects and harmful pests

Pest - southern green stink bug

Beneficial - a predatory stink bug

State Agricultural Response Team 10

Major G…sts

- Scales & Mea…
- Aphids & Whit…
- Spider Mites
- Borers & Beet…
- Caterpillars &…

…nology Group, …aign

State Agricultural Respo… 11

Scales & Mealybugs

Scales & Mealybugs
- Host Range: Most generalists some specialists
- Sampling Methods: Visual inspection; look for crawlers every 7-10 days

Settled crawler of lobate lac scale

Lobate lac scale

Long-tailed mealybug

State Agricultural Response Team 12

PowerPoint Slides

Slides 13-18

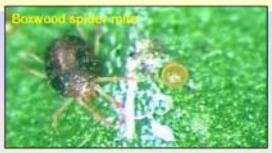
Aphids & Whiteflies

Aphids
- Damage: tips, leaves; watch for detectable sooty mold
- Sampling Methods: visual inspection 1-2x Per week
- Potential vector for disease

Whiteflies
- Host Range: some specialists, several generalists
- Sampling Methods: visual inspection every 7-10 days
- Potential vector for disease

Spider Mites

Spider Mites
- Damage: leaf chlorosis, defoliation
- Host Range: some specialists, several generalists
- Sampling Methods: tap leaves on paper 1-2x per week



Beetles & Borers

Borers
- 'Bore' into host trunk, stem, twig or root during life cycle
- Sampling Method: inspect trunk/branches for damage

Beetles
- Damage: foliage, fruit, roots; some wood-boring species
- Host Range: some generalists and specialists
- Sampling Method: inspect host and associated damage

Caterpillars & Thrips

Caterpillars
- Damage: foliae, stems, webs, tents
- Host Range: some generalists and specialists
- Sampling Methods: visually look for caterpillars associated with damage

Thrips
- Damage: foliage, flowers
- Sampling Methods: inspect foliage, flowers; tap flower heads; yellow and blue sticky traps
- Potential disease vector

Florida – A "Sentinel State"

- Florida is a "Sentinel State"
  - A constant invasion of exotic species
    - Not native to the Florida eco-system
    - Causes harm to or has potential to cause harm to the environment
  - Can be a native American species that has invaded a new area or crop or from Africa or Asia or even from another world!

Florida Entomological Emergencies

The major source of new plant pests is from movement of plants by people.

PowerPoint Slides

Slides 19-24

Emergency Responses
Eradication vs. Management

- Timely response needed to prevent further damage
- Response will depend on the nature of the new problem
  - Eradication vs. Management
- First choice is eradication, but there are *conditions*
  - Insect is not very mobile (some scales)
  - Good baits are available (fruit flies)
  - Insects are confined (as in a greenhouse)
  - Infestation is limited
- If eradication is not possible, then a management program is developed

Eradication Example
The 1997-98 Medfly Program

- Latest Mediterranean fruit fly or "medfly" in late May 1997
- Multiple outbreaks were involved
- Rapid response from survey crews
- Teams immediately organized
  - Unified Command and Area Command
  - Multiple agencies involved, so multi-agency coordination was needed
  - Public Information Officer (PIO) and a well-supervised public "Help Line" were very important
- The only alternative to eradication is to bag *individual fruits to prevent infection!*

Bagging individual peaches to prevent infection in Taiwan

Why the emergency?

Mediterranean fruit fly damage to grapefruit

Why the emergency?

An African fly.

Spread around the world. First known in Florida in 1929. Continuing eradication efforts prevent it from becoming established and destroying our citrus economy.

Grapefruit trees with fallen fruit were prime suspect locations indicating presence of destructive medflies.

Why the emergency?

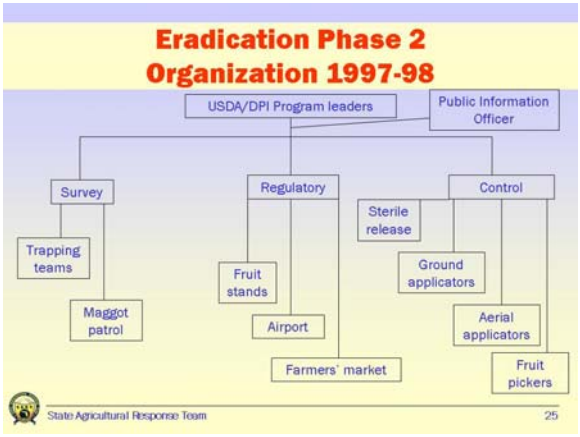
- One of Florida's largest agricultural commodities
- Florida produces 80% of all United States citrus.
- Total citrus production is 2nd in the world following Brazil.
  - 287 million boxes (15 million metric tons) of citrus
  - On-tree value (before value-added operations such as shipping and processing) about $879 million
  - Post value-added worth about $9.13 billion
- 90,000 jobs and 800,000 acres of cultivation in 32 counties; $39 million in *ad valorem* (property) taxes; and $900 million in taxes at all government levels

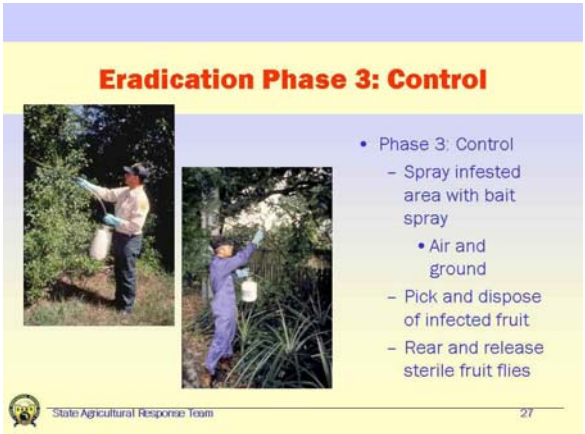
Eradication Phase 1: Survey

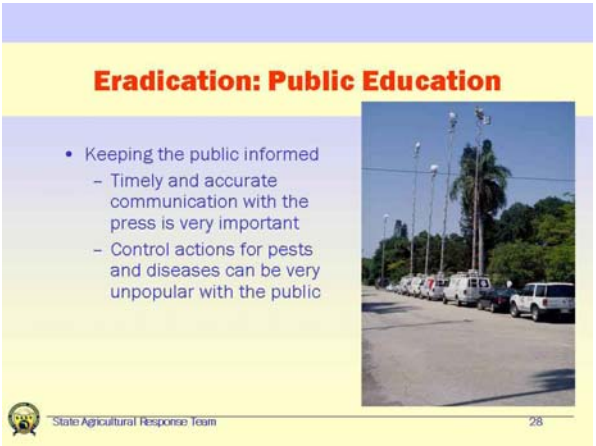
Phase 1: Survey groves and home yards, then plot finds on the map.

PowerPoint Slides

Slides 25-30







PowerPoint Slides

Slides 31-36

Not an Emergency, but a Management Dilemma

- Hibiscus a magnificent decorative flower, but is not economically significant
  - 200-220 varieties and grown throughout Florida
  - State flower of Hawaii; national flower of South Korea, Malaysia
  - Large, trumpet-shaped flowers in many colors: red, pink, yellow, blue, lavender, white, brown, gold and mixed

  - Unfortunately, this bug also attacks many Florida food crops!

Not an Emergency, but a Management Dilemma

- Damage from PHM feeding can be seen as "bunchy top" or distorted plant tissues
- Presence of white wax with pinkish mealybugs (pink eggs) are a good sign that PHM may be present
- Program is on-going
- Male pheromone traps now being used
- Geographical range of PHM is expanding as a result of the nursery trade
  - August 2004: Grower in Homestead, Florida accidentally ships PHM-infected plants to 30+ states
  - Confirmed presence in Kansas, Louisiana and North Carolina

Emergencies, Interceptions and Discoveries

Two of Florida's *Current* Entomological Emergencies

Citrus greening

- Spread by bacterium on Asian citrus psyllid: Effects are spot/sector yellowing, notched leaves, misshapen, bitter fruit: Potentially devastating to Florida's $9.13 billion citrus industry.

Africanized bees

- Originally from Africa Introduced to Americas in 1956: very aggressive, easily agitated, pursues ¼-mile to continue attack can easily kill. Present in Florida now.

Recent Interceptions

- *Chlorophorus strobilicola*
  - Found in scented pine cones from India
  - Packaged with potpourri, December 2003
  - Not known to be established

Recent Interceptions

- *Anastrepha ludens* (Mexican fruit fly)
  - With Manzano peppers originating from Mexico in May 2003 (Pinellas County)
  - Potential pest of citrus
  - No lures for this pest
  - Not known to be established

PowerPoint Slides

Slides 37-42

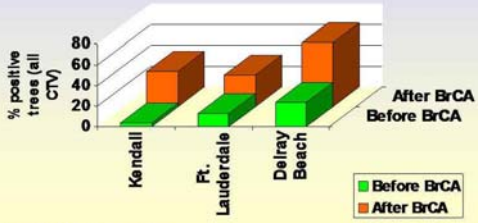
Exotics Recently Discovered In Florida: Brown Citrus Aphid

- Found in Florida November 1997
- Spreads citrus tristeza virus
- Occurrences of CTV have increased since the establishment of this exotic aphid

State Agricultural Response Team 37

Brown Citrus Aphid

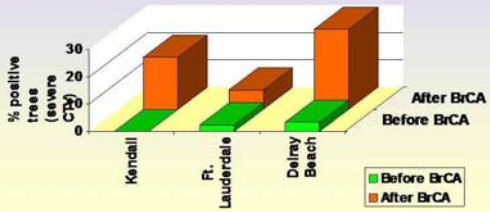
Overall CTV Occurrence in Southeast Florida
Before and After Brown Citrus Aphid



State Agricultural Response Team 38

Brown Citrus Aphid

Severe CTV in Southeast Florida
Before and After Brown Citrus Aphid



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Exotics Recently Discovered In Florida: *Dieuches armatipes*

- In Florida for about a decade
- Found as far north as Gainesville
- Serious peanut pest in Africa
- Pest status in Florida not known

State Agricultural Response Team 40

Exotics Recently Discovered In Florida: Cactus Moth

- In Florida for about 15 years, perhaps spread by hurricanes
- Threatens $70 million US cactus industry (and Mexico's, estimated $50-$100 million)
- Spread by transportation of infected plants

UF Associate Professor Jim Cuda studies cactus moth caterpillars on prickly pear. Moth has no natural predators in North America.

State Agricultural Response Team 41

Exotics Recently Discovered In Florida: *Myllocerus undatus*

- Weevil native to Sri Lanka
- Found established in September 2000
- Many hosts including sea grape, Turk's cap, upland cotton, peach, live oak and some palms

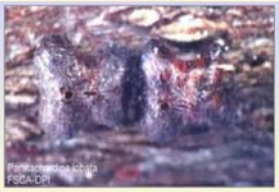
State Agricultural Response Team 42

PowerPoint Slides

Slides 43-48

Exotics Recently Discovered In Florida: Lobate Lac Scale

- *Paratachardina lobata*
- First reported in Florida in 1999 but already established
- Polyphagous scale
  - Could be a problem for native woody plants
- Sign of possible infestation is trees looking black from sooty mold



State Agricultural Response Team 43

Exotics Recently Discovered In Florida: Mexican Red-Rump Tarantula

- Established in a citrus grove in Ft. Pierce
- Unwanted pets probably were the source of the population

State Agricultural Response Team 44

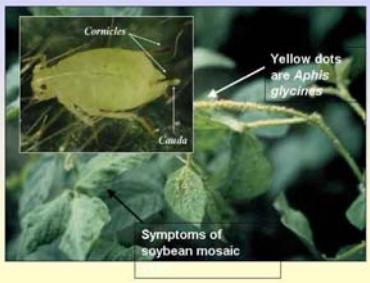
More Really Bad Bugs Suni Bug

- *Eurygaster integriceps*
- Absolutely the world's worst agricultural pest!
- Feeds on wheat, perhaps the world's most important food crop.
- Not found in western hemisphere … yet.
- Unlikely to be a problem in Florida, although an insect of this genus has been intercepted in Florida on European tile

State Agricultural Response Team 46

More Really Bad Bugs Soybean Aphid

- *Aphis glycines*
- Asian species
- Found in Minnesota in 2000
- Occurs as far south as Georgia



State Agricultural Response Team 47

More Really Bad Bugs Foxglove Aphid (Asian Strain)

- Not in Western Hemisphere
- Colonizes soybean plants and many ornamentals
- Causes bright yellow damage
- Transmits soybean dwarf virus, a persistent virus of legumes
- Possible hosts travel the world as cut flowers and nursery plants
- Aphids themselves do not invoke an automatic quarantine in many cases, especially if the species is already present in the US

State Agricultural Response Team 48

PowerPoint Slides

Slides 49-54

More Really Bad Bugs
Oxycarenus hyalinipennis

- Serious pest of cotton
- Established now in the Caribbean

State Agricultural Response Team 49

More Really Bad Bugs
Russelliana solanicola

- A potato psyllid
- Found in South America (Peru)
- Causes serious damage to potato
- Transmits a newly discovered plant pathogen

State Agricultural Response Team 50

More Really Bad Bugs
Asian Longhorn Beetle

- Established in Chicago and New York
- Discovered during an agricultural "stake-out"
- Eradication effort involves cutting down large trees in residential areas

State Agricultural Response Team 51

And *Even More* Really Bad Bugs
Citrus Longhorn Beetle

- Not established in United States, but intercepted on bonsai trees in Georgia and Washington
- Host plants are numerous hardwoods and *citrus* spp., hibiscus, *Ficus*, sycamore, willow, pear, oak, maple, Japanese red cedar, etc.

State Agricultural Response Team 52

And *Even More* Really Bad Bugs
Citrus Longhorn Beetle, ctd.

Signs of damage

- Emergence holes located on the lower trunk and exposed roots

Identification

- Adults 1-1.5" long, shiny black with white dots, rows of polished tubercles at base of front wings

State Agricultural Response Team 53

And *Even More* Really Bad Bugs
African Citrus Psyllid

- *Trioza erytreae*
- Not in Western Hemisphere
- Occurs in Africa and several islands in the Indian Ocean
- Is *the other* known vector of citrus greening disease
- Causes puckers in the leaves that look like an incipient scab infection

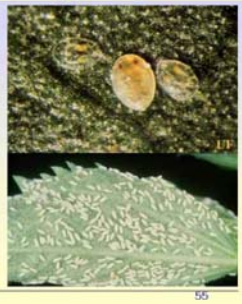
State Agricultural Response Team 54

PowerPoint Slides

Slides 55-60

And *Even More* Really Bad Bugs Bemisia tabaci, Biotype 'Q'

- *Bemisia tabaci* biotypes are prolific pests worldwide
- Occasional outbreaks reported in US in early 1800s
- In 1986 became economically important; listed as *Biotype B*
- March 2005, University of California and Arizona researchers identify *Biotype Q* on poinsettias
- Resistant to systemic pesticides and IGRs



State Agricultural Response Team 55

And *Even More* Really Bad Bugs Bemisia tabaci, Biotype 'Q' ctd.

- FDACS-Division of Plant Industry response

(1) Inquire with growers, "Are you having problems with white fly control? Do they seem to be resistant to systemics and IGRs?"

(2) Pest alert issued (see Resources)

(3) Samples identified at DPI – *Bemisia* or not?

(4) *Bemisia* samples sent to USDA collaborator for biotype identification

State Agricultural Response Team 56

A Take-Home Message...

Be aware!!

- Recognize plant damage you have not seen before
- Notice odd plant coloration, defoliation, fallen fruit, etc.

State Agricultural Response Team 57

Key Resources

- United States Department of Agriculture (USDA) www.usda.gov
- Florida Department of Agriculture and Consumer Services (FDACS) www.doacs.state.fl.us
- FDACS-Division of Plant Industry www.doacs.state.fl.us/pi/
- FDACS Division of Animal Industry www.doacs.state.fl.us/ai/
- Florida Agriculture Statistical Directory 2004 www.florida-agriculture.com/pubs/pubform/pdf/Florida Agriculture Statistical Directory 2004.pdf
- Bemesia pest alert issues by FDACS-DPI www.doacs.state.fl.us/pi/enpp/ento/b.tabaci.html

State Agricultural Response Team 58

Key Resources

- Florida Department of Agriculture Annual Report 2004 (www.florida-agriculture.com/pubs/puform/pdf/FDACS_Annual_Report_2004.pdf)
- FDACS' Division of Marketing and Development Internet site provides information to agribusinesses and the general public about Florida agriculture (www.florida-agriculture.com)
- USDA, Animal and Plant Health Inspection Service, National Center for Import and Export (www.aphis.usda.gov/vs/ncie/)
- Insecta Inspecta World (www.insecta-inspecta.com/bees/killer/)
- Florida State Agricultural Response Team (www.flsart.com)
- Integrated Pest Management, IFAS Extension, University of Florida (http://ipm.ufl.edu/)

State Agricultural Response Team 59

Florida and The World

State Agricultural Response Team 60

PowerPoint Slides

Slides 61-66

Working Together To Protect Florida's Agriculture & Way of Life

Thank You!

State Agricultural Response Team 61

Now, Test Your Knowledge and Awareness (1 of 3)

1. (True/False) Florida "SART" is a rescue team of trained dog handlers and crime scene investigators on-call following an emergency.
2. You might say that insects and man have a love-hate relationship – even though bugs may not be capable of feeling those emotions. Nevertheless, which of the following activities is actually beneficial to man?
   a. pollination of plants
   b. nature's recyclers
   c. used in medical research
   d. predation on other insects
   e. all of the above are beneficial
3. Because of its sub-tropical climate, unusual geography as a peninsula pointing 300 miles from the mainland of North America to the heart of the tropics and accessibility for exotic imports, Florida is considered a "_____ State."

State Agricultural Response Team 62

Pre/Post Test (2 of 3)

4. (True/False) The major source of new plant pests is from movement of plants by people.
5. An invasive plant pest such as the Africanized honeybee or pink hibiscus mealybug will be met with one of two control strategies. Name these two threat responses.
6. The on-going phase of an eradication effort aimed at an invasive exotic species, the continuing public effort before, during and following A. Survey, B. Organize and Regulate and C. Control is _____.
7. Two current invasive threats that have potentially deadly and/or devastating consequences in Florida are _____ and _____.
8. Which of the following has not been identified yet in Florida?
   A. Mexican fruit fly B. Suni bug C. Onion thrips D. Mediterranean fruit fly

State Agricultural Response Team 63

Pre/Post Test (3 of 3)

9. If you recognize an unusual insect or plant damage that seems extra-ordinary you should notify:
   a. nobody – you're not an expert and your meddling will only take up the time of people who are involved in serious work to eliminate exotic pests
   b. Ghost Busters
   c. your County Agricultural Extension Service
   d. the Department of Agriculture and Consumer Services consumer *Help Line* 888-397-1517.
10. Approximately how many species of arthropods (insects, spiders, crustaceans, etc.) are there on earth?

State Agricultural Response Team 64

Test Answer Key

1. False
2. (d) all of the above
3. a "Sentinel State"
4. True
5. Eradication or management
6. Public Relations
7. Africanized honeybees and citrus greening
8. Suni bug
9. c. or d. – your County Agricultural Extension Service or the DACS *Help Line* [1-888-397-1517] are acceptable.
10. About 1,000,000

State Agricultural Response Team 65

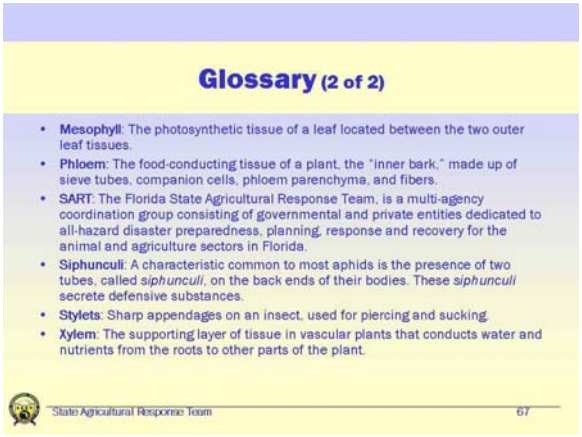
Glossary (1 of 2)

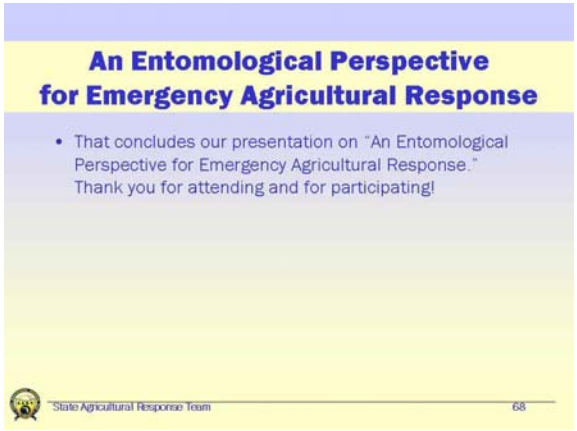
- **Agroterrorism**: When any person knowingly or maliciously uses biological or chemical agents as weapons against the agriculture industry and food supply. It may also be thought of as the malicious use of plant or animal pathogens to cause disease in the agricultural sector – plants or animals.
- **Arthropod**: Any organism belonging to the phylum *Arthropoda*, characterized by a segmented body, jointed legs, a digestive tract and, in most cases, a *chitinous* shell that is periodically molted to allow growth. Modern-day arthropods include spiders, insects, crustaceans, scorpions and horseshoe crabs.
- **Chitin**: The tough, horny protein material similar to fingernails, it is a nitrogenous polysaccharide, which forms the exoskeleton of an insect.
- **Entomology**: The study of insects: life cycle, behavior, ecology, diversity, control.
- **Exotic**: Not native, introduced from abroad.
- **Killer bees** (Africanized honeybees): A strain of honeybees that originated in Brazil in the 1950s, a cross between an aggressive African bee and a European honeybee. These bees retain most of the African traits: highly aggressive, relatively poor pollinators and poor honey producers.

State Agricultural Response Team 66

PowerPoint Slides

Slides 67-68





PowerPoint Slides – Handout Pages

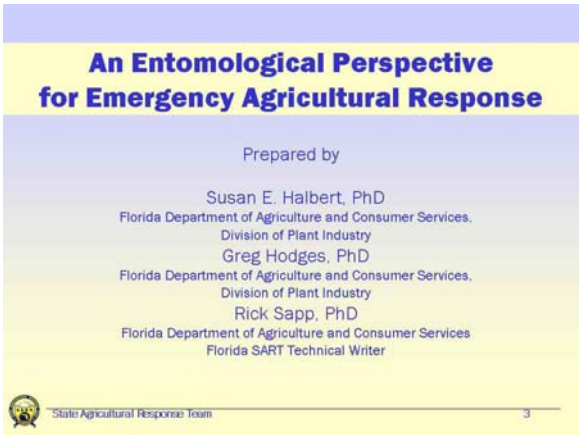
The slides for *An Entomological Perspective for Emergency Agricultural Response* are reproduced on the following pages at reduced size with space for participant notes.

These slides are also included in the participant workbook, available on the web at: www.flsart.org.

Slides 1-3


STATE AGRICULTURAL RESPONSE TEAM
S. A. R. T.
FLORIDA


An Entomological Perspective
for Emergency Agricultural Response
State Agricultural Response Team
2


An Entomological Perspective
for Emergency Agricultural Response
Prepared by
Susan E. Halbert, PhD
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State Agricultural Response Team
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Slides 4-6

Acknowledgements

- Photos
  - Jeff Lotz, Gary Steck, Steve Garnsey, Julieta Brambila, Paul Skelley, Avas Hamon, Susan Halbert, Russ Mizell, Jim Cuda
  - USDA: APHIS, Forest Service
  - FDACS-DPI, SPDN/NPDN
  - University of Florida/IFAS, University of Georgia, University of Illinois at Urbana-Champaign (Beckman Institute)
  - Virginia Cooperative Extension Service, Pennsylvania Dept. of Agriculture, Washington State Dept. of Agriculture, Minnesota Dept. of Agriculture
  - Wikipedia: The Free Encyclopedia
  - Orkin, Inc.

State Agricultural Response Team 4

Learning Objectives

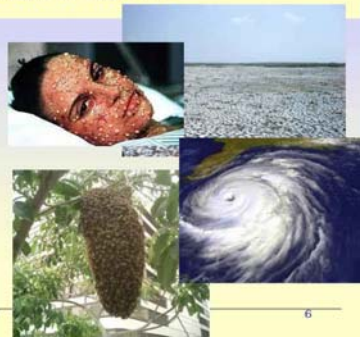
At the end of this training module, participants will be able to:

- Identify some of the exotic insect pests currently present and those which pose a significant potential threat to Florida
- Discuss the nature of the threat associated with each significant exotic pest currently in Florida and the consequences of unchecked spread
- Identify steps being taken to ameliorate the effects of current exotic insect pest infestation and to prevent the introduction of additional threats
- Identify key resources that participants can easily access for further information and assistance

State Agricultural Response Team 5

What is SART?

- Multi-agency coordination
  - Governmental and private
  - All-hazard preparation, response and recovery
  - Animal and agricultural



State Agricultural Response Team 6

Slides 7-9

Bugs Rule!
The Wide World of Arthropods

Insects, spiders, bees, cockroaches, butterflies .... Any invertebrate with a segmented body, jointed limbs and a mineralized shell covering

- Almost one million species
- Oldest was alive 350,000,000 years ago
- In the forest, almost 10,000/square foot or 425 million individual animals per acre
- Airborne collection has estimated 25 million per cubic mile
- Estimated of fly reproduction from one pair, April to August if none died = (191 million) x (1 trillion)
- A 5 mph locust swarm estimated 100 miles wide, 300 miles long, and more than ½-mile high


A rare Florida purplewing

State Agricultural Response Team 7

Some are Beneficial to Man

- Beneficial
  - Honeybees and wild bees
  - Ladybug (larvae)
  - Praying mantis
  - Ambush bugs
  - Common lacewing (larvae)
  - Ground beetle
  - Robber flies
  - Predatory thrips
  - Tachinid flies
- Beneficial Activities
  - Decomposers/recyclers
  - Pollinators
  - Pest controllers
  - Food sources for other animals (or humans)
  - Products for humans
  - Medical research
  - Soil engineers

State Agricultural Response Team 8

Some are *NOT* Beneficial

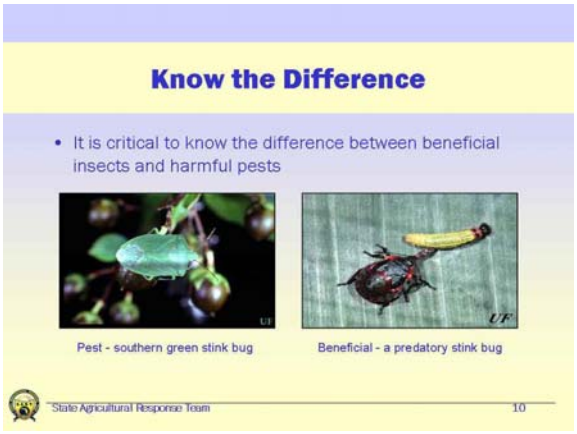
- People pests
  Mosquitoes, fire ants, venomous spiders and hornets can injure and annoy people
- Plant pests
  Other insects threaten plants including plants that humans depend on for food


Black Widow Spider


Wheat Aphid

State Agricultural Response Team 9

Slides 10-12


Know the Difference
• It is critical to know the difference between beneficial insects and harmful pests
Pest - southern green stink bug
Beneficial - a predatory stink bug
State Agricultural Response Team
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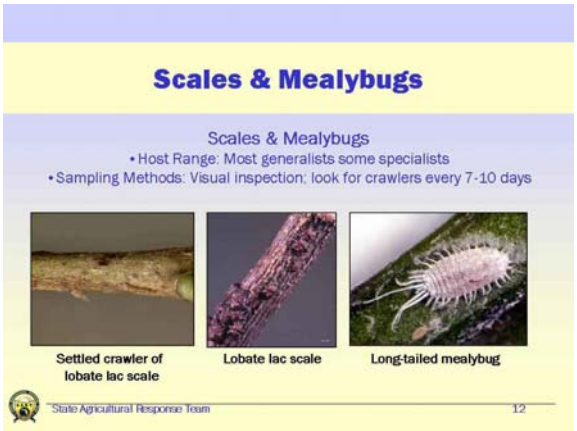
Bug Invasion
• Scales & Mea
• Aphids & Whit
• Spider Mites
• Borers & Beet
• Caterpillars &
11


Scales & Mealybugs
Scales & Mealybugs
• Host Range: Most generalists some specialists
• Sampling Methods: Visual inspection; look for crawlers every 7-10 days
Settled crawler of lobate lac scale
Lobate lac scale
Long-tailed mealybug
State Agricultural Response Team
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Slides 13-15


Aphids & Whiteflies
Aphids
• Damage: tips, leaves; watch for detectable sooty mold
• Sampling Methods: visual inspection 1-2x Per week
• Potential vector for disease
Green peach aphid
Wingless and winged forms
Whiteflies
• Host Range: some specialists, several generalists
• Sampling Methods: visual inspection every 7-10 days
• Potential vector for disease
State Agricultural Response Team
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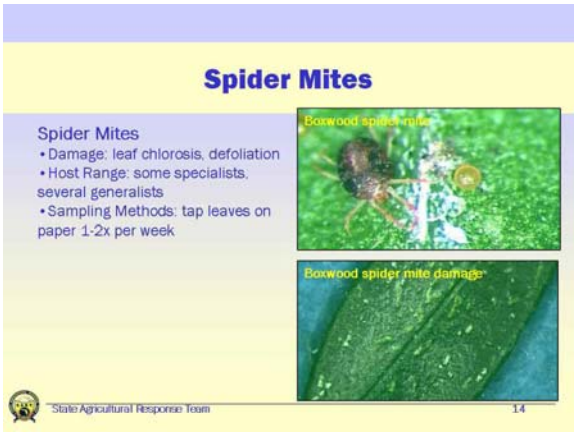
Spider Mites
Spider Mites
• Damage: leaf chlorosis, defoliation
• Host Range: some specialists, several generalists
• Sampling Methods: tap leaves on paper 1-2x per week
Boxwood spider mite
Boxwood spider mite damage
State Agricultural Response Team
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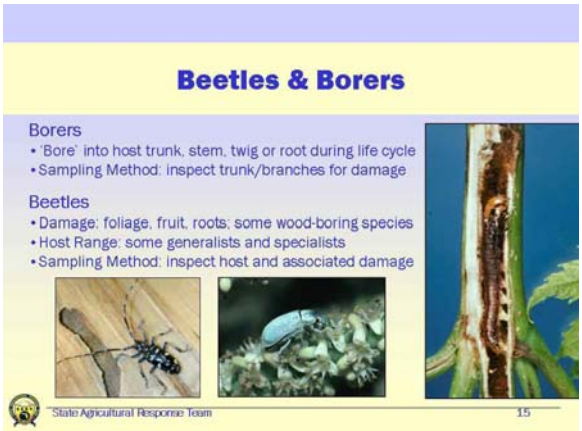
Beetles & Borers
Borers
• 'Bore' into host trunk, stem, twig or root during life cycle
• Sampling Method: inspect trunk/branches for damage
Beetles
• Damage: foliage, fruit, roots; some wood-boring species
• Host Range: some generalists and specialists
• Sampling Method: inspect host and associated damage
State Agricultural Response Team
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Slides 16-18

Caterpillars & Thrips

Caterpillars
- Damage: foliae, stems, webs, tents
- Host Range: some generalists and specialists
- Sampling Methods: visually look for caterpillars associated with damage

Thrips
- Damage: foliage, flowers
- Sampling Methods: inspect foliage, flowers; tap flower heads; yellow and blue sticky traps
- Potential disease vector

Florida – A "Sentinel State"

- Florida is a "Sentinel State"
  - A constant invasion of exotic species
    - Not native to the Florida eco-system
    - Causes harm to or has potential to cause harm to the environment
  - Can be a native American species that has invaded a new area or crop or from Africa or Asia or even from another world!

Florida Entomological Emergencies

The major source of new plant pests is from movement of plants by people.

Slides 19-21

Emergency Responses
Eradication vs. Management

- Timely response needed to prevent further damage
- Response will depend on the nature of the new problem
  - Eradication vs. Management
- First choice is eradication, but there are *conditions*
  - Insect is not very mobile (some scales)
  - Good baits are available (fruit flies)
  - Insects are confined (as in a greenhouse)
  - Infestation is limited
- If eradication is not possible, then a management program is developed

Eradication Example
The 1997-98 Medfly Program

- Latest Mediterranean fruit fly or "medfly" in late May 1997
- Multiple outbreaks were involved
- Rapid response from survey crews
- Teams immediately organized
  - Unified Command and Area Command
  - Multiple agencies involved, so multi-agency coordination was needed
  - Public Information Officer (PIO) and a well-supervised public "Help Line" were very important
- The only alternative to eradication is to bag *individual fruits to prevent infection!*

Why the emergency?

Mediterranean fruit fly damage to grapefruit

Slides 22-24

Why the emergency?

An African fly.
Spread around the world. First known in Florida in 1929. Continuing eradication efforts prevent it from becoming established and destroying our citrus economy.
Grapefruit trees with fallen fruit were prime suspect locations indicating presence of destructive medflies.

State Agricultural Response Team 22

Why the emergency?

- One of Florida's largest agricultural commodities
- Florida produces 80% of all United States citrus.
- Total citrus production is 2nd in the world following Brazil.
  - 287 million boxes (15 million metric tons) of citrus
  - On-tree value (before value-added operations such as shipping and processing) about $879 million
  - Post value-added worth about $9.13 billion
- 90,000 jobs and 800,000 acres of cultivation in 32 counties; $39 million in *ad valorem* (property) taxes; and $900 million in taxes at all government levels

State Agricultural Response Team 23

Eradication Phase 1: Survey

Phase 1: Survey groves and home yards, then plot finds on the map.

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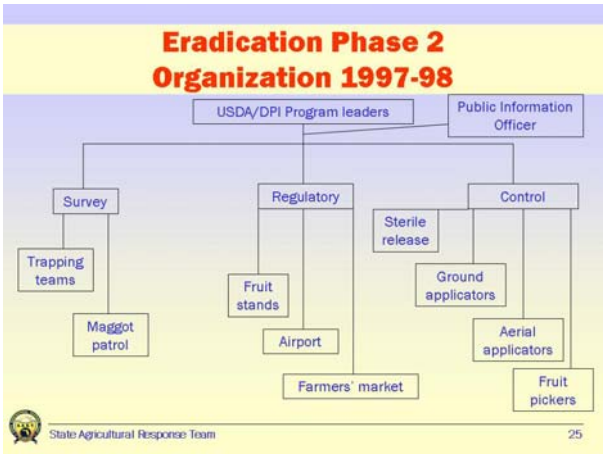
Slides 25-27


Eradication Phase 2
Organization 1997-98
USDA/DPI Program leaders
Public Information Officer
Survey
Regulatory
Control
Sterile release
Trapping teams
Fruit stands
Ground applicators
Maggot patrol
Airport
Aerial applicators
Farmers' market
Fruit pickers
State Agricultural Response Team
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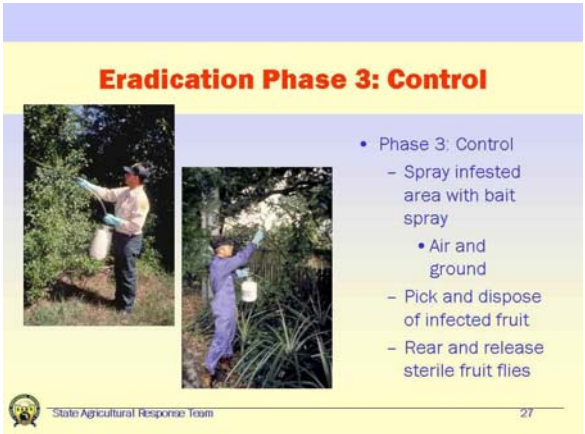
Eradication Phase 3: Control
• Phase 3: Control
– Spray infested area with bait spray
• Air and ground
– Pick and dispose of infected fruit
– Rear and release sterile fruit flies
State Agricultural Response Team
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Slides 28-30

Eradication: Public Education

- Keeping the public informed
  - Timely and accurate communication with the press is very important
  - Control actions for pests and diseases can be very unpopular with the public

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Eradication Success!

The program was successful.

No additional non-sterile medflies have been found in Florida since 1998.

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Management Example
Pink Hibiscus Mealybug

- Pink hibiscus mealybug (PHM) has been a major pest in the Caribbean basin
- PHM appeared in Florida in June 2002
- No eradication attempt was made
- Biological controls of PHM are determined to work well

State Agricultural Response Team 30

Slides 31-33

Not an Emergency, but a Management Dilemma

- Hibiscus a magnificent decorative flower, but is not economically significant
  - 200-220 varieties and grown throughout Florida
  - State flower of Hawaii; national flower of South Korea, Malaysia
  - Large, trumpet-shaped flowers in many colors: red, pink, yellow, blue, lavender, white, brown, gold and mixed

  - Unfortunately, this bug also attacks many Florida food crops!

State Agricultural Response Team 31

Not an Emergency, but a Management Dilemma

- Damage from PHM feeding can be seen as "bunchy top" or distorted plant tissues
- Presence of white wax with pinkish mealybugs (pink eggs) are a good sign that PHM may be present
- Program is on-going
- Male pheromone traps now being used
- Geographical range of PHM is expanding as a result of the nursery trade
  - August 2004: Grower in Homestead, Florida accidentally ships PHM-infected plants to 30+ states
  - Confirmed presence in Kansas, Louisiana and North Carolina

State Agricultural Response Team 32

Emergencies, Interceptions and Discoveries

State Agricultural Response Team 33

Slides 34-36

Two of Florida's *Current* Entomological Emergencies

Citrus greening

- Spread by bacterium on Asian citrus psyllid: Effects are spot/sector yellowing, notched leaves, misshapen, bitter fruit: Potentially devastating to Florida's $9.13 billion citrus industry.

Africanized bees

- Originally from Africa Introduced to Americas in 1956: very aggressive, easily agitated, pursues ¼-mile to continue attack can easily kill. Present in Florida now.

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Recent Interceptions

- *Chlorophorus strobilicola*
  - Found in scented pine cones from India
  - Packaged with potpourri, December 2003
  - Not known to be established

State Agricultural Response Team 35

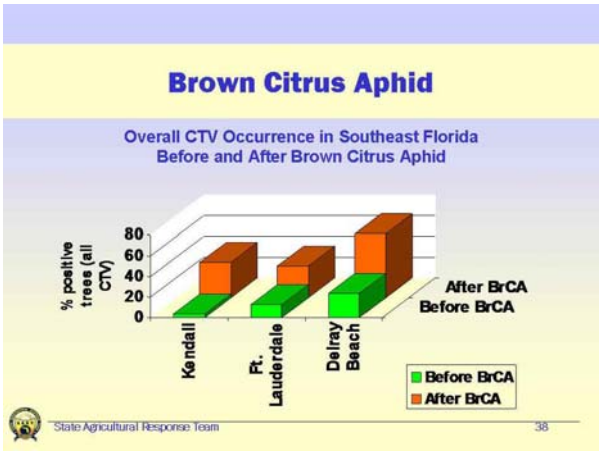
Recent Interceptions

- *Anastrepha ludens* (Mexican fruit fly)
  - With Manzano peppers originating from Mexico in May 2003 (Pinellas County)
  - Potential pest of citrus
  - No lures for this pest
  - Not known to be established

State Agricultural Response Team 36

Slides 37-39


Exotics Recently Discovered
In Florida: Brown Citrus Aphid
• Found in Florida November 1997
• Spreads citrus tristeza virus
• Occurrences of CTV have increased since the establishment of this exotic aphid
State Agricultural Response Team
37


Brown Citrus Aphid
Overall CTV Occurrence in Southeast Florida
Before and After Brown Citrus Aphid
% positive trees (all CTV)
80
60
40
20
0
Kendall
Ft. Lauderdale
Delray Beach
After BrCA
Before BrCA
Before BrCA
After BrCA
State Agricultural Response Team
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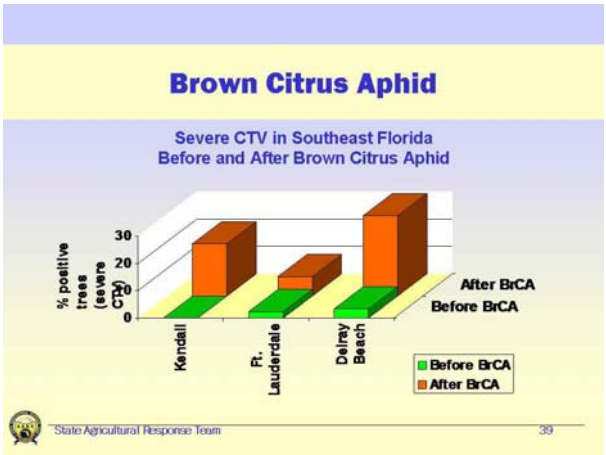
Brown Citrus Aphid
Severe CTV in Southeast Florida
Before and After Brown Citrus Aphid
% positive trees (severe CTV)
30
20
10
0
Kendall
Ft. Lauderdale
Delray Beach
After BrCA
Before BrCA
Before BrCA
After BrCA
State Agricultural Response Team
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Slides 40-42

Exotics Recently Discovered In Florida: *Dieuches armatipes*

- In Florida for about a decade
- Found as far north as Gainesville
- Serious peanut pest in Africa
- Pest status in Florida not known

State Agricultural Response Team 40

Exotics Recently Discovered In Florida: Cactus Moth

- In Florida for about 15 years, perhaps spread by hurricanes
- Threatens $70 million US cactus industry (and Mexico's, estimated $50-$100 million)
- Spread by transportation of infected plants

UF Associate Professor Jim Cuda studies cactus moth caterpillars on prickly pear. Moth has no natural predators in North America.

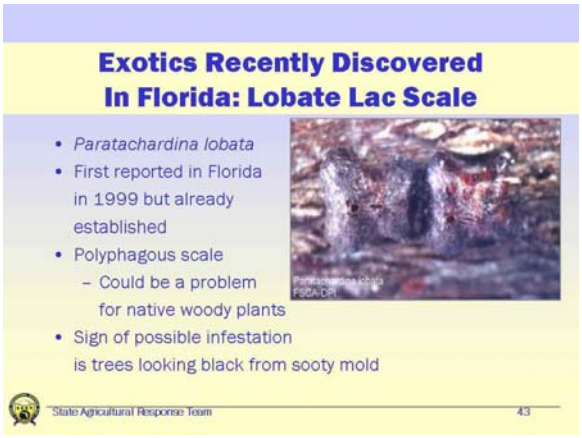
State Agricultural Response Team 41

Exotics Recently Discovered In Florida: *Myllocerus undatus*

- Weevil native to Sri Lanka
- Found established in September 2000
- Many hosts including sea grape, Turk's cap, upland cotton, peach, live oak and some palms

State Agricultural Response Team 42

Slides 43-45


Exotics Recently Discovered
In Florida: Lobate Lac Scale
• Paratachardina lobata
• First reported in Florida in 1999 but already established
• Polyphagous scale
– Could be a problem for native woody plants
• Sign of possible infestation is trees looking black from sooty mold
FSCA-DPI
State Agricultural Response Team
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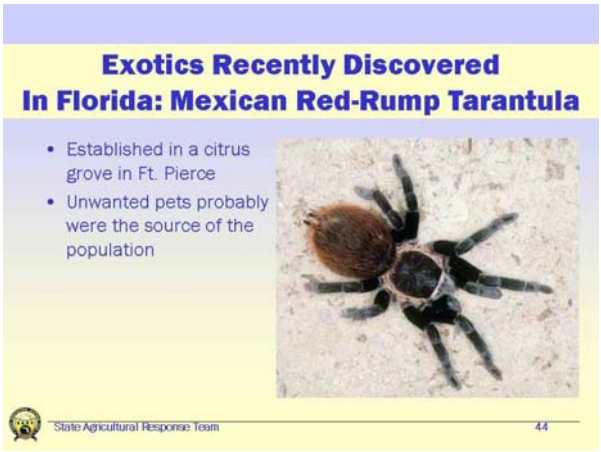
Exotics Recently Discovered
In Florida: Mexican Red-Rump Tarantula
• Established in a citrus grove in Ft. Pierce
• Unwanted pets probably were the source of the population
State Agricultural Response Team
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Slides 46-48

More Really Bad Bugs
Suni Bug

- *Eurygaster integriceps*
- Absolutely the world's worst agricultural pest!
- Feeds on wheat, perhaps the world's most important food crop.
- Not found in western hemisphere … yet.
- Unlikely to be a problem in Florida, although an insect of this genus has been intercepted in Florida on European tile

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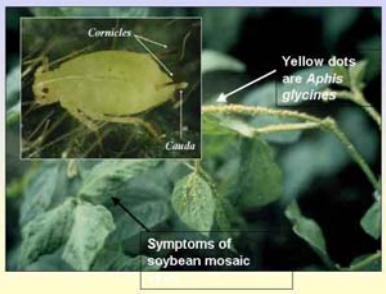
More Really Bad Bugs
Soybean Aphid

- *Aphis glycines*
- Asian species
- Found in Minnesota in 2000
- Occurs as far south as Georgia



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More Really Bad Bugs
Foxglove Aphid (Asian Strain)

- Not in Western Hemisphere
- Colonizes soybean plants and many ornamentals
- Causes bright yellow damage
- Transmits soybean dwarf virus, a persistent virus of legumes
- Possible hosts travel the world as cut flowers and nursery plants
- Aphids themselves do not invoke an automatic quarantine in many cases, especially if the species is already present in the US

State Agricultural Response Team 48

Slides 49-51


More Really Bad Bugs
Oxycarenus hyalinipennis
• Serious pest of cotton
• Established now in the Caribbean
State Agricultural Response Team
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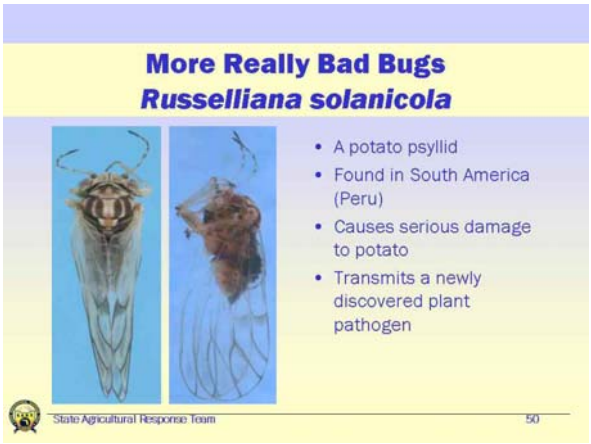

More Really Bad Bugs
Russelliana solanicola
• A potato psyllid
• Found in South America (Peru)
• Causes serious damage to potato
• Transmits a newly discovered plant pathogen
State Agricultural Response Team
50


More Really Bad Bugs
Asian Longhorn Beetle
• Established in Chicago and New York
• Discovered during an agricultural "stake-out"
• Eradication effort involves cutting down large trees in residential areas
State Agricultural Response Team
51

Slides 52-54

And *Even More* Really Bad Bugs
Citrus Longhorn Beetle

- Not established in United States, but intercepted on bonsai trees in Georgia and Washington
- Host plants are numerous hardwoods and *citrus* spp., hibiscus, *Ficus*, sycamore, willow, pear, oak, maple, Japanese red cedar, etc.

State Agricultural Response Team 52

And *Even More* Really Bad Bugs
Citrus Longhorn Beetle, ctd.

Signs of damage
- Emergence holes located on the lower trunk and exposed roots

Identification
- Adults 1-1.5" long, shiny black with white dots, rows of polished tubercles at base of front wings

State Agricultural Response Team 53

And *Even More* Really Bad Bugs
African Citrus Psyllid

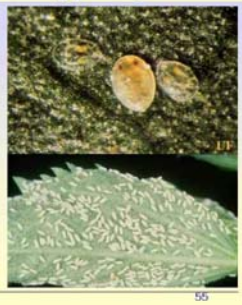
- *Trioza erytreae*
- Not in Western Hemisphere
- Occurs in Africa and several islands in the Indian Ocean
- Is *the other* known vector of citrus greening disease
- Causes puckers in the leaves that look like an incipient scab infection

State Agricultural Response Team 54

Slides 55-57

And *Even More* Really Bad Bugs
Bemisia tabaci, Biotype 'Q'

- *Bemisia tabaci* biotypes are prolific pests worldwide
- Occasional outbreaks reported in US in early 1800s
- In 1986 became economically important; listed as *Biotype B*
- March 2005, University of California and Arizona researchers identify *Biotype Q* on poinsettias
- Resistant to systemic pesticides and IGRs



State Agricultural Response Team 55

And *Even More* Really Bad Bugs
Bemisia tabaci, Biotype 'Q' ctd.

- FDACS-Division of Plant Industry response

  (1) Inquire with growers, "Are you having problems with white fly control? Do they seem to be resistant to systemics and IGRs?"

  (2) Pest alert issued (see Resources)

  (3) Samples identified at DPI – *Bemisia* or not?

  (4) *Bemisia* samples sent to USDA collaborator for biotype identification

State Agricultural Response Team 56

A Take-Home Message...

Be aware!!

- Recognize plant damage you have not seen before
- Notice odd plant coloration, defoliation, fallen fruit, etc.

State Agricultural Response Team 57

Slides 58-60

Key Resources

- United States Department of Agriculture (USDA)
  www.usda.gov
- Florida Department of Agriculture and Consumer Services (FDACS)
  www.doacs.state.fl.us
- FDACS-Division of Plant Industry
  www.doacs.state.fl.us/pi/
- FDACS Division of Animal Industry
  www.doacs.state.fl.us/ai/
- Florida Agriculture Statistical Directory 2004
  www.florida-agriculture.com/pubs/pubform/pdf/Florida Agriculture Statistical Directory 2004.pdf
- Bemesia pest alert issues by FDACS-DPI
  www.doacs.state.fl.us/pi/enpp/ento/b.tabaci.html

State Agricultural Response Team 58

Key Resources

- Florida Department of Agriculture Annual Report 2004
  (www.florida-agriculture.com/pubs/puform/pdf/FDACS_Annual_Report_2004.pdf)
- FDACS' Division of Marketing and Development Internet site provides information to agribusinesses and the general public about Florida agriculture (www.florida-agriculture.com)
- USDA, Animal and Plant Health Inspection Service, National Center for Import and Export (www.aphis.usda.gov/vs/ncie/)
- Insecta Inspecta World (www.insecta-inspecta.com/bees/killer/)
- Florida State Agricultural Response Team (www.flsart.com)
- Integrated Pest Management, IFAS Extension, University of Florida (http://ipm.ufl.edu/)

State Agricultural Response Team 59

Florida and The World

State Agricultural Response Team 60

Slides 61-63

Working Together To Protect Florida's Agriculture & Way of Life

Thank You!

State Agricultural Response Team 61

Now, Test Your Knowledge and Awareness (1 of 3)

1. (True/False) Florida "SART" is a rescue team of trained dog handlers and crime scene investigators on-call following an emergency.
2. You might say that insects and man have a love-hate relationship – even though bugs may not be capable of feeling those emotions. Nevertheless, which of the following activities is actually beneficial to man?
   a. pollination of plants
   b. nature's recyclers
   c. used in medical research
   d. predation on other insects
   e. all of the above are beneficial
3. Because of its sub-tropical climate, unusual geography as a peninsula pointing 300 miles from the mainland of North America to the heart of the tropics and accessibility for exotic imports, Florida is considered a "_____ State."

State Agricultural Response Team 62

Pre/Post Test (2 of 3)

4. (True/False) The major source of new plant pests is from movement of plants by people.
5. An invasive plant pest such as the Africanized honeybee or pink hibiscus mealybug will be met with one of two control strategies. Name these two threat responses.
6. The on-going phase of an eradication effort aimed at an invasive exotic species, the continuing public effort before, during and following A. Survey, B. Organize and Regulate and C. Control is _____.
7. Two current invasive threats that have potentially deadly and/or devastating consequences in Florida are _____ and _____.
8. Which of the following has not been identified yet in Florida?
   A. Mexican fruit fly B. Suni bug C. Onion thrips D. Mediterranean fruit fly

State Agricultural Response Team 63

Slides 64-66

Pre/Post Test (3 of 3)

9. If you recognize an unusual insect or plant damage that seems extra-ordinary you should notify:
   a. nobody – you're not an expert and your meddling will only take up the time of people who are involved in serious work to eliminate exotic pests
   b. Ghost Busters
   c. your County Agricultural Extension Service
   d. the Department of Agriculture and Consumer Services consumer *Help Line* 888-397-1517.
10. Approximately how many species of arthropods (insects, spiders, crustaceans, etc.) are there on earth?

State Agricultural Response Team 64

Test Answer Key

1. False
2. (d) all of the above
3. a "Sentinel State"
4. True
5. Eradication or management
6. Public Relations
7. Africanized honeybees and citrus greening
8. Suni bug
9. c. or d. – your County Agricultural Extension Service or the DACS *Help Line* [1-888-397-1517] are acceptable.
10. About 1,000,000

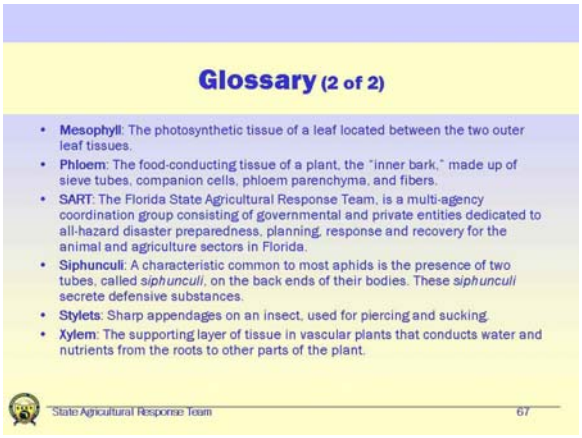
State Agricultural Response Team 65

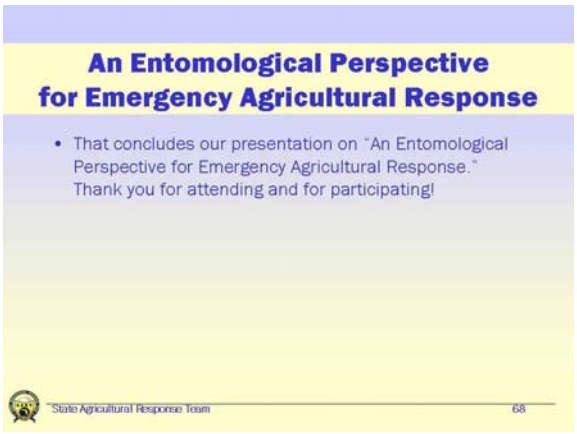
Glossary (1 of 2)

- **Agroterrorism**: When any person knowingly or maliciously uses biological or chemical agents as weapons against the agriculture industry and food supply. It may also be thought of as the malicious use of plant or animal pathogens to cause disease in the agricultural sector – plants or animals.
- **Arthropod**: Any organism belonging to the phylum *Arthropoda*, characterized by a segmented body, jointed legs, a digestive tract and, in most cases, a *chitinous* shell that is periodically molted to allow growth. Modern-day arthropods include spiders, insects, crustaceans, scorpions and horseshoe crabs.
- **Chitin**: The tough, horny protein material similar to fingernails, it is a nitrogenous polysaccharide, which forms the exoskeleton of an insect.
- **Entomology**: The study of insects: life cycle, behavior, ecology, diversity, control.
- **Exotic**: Not native, introduced from abroad.
- **Killer bees** (Africanized honeybees): A strain of honeybees that originated in Brazil in the 1950s, a cross between an aggressive African bee and a European honeybee. These bees retain most of the African traits: highly aggressive, relatively poor pollinators and poor honey producers.

State Agricultural Response Team 66

Slides 67-68


Glossary (2 of 2)
Mesophyll: The photosynthetic tissue of a leaf located between the two outer leaf tissues.
Phloem: The food-conducting tissue of a plant, the "inner bark," made up of sieve tubes, companion cells, phloem parenchyma, and fibers.
SART: The Florida State Agricultural Response Team, is a multi-agency coordination group consisting of governmental and private entities dedicated to all-hazard disaster preparedness, planning, response and recovery for the animal and agriculture sectors in Florida.
Siphunculi: A characteristic common to most aphids is the presence of two tubes, called siphunculi, on the back ends of their bodies. These siphunculi secrete defensive substances.
Stylets: Sharp appendages on an insect, used for piercing and sucking.
Xylem: The supporting layer of tissue in vascular plants that conducts water and nutrients from the roots to other parts of the plant.
State Agricultural Response Team
67


An Entomological Perspective for Emergency Agricultural Response
That concludes our presentation on "An Entomological Perspective for Emergency Agricultural Response." Thank you for attending and for participating!
State Agricultural Response Team
68

PowerPoint Slides
Full-Size

The PowerPoint slides for *An Entomological Perspective for Emergency Agricultural Response* are reproduced full-size on the following pages. You can use these pages as a display or photocopy them onto plastic overhead sheets for use with an overhead projector.

Color versions of these slides can be downloaded at www.flsart.org.


STATE AGRICULTURAL RESPONSE TEAM
FLORIDA
S. A. R. T.

An Entomological Perspective for Emergency Agricultural Response

An Entomological Perspective for Emergency Agricultural Response

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Florida SART Technical Writer

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  - Jeff Lotz, Gary Steck, Steve Garnsey, Julieta Brambila, Paul Skelley, Avas Hamon, Susan Halbert, Russ Mizell, Jim Cuda
  - USDA: APHIS, Forest Service
  - FDACS-DPI, SPDN/NPDN
  - University of Florida/IFAS, University of Georgia, University of Illinois at Urbana-Champaign (Beckman Institute)
  - Virginia Cooperative Extension Service, Pennsylvania Dept. of Agriculture, Washington State Dept. of Agriculture, Minnesota Dept. of Agriculture
  - Wikipedia: The Free Encyclopedia
  - Orkin, Inc.

Learning Objectives

At the end of this training module, participants will be able to:

- Identify some of the exotic insect pests currently present and those which pose a significant potential threat to Florida
- Discuss the nature of the threat associated with each significant exotic pest currently in Florida and the consequences of unchecked spread
- Identify steps being taken to ameliorate the effects of current exotic insect pest infestation and to prevent the introduction of additional threats
- Identify key resources that participants can easily access for further information and assistance

What is SART?

- Multi-agency coordination
  - Governmental and private
  - All-hazard preparation, response and recovery
  - Animal and agricultural

Bugs Rule!
The Wide World of Arthropods

Insects, spiders, bees, cockroaches, butterflies .... Any invertebrate with a segmented body, jointed limbs and a mineralized shell covering

- Almost one million species
- Oldest was alive 350,000,000 years ago
- In the forest, almost 10,000/square foot or 425 million individual animals per acre
- Airborne collection has estimated 25 million per cubic mile
- Estimated of fly reproduction from one pair, April to August if none died = (191 million) x (1 trillion)
- A 5 mph locust swarm estimated 100 miles wide, 300 miles long, and more than ½-mile high


A rare Florida purplewing

Some are Beneficial to Man

- Beneficial
  - Honeybees and wild bees
  - Ladybug (larvae)
  - Praying mantis
  - Ambush bugs
  - Common lacewing (larvae)
  - Ground beetle
  - Robber flies
  - Predatory thrips
  - Tachinid flies

- Beneficial Activities
  - Decomposers/recyclers
  - Pollinators
  - Pest controllers
  - Food sources for other animals (or humans)
  - Products for humans
  - Medical research
  - Soil engineers

Some are *NOT* Beneficial

- People pests

  Mosquitoes, fire ants, venomous spiders and hornets can injure and annoy people
- Plant pests

  Other insects threaten plants including plants that humans depend on for food

Black Widow Spider

Wheat Aphid

Know the Difference

- It is critical to know the difference between beneficial insects and harmful pests

Pest - southern green stink bug

Beneficial - a predatory stink bug

Major G ests

- Scales & Mea
- Aphids & Whit
- Spider Mites
- Borers & Beet
- Caterpillars &

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aign

Scales & Mealybugs

Scales & Mealybugs

- Host Range: Most generalists some specialists
- Sampling Methods: Visual inspection; look for crawlers every 7-10 days

Settled crawler of lobate lac scale

Lobate lac scale

Long-tailed mealybug

Aphids & Whiteflies

Aphids

- Damage: tips, leaves; watch for detectable sooty mold
- Sampling Methods: visual inspection 1-2x Per week
- Potential vector for disease

Whiteflies

- Host Range: some specialists, several generalists
- Sampling Methods: visual inspection every 7-10 days
- Potential vector for disease

Spider Mites

Spider Mites

- Damage: leaf chlorosis, defoliation
- Host Range: some specialists, several generalists
- Sampling Methods: tap leaves on paper 1-2x per week

Beetles & Borers

Borers

- 'Bore' into host trunk, stem, twig or root during life cycle
- Sampling Method: inspect trunk/branches for damage

Beetles

- Damage: foliage, fruit, roots; some wood-boring species
- Host Range: some generalists and specialists
- Sampling Method: inspect host and associated damage

Caterpillars & Thrips

Caterpillars

- Damage: foliae, stems, webs, tents
- Host Range: some generalists and specialists
- Sampling Methods: visually look for caterpillars associated with damage

Thrips

- Damage: foliage, flowers
- Sampling Methods: inspect foliage, flowers; tap flower heads; yellow and blue sticky traps
- Potential disease vector

Florida – A "Sentinel State"

- Florida is a "Sentinel State"
  - A constant invasion of exotic species
    - Not native to the Florida eco-system
    - Causes harm to or has potential to cause harm to the environment
  - Can be a native American species that has invaded a new area or crop or from Africa or Asia or even from another world!

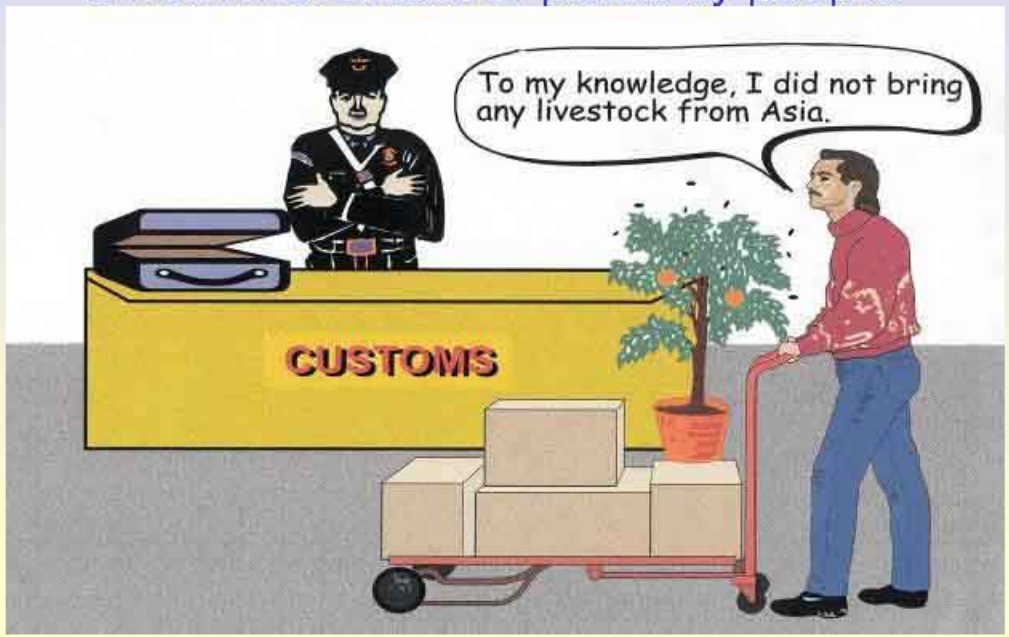
Love bugs

Armadillo

Melaleuca

Florida Entomological Emergencies

The major source of new plant pests
is from movement of plants by people.



Emergency Responses
Eradication vs. Management

- Timely response needed to prevent further damage
- Response will depend on the nature of the new problem
  - Eradication vs. Management
- First choice is eradication, but there are *conditions*
  - Insect is not very mobile (some scales)
  - Good baits are available (fruit flies)
  - Insects are confined (as in a greenhouse)
  - Infestation is limited
- If eradication is not possible, then a management program is developed

Eradication Example
The 1997-98 Medfly Program

- Latest Mediterranean fruit fly or "medfly" in late May 1997
- Multiple outbreaks were involved
- Rapid response from survey crews
- Teams immediately organized
  - Unified Command and Area Command
  - Multiple agencies involved, so multi-agency coordination was needed
  - Public Information Officer (PIO) and a well-supervised public "Help Line" were very important
- The only alternative to eradication is to bag *individual fruits to prevent infection!*

Ceratitis capitata

Bagging individual peaches to prevent infection In Taiwan

Why the emergency?

Mediterranean fruit fly damage to grapefruit

Why the emergency?

An African fly.

Spread around the world. First known in Florida in 1929. Continuing eradication efforts prevent it from becoming established and destroying our citrus economy.

Grapefruit trees with fallen fruit were prime suspect locations indicating presence of destructive medflies.

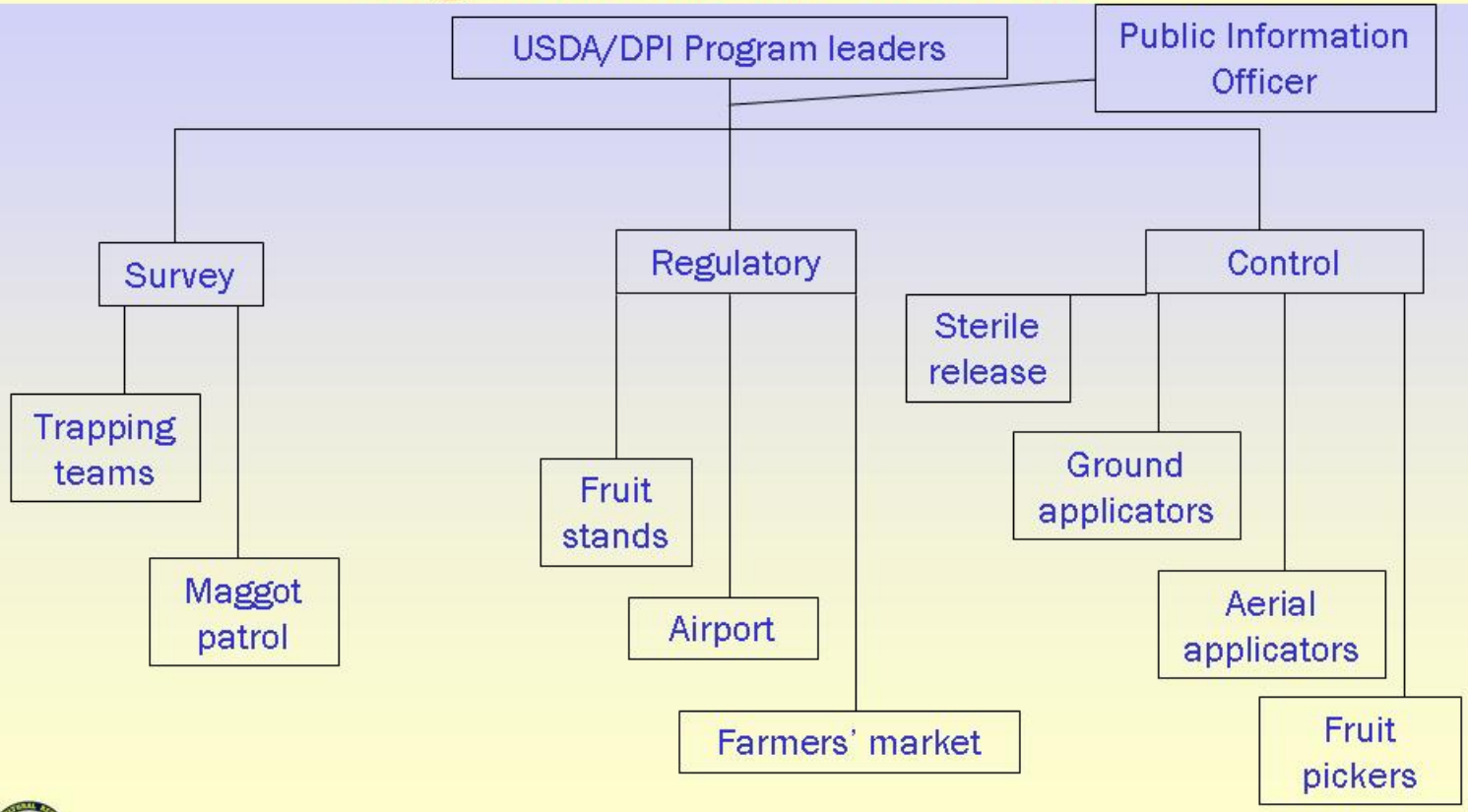
Why the emergency?

- One of Florida's largest agricultural commodities
- Florida produces 80% of all United States citrus.
- Total citrus production is 2nd in the world following Brazil.
  - 287 million boxes (15 million metric tons) of citrus
  - On-tree value (before value-added operations such as shipping and processing) about $879 million
  - Post value-added worth about $9.13 billion
- 90,000 jobs and 800,000 acres of cultivation in 32 counties; $39 million in *ad valorem* (property) taxes; and $900 million in taxes at all government levels

Eradication Phase 1: Survey

Phase 1: Survey groves and home yards, then plot finds on the map.

Eradication Phase 2 Organization 1997-98



Eradication Phase 3: Control

- Phase 3: Control
  - Spray infested area with bait spray
    - Air and ground
  - Pick and dispose of infected fruit
  - Rear and release sterile fruit flies

Eradication: Public Education

- Keeping the public informed
  - Timely and accurate communication with the press is very important
  - Control actions for pests and diseases can be very unpopular with the public

Eradication Success!

The program was successful.

No additional non-sterile medflies have been found in Florida since 1998.

Management Example
Pink Hibiscus Mealybug

- Pink hibiscus mealybug (PHM) has been a major pest in the Caribbean basin
- PHM appeared in Florida in June 2002
- No eradication attempt was made
- Biological controls of PHM are determined to work well

Not an Emergency, but a Management Dilemma

- Hibiscus a magnificent decorative flower, but is not economically significant
  - 200-220 varieties and grown throughout Florida
  - State flower of Hawaii; national flower of South Korea, Malaysia
  - Large, trumpet-shaped flowers in many colors: red, pink, yellow, blue, lavender, white, brown, gold and mixed

  - Unfortunately, this bug also attacks many Florida food crops!

Not an Emergency, but a Management Dilemma

- Damage from PHM feeding can be seen as "bunchy top" or distorted plant tissues
- Presence of white wax with pinkish mealybugs (pink eggs) are a good sign that PHM may be present
- Program is on-going
- Male pheromone traps now being used
- Geographical range of PHM is expanding as a result of the nursery trade
  - August 2004: Grower in Homestead, Florida accidentally ships PHM-infected plants to 30+ states
  - Confirmed presence in Kansas, Louisiana and North Carolina

Emergencies, Interceptions and Discoveries

Two of Florida's *Current* Entomological Emergencies

Citrus greening

- Spread by bacterium on Asian citrus psyllid: Effects are spot/sector yellowing, notched leaves, misshapen, bitter fruit: Potentially devastating to Florida's $9.13 billion citrus industry.

Africanized bees

- Originally from Africa Introduced to Americas in 1956: very aggressive, easily agitated, pursues ¼-mile to continue attack can easily kill. Present in Florida now.

Recent Interceptions

- *Chlorophorus strobilicola*
  - Found in scented pine cones from India
  - Packaged with potpourri, December 2003
  - Not known to be established

Recent Interceptions

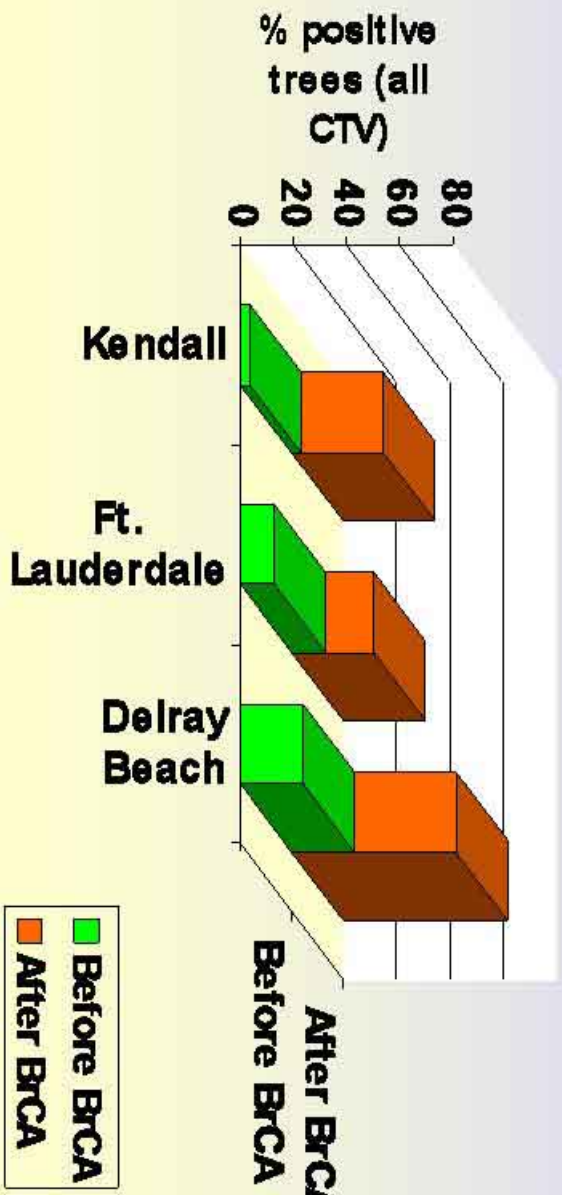
- *Anastrepha ludens* (Mexican fruit fly)
  - With Manzano peppers originating from Mexico in May 2003 (Pinellas County)
  - Potential pest of citrus
  - No lures for this pest
  - Not known to be established

Exotics Recently Discovered In Florida: Brown Citrus Aphid

- Found in Florida November 1997
- Spreads citrus tristeza virus
- Occurrences of CTV have increased since the establishment of this exotic aphid

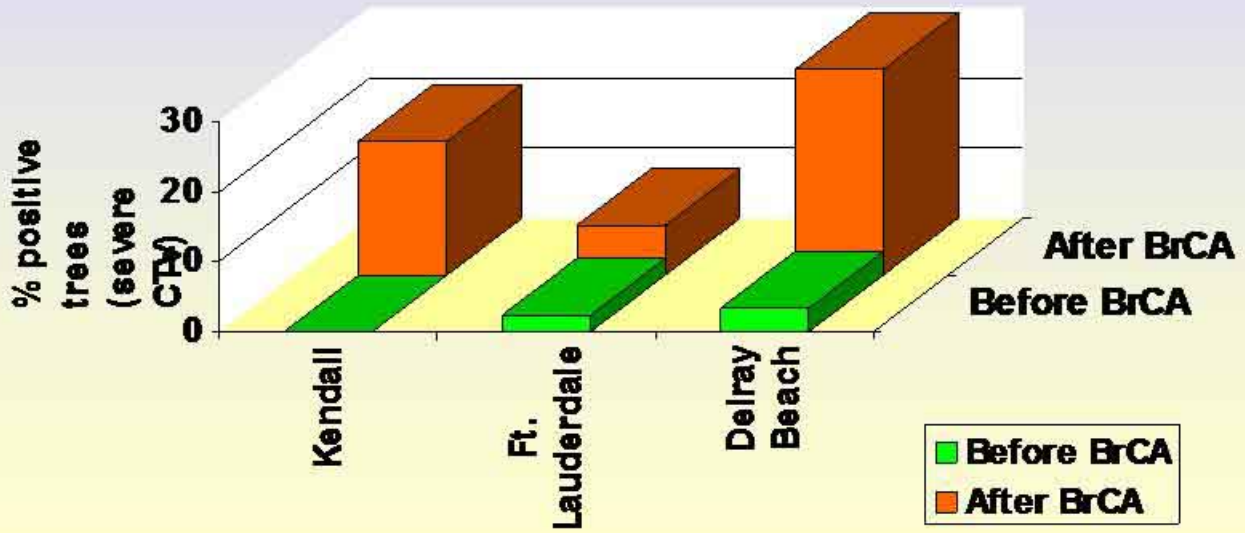
Brown Citrus Aphid

Overall CTV Occurrence in Southeast Florida Before and After Brown Citrus Aphid



Brown Citrus Aphid

Severe CTV in Southeast Florida Before and After Brown Citrus Aphid



Exotics Recently Discovered In Florida: *Dieuches armatipes*

- In Florida for about a decade
- Found as far north as Gainesville
- Serious peanut pest in Africa
- Pest status in Florida not known

Exotics Recently Discovered In Florida: Cactus Moth

- In Florida for about 15 years, perhaps spread by hurricanes
- Threatens $70 million US cactus industry (and Mexico's, estimated $50-$100 million)
- Spread by transportation of infected plants

UF Associate Professor Jim Cuda studies cactus moth caterpillars on prickly pear. Moth has no natural predators in North America.

Exotics Recently Discovered In Florida: *Myllocerus undatus*

- Weevil native to Sri Lanka
- Found established in September 2000
- Many hosts including sea grape, Turk's cap, upland cotton, peach, live oak and some palms

Exotics Recently Discovered In Florida: Lobate Lac Scale

- *Paratachardina lobata*
- First reported in Florida in 1999 but already established
- Polyphagous scale
  - Could be a problem for native woody plants
- Sign of possible infestation is trees looking black from sooty mold

Exotics Recently Discovered In Florida: Mexican Red-Rump Tarantula

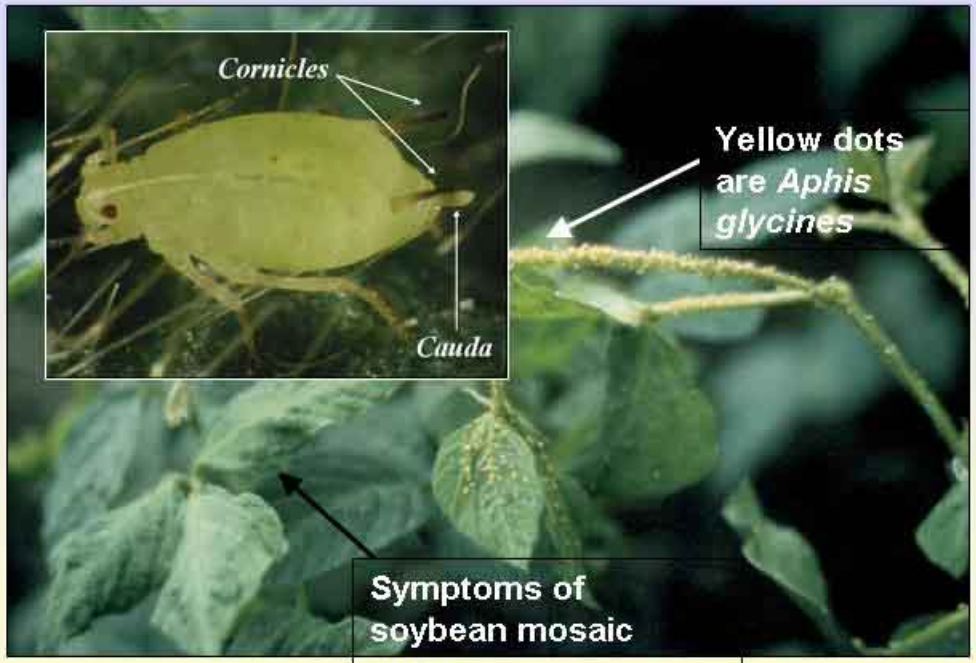
- Established in a citrus grove in Ft. Pierce
- Unwanted pets probably were the source of the population

More Really Bad Bugs
Suni Bug

- *Eurygaster integriceps*
- Absolutely the world's worst agricultural pest!
- Feeds on wheat, perhaps the world's most important food crop.
- Not found in western hemisphere … yet.
- Unlikely to be a problem in Florida, although an insect of this genus has been intercepted in Florida on European tile

More Really Bad Bugs
Soybean Aphid

- *Aphis glycines*
- Asian species
- Found in Minnesota in 2000
- Occurs as far south as Georgia



More Really Bad Bugs
Foxglove Aphid (Asian Strain)

- Not in Western Hemisphere
- Colonizes soybean plants and many ornamentals
- Causes bright yellow damage
- Transmits soybean dwarf virus, a persistent virus of legumes
- Possible hosts travel the world as cut flowers and nursery plants
- Aphids themselves do not invoke an automatic quarantine in many cases, especially if the species is already present in the US

More Really Bad Bugs
Oxycarenus hyalinipennis

- Serious pest of cotton
- Established now in the Caribbean

More Really Bad Bugs
Russelliana solanicola

- A potato psyllid
- Found in South America (Peru)
- Causes serious damage to potato
- Transmits a newly discovered plant pathogen

More Really Bad Bugs
Asian Longhorn Beetle

- Established in Chicago and New York
- Discovered during an agricultural "stake-out"
- Eradication effort involves cutting down large trees in residential areas

And *Even More* Really Bad Bugs
Citrus Longhorn Beetle

- Not established in United States, but intercepted on bonsai trees in Georgia and Washington
- Host plants are numerous hardwoods and *citrus* spp., hibiscus, *Ficus*, sycamore, willow, pear, oak, maple, Japanese red cedar, etc.

And *Even More* Really Bad Bugs
Citrus Longhorn Beetle, ctd.

Signs of damage

- Emergence holes located on the lower trunk and exposed roots

Identification

- Adults 1-1.5" long, shiny black with white dots, rows of polished tubercles at base of front wings

And *Even More* Really Bad Bugs
African Citrus Psyllid

- *Trioza erytreae*
- Not in Western Hemisphere
- Occurs in Africa and several islands in the Indian Ocean
- Is *the other* known vector of citrus greening disease
- Causes puckers in the leaves that look like an incipient scab infection


Photo by Stephen M. Garnsey

And *Even More* Really Bad Bugs
Bemisia tabaci, Biotype 'Q'

- *Bemisia tabaci* biotypes are prolific pests worldwide
- Occasional outbreaks reported in US in early 1800s
- In 1986 became economically important; listed as *Biotype B*
- March 2005, University of California and Arizona researchers identify *Biotype Q* on poinsettias
- Resistant to systemic pesticides and IGRs

And *Even More* Really Bad Bugs
Bemisia tabaci, Biotype 'Q' ctd.

- FDACS-Division of Plant Industry response

  (1) Inquire with growers, "Are you having problems with white fly control? Do they seem to be resistant to systemics and IGRs?"

  (2) Pest alert issued (see Resources)

  (3) Samples identified at DPI – *Bemisia* or not?

  (4) *Bemisia* samples sent to USDA collaborator for biotype identification

A Take-Home Message...

Be aware!!

- Recognize plant damage you have not seen before
- Notice odd plant coloration, defoliation, fallen fruit, etc.

Key Resources

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- FDACS Division of Animal Industry
  www.doacs.state.fl.us/ai/
- Florida Agriculture Statistical Directory 2004
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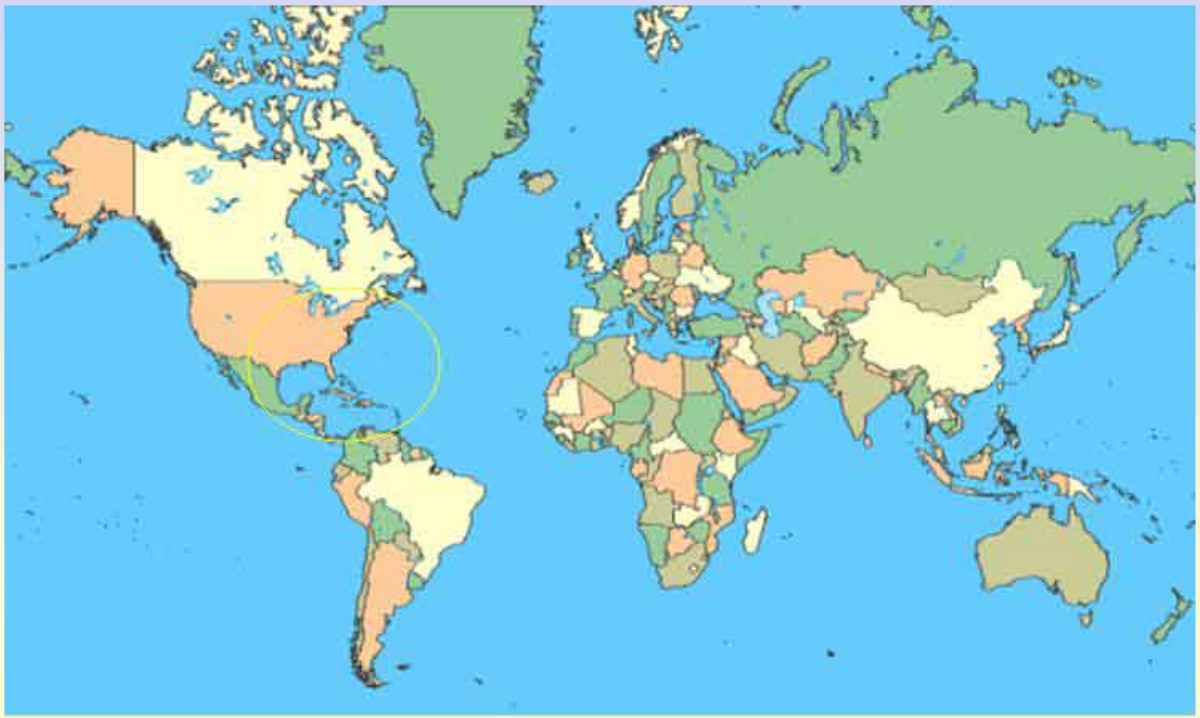
- USDA, Animal and Plant Health Inspection Service, National Center for Import and Export (www.aphis.usda.gov/vs/ncie/)
- Insecta Inspecta World (www.insecta-inspecta.com/bees/killer/)
- Florida State Agricultural Response Team (www.flsart.com)
- Integrated Pest Management, IFAS Extension, University of Florida (http://ipm.ufl.edu/)

Florida and The World



Working Together To Protect Florida's Agriculture & Way of Life

Thank You!

Now, Test Your Knowledge and Awareness (1 of 3)

1. (True/False) Florida "SART" is a rescue team of trained dog handlers and crime scene investigators on-call following an emergency.
2. You might say that insects and man have a love-hate relationship – even though bugs may not be capable of feeling those emotions. Nevertheless, which of the following activities is actually beneficial to man?

   a. pollination of plants
   b. nature's recyclers
   c. used in medical research
   d. predation on other insects
   e. all of the above are beneficial

3. Because of its sub-tropical climate, unusual geography as a peninsula pointing 300 miles from the mainland of North America to the heart of the tropics and accessibility for exotic imports, Florida is considered a "_____ State."

Pre/Post Test (2 of 3)

4. (True/False) The major source of new plant pests is from movement of plants by people.
5. An invasive plant pest such as the Africanized honeybee or pink hibiscus mealybug will be met with one of two control strategies. Name these two threat responses.
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7. Two current invasive threats that have potentially deadly and/or devastating consequences in Florida are _____ and _____.
8. Which of the following has not been identified yet in Florida?

   A. Mexican fruit fly B. Suni bug C. Onion thrips D. Mediterranean fruit fly

Pre/Post Test (3 of 3)

9. If you recognize an unusual insect or plant damage that seems extra-ordinary you should notify:

   a. nobody – you're not an expert and your meddling will only take up the time of people who are involved in serious work to eliminate exotic pests

   b. Ghost Busters

   c. your County Agricultural Extension Service

   d. the Department of Agriculture and Consumer Services consumer *Help Line* 888-397-1517.

10. Approximately how many species of arthropods (insects, spiders, crustaceans, etc.) are there on earth?

Test Answer Key

1. False
2. (d) all of the above
3. a "Sentinel State"
4. True
5. Eradication or management
6. Public Relations
7. Africanized honeybees and citrus greening
8. Suni bug
9. c. or d. – your County Agricultural Extension Service or the DACS *Help Line* [1-888-397-1517] are acceptable.
10. About 1,000,000

Glossary (1 of 2)

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- **Arthropod**: Any organism belonging to the phylum *Arthropoda*, characterized by a segmented body, jointed legs, a digestive tract and, in most cases, a *chitinous* shell that is periodically molted to allow growth. Modern-day arthropods include spiders, insects, crustaceans, scorpions and horseshoe crabs.
- **Chitin**: The tough, horny protein material similar to fingernails, it is a nitrogenous polysaccharide, which forms the exoskeleton of an insect.
- **Entomology**: The study of insects: life cycle, behavior, ecology, diversity, control.
- **Exotic**: Not native, introduced from abroad.
- **Killer bees** (Africanized honeybees): A strain of honeybees that originated in Brazil in the 1950s, a cross between an aggressive African bee and a European honeybee. These bees retain most of the African traits: highly aggressive, relatively poor pollinators and poor honey producers.

Glossary (2 of 2)

- **Mesophyll**: The photosynthetic tissue of a leaf located between the two outer leaf tissues.
- **Phloem**: The food-conducting tissue of a plant, the "inner bark," made up of sieve tubes, companion cells, phloem parenchyma, and fibers.
- **SART**: The Florida State Agricultural Response Team, is a multi-agency coordination group consisting of governmental and private entities dedicated to all-hazard disaster preparedness, planning, response and recovery for the animal and agriculture sectors in Florida.
- **Siphunculi**: A characteristic common to most aphids is the presence of two tubes, called *siphunculi*, on the back ends of their bodies. These *siphunculi* secrete defensive substances.
- **Stylets**: Sharp appendages on an insect, used for piercing and sucking.
- **Xylem**: The supporting layer of tissue in vascular plants that conducts water and nutrients from the roots to other parts of the plant.

An Entomological Perspective for Emergency Agricultural Response

- That concludes our presentation on "An Entomological Perspective for Emergency Agricultural Response." Thank you for attending and for participating!