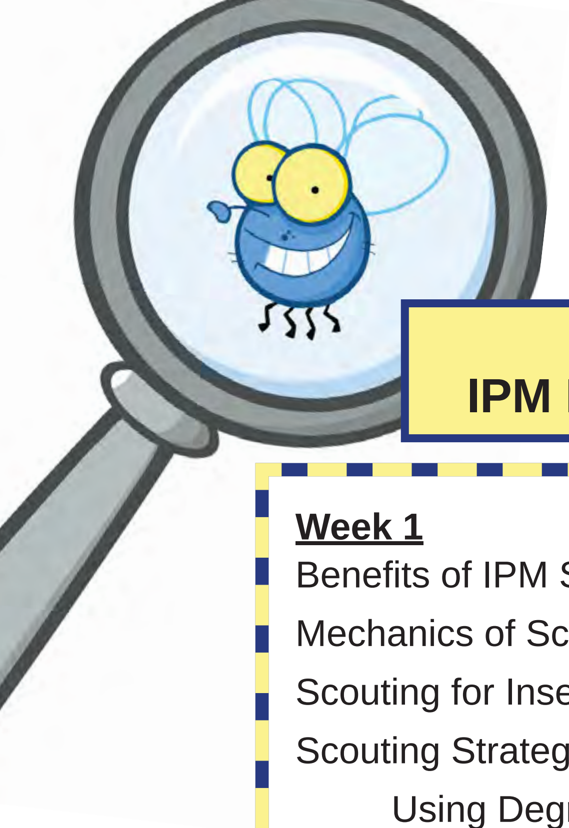

Table of Contents
IPM Nursery Scouting Training

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Benefits of IPM Scouting

Liz Felter
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Orange County Government Florida

What is IPM?

- Integrated Pest Management
  - The use of a broad range of inter-related cultural, chemical, biological and other methods of pest control in combination with routine scouting to produce quality agricultural crops.

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How IPM Works

- Avoid or prevent pest damage with minimum impact on humans, environment, non-target organisms
- Proper ID of insect or pest
  - Pests can be:
    - Insects
    - Mites
    - Nematodes
    - Pathogens
    - Weeds
    - Improper cultural practices
    - Incorrect environmental conditions

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What is Scouting?

- The routine monitoring of a crop to aid in early detection of an insect, disease or other problem.

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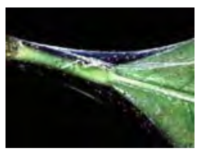
IPM and Scouting Work to:



- Prevent problems
- Regularly monitor crops and growing areas
- Timely sample submission
- Accurately diagnose problems
- Develop control action thresholds

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IPM and Scouting Work to:

- Use effective management tools
- Take non-chemical preventive actions
- Gradually modify pesticide use
  - To reduce the number of applications
  - Adjust intervals between applications
  - Switch to more pest-specific pesticides
- Increase profit (less $ on pesticides, labor)

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Modified Pest Management

- Proper ID of insect or pest
- Does not mean less pesticide will be used
- Reduces use of high risk pesticides
- Apply chemicals only when needed
- Correct chemical, correct time – life cycle
- Thresholds

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Detect Lack of Control

- Due to poor coverage
  - Spray cards can be used
- Due to possible resistance development
- Certain pesticides cause death in different time frames and with differing results
  - Some pesticides take about 5 days to work
  - Growth regulators do not kill adults – impact immature stages

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Biological Controls

- Can be difficult to use and protect from other treatments that may be required
- “soft chemicals”
- Banker plants

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Other Scouting Benefits

- Detect phytotoxicity/chemical burn and other "unusual" problems before entire crops are lost
- Accurate record keeping allows true sense of security that spray applications work
- Early detection
  - Smaller problems
  - Avoids crisis

- Environmentally friendly

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Your IPM Implementation

- Determine the objectives of your IPM program
  - Saving money?
  - Improving crop quality?
  - Reducing pesticide applications?
  - Switching from broad-spectrum to reduced-risk pesticides?
- All objectives may not be compatible with each other

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What we will be talking about

- Mechanics of scouting, scouting strategies, making maps, using diagnostic labs, keeping records
- Scouting for Insects
- Scouting for Diseases
- Scouting for Abiotics
- Weed ID and control
- Scouting for Nematodes
- Media pH and EC
- Water Quality

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Questions?

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Mechanics of Scouting

Hannah Wooten,
UF/IFAS Extension Seminole County

Adapted from Juanita Popenoe,
UF/IFAS Extension Lake County

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Situational Scouting

- Routinely inspect nursery with two goals in mind:
  - Problem prevention
  - Problem detection

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Situational Scouting

- Use following to evaluate nurseries:
  - Nursery design
  - Nursery maintenance
  - Water source and quality
  - Nursery media
  - Nursery containers and storage
  - Fertilization
  - Plant propagation
  - Plant production

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Situational Scouting

- Does this encourage a pathogen or pest?
- Does this allow the spread of a pathogen or pest?
- Does this favor the development of a plant problem?
- Does this allow the persistence of a pathogen/pest on site?

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Nursery Design Flaws

- Land selection: Land should be chosen with regard to natural slope, soil percolation and soil type.
- Bed design: Inadequate attention to design can lead to seasonal flooding of greenhouses and field blocks of plants.

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Nursery Design Flaws

- Different size containers grouped together
- Tiered production
  - Requires special care to be successful
- No isolation or quarantine area
  - New plant material should be isolated for at least two weeks.

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Nursery Maintenance

- Torn ground cloth – allows introduction of soil-borne pathogens
- Torn shade cloth – cause undesirable light stress
- Poor perimeter management – weeds host pathogens and pests
- Plant disposal – introduce foliar pathogens, nematodes and insect pests

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Nursery Water Source

- Water Source can introduce plant pathogens.
- Timing, frequency and amount of irrigation
  - Pythium
  - Phytophthora

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Nursery Media

- Media preparation and storage can be source of root-rotting pathogens, nematodes and fungi
  - Cylindrocladium
  - Fusarium
  - Phytophythora
  - Pythium
  - Rhizoctonia
  - Thielaviopsis
  - Nematodes

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Nursery Containers and Fertilization

- Containers stored on ground or open to wind can allow pathogens into the production cycle.
- Recycled containers act as a reservoir for low levels of media-borne pathogens.
- Top dressing fertilizers can result in soluble salt levels that can kill feeder roots or damage lower stems through direct contact.

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Plant Propagation

- Stock plants should be free of foliar symptoms of leaf spots, blights, dieback and gall diseases.
- Don’t shear close to soil line.
- Use clean dip solutions.
- Be alert for cell trays or beds with significant cutting mortality.

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Plant Production Practices

- Check planting depth
- Tight spacing and overlapping canopies
- Remove plant debris from pruning.

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Mechanics of Scouting

- Perform routinely and consistently
- Divide nursery into logical units and make maps of units to efficiently monitor
- Define key plants/key pests

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Frequency of Monitoring

- Short-cycle crops – three to four days
- Longer-cycle crops - seven to fourteen days
- Long cycle woody ornamentals – fourteen days

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Routine Scouting

- Look for
  - Abnormal plant symptoms
  - Direct evidence of insects, mites or pathogens
  - Situational problems i.e. malfunctioning sprinkler heads
- Walk at random in a zigzag pattern
- Select less healthy plants
- Lift plants out of pots to look at roots
- Examine new and old foliage growth looking at both leaf surfaces

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Routine Scouting

- In container or field nurseries, pay attention to areas on the windward side, and sides bordering ditches, canals or other uncultivated areas.
- Follow the same general pattern at each sampling.
- Vary the entrance point 3 to 10 feet at subsequent samplings.

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Routine Scouting

- In greenhouses, walk every aisle and move from bench to bench in a snakelike path. Always begin scouting at a major doorway.
- Concentrate on the beginning, middle and the end of each bench and on areas near vents and other openings.

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Aids Available to Scouts

- Yellow sticky traps – check 2 to 3 x/week, place 1/1000 sq ft., replace weekly.
- Sail traps – male scales and mealy bugs
- Indicator plants for detecting insects and mites
  - Tomato, lantana, gerbera, pentas, poinsettia, marigold, rose, *Ficus* spp., *Hedera* spp., hibiscus, chrysanthemum, impatiens and gloxinia.

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Routine Scouting

- The simple presence of pests on plants does not necessarily indicate that control actions are appropriate.
- The action threshold triggers a decision to prevent populations from reaching the aesthetic or economic injury threshold.

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Mechanics of Scouting

- Intelligent handling of the risk appropriate to each situation is the essence of IPM philosophy and practice and is fundamental to economically sound, and environmentally and socially acceptable decision making.

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Scouting Ornamental Production BUGS

University of Florida

Lance Osborne & Catharine Mannion

October 2, 2013

Why is scouting so important today?

- Backbone of Integrated Pest Management (IPM)
- Fewer pesticides; expensive
- New pesticides often target specific pests / life stages or diseases and require precise timing
- Biological control often requires information on pest and predator/parasite numbers
- Invasive pests and diseases require detection at very low levels. Regulatory action can have a profound economic impact.

What is Scouting ?

Inspection

Locate and Identify

Data Collection

Quantify and record

Evaluation

Do Treatments work?

General comments

- Identify the pest or disease
- Start scouting efforts simply and then expand efforts as needs or time allow
- Record: presence, absence (good) or quantity (better)
- Cover the entire production area and perimeters at least every 1 or 2 weeks
- Scouting is a team effort
- Develop a pest management history that can be used by others


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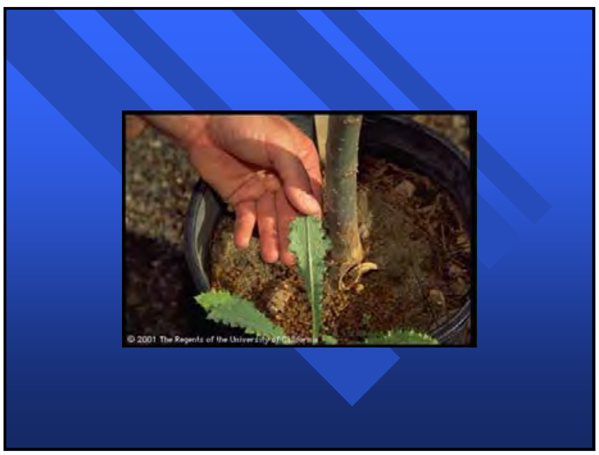
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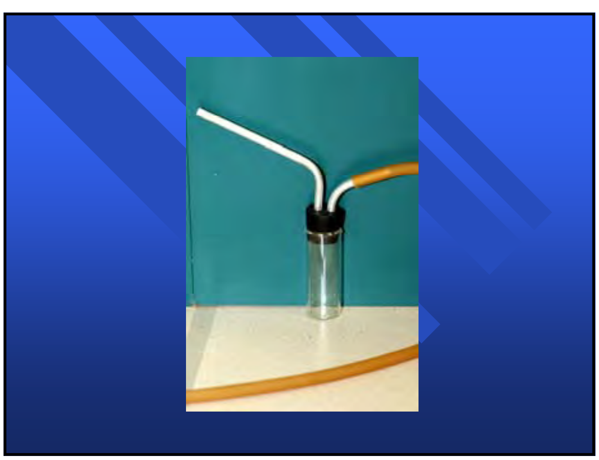

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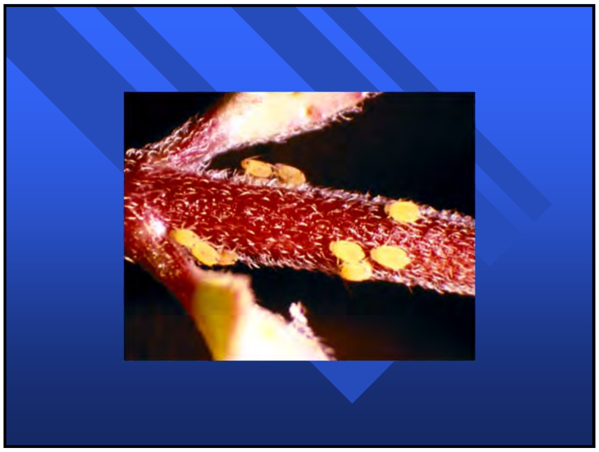
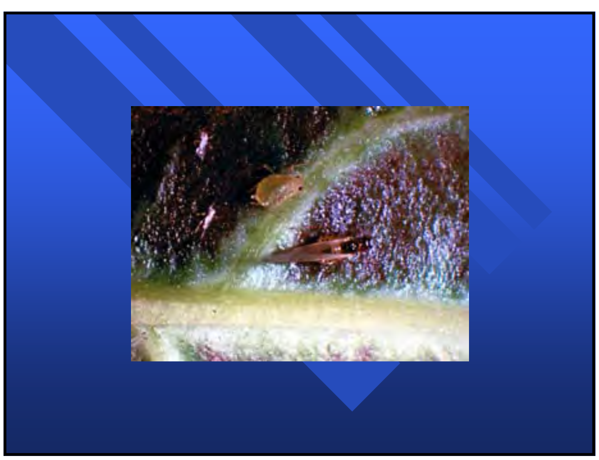
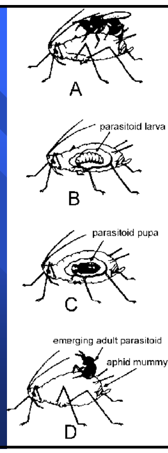
IDENTIFICATION

mrec.ifas.ufl.edu/LSO

APHIDS






A
parasitoid larva
B
parasitoid pupa
C
emerging adult parasitoid
aphid mummy
D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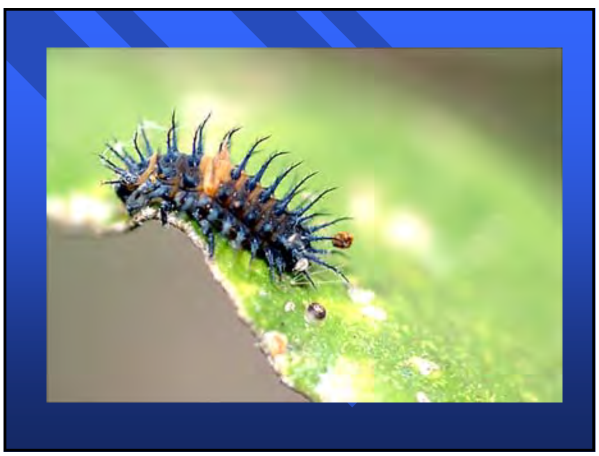


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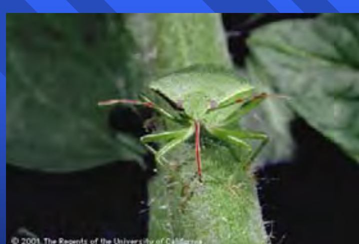
Lacebugs, Leafhoppers, etc.



Brown marmorated stink bug

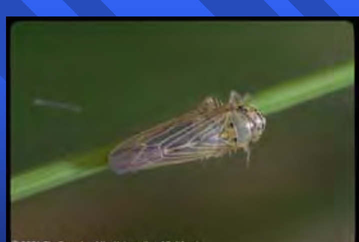
Karen Bernhard, Lehigh County Extension, Pennsylvania State University.

Brown marmorated stink bug

Deepak Matadha
Rutgers University

Brown marmorated stink bug

Gary Bernon, USDA

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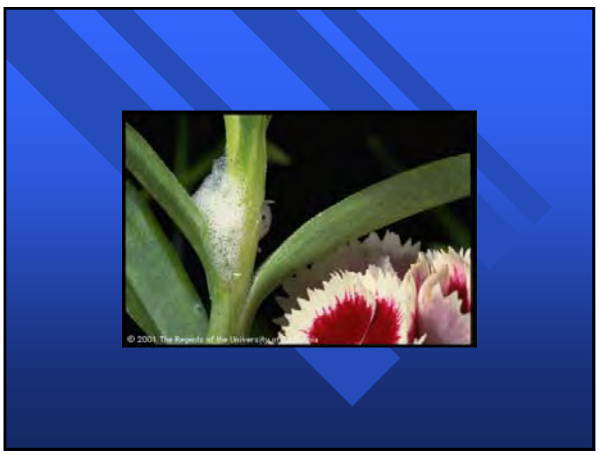
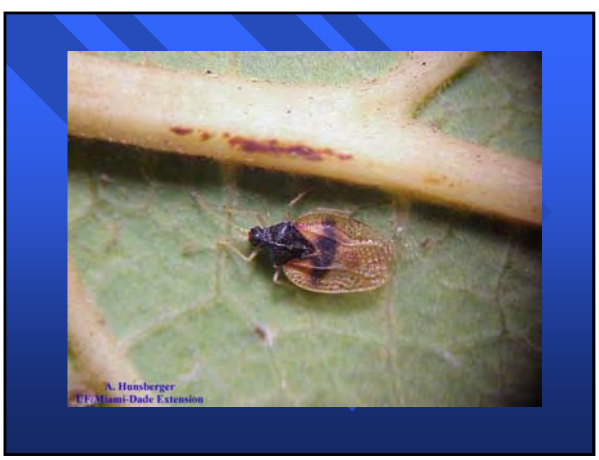



Clastoptera
Lyle Buss


Clastoptera
Lyle Buss


Clastoptera
Lyle Buss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UF/Miami-Dade Extension


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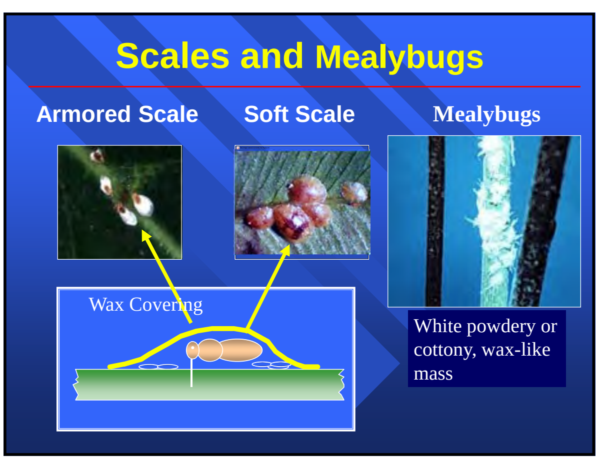

Scales and Mealybugs
Armored Scale
Soft Scale
Mealybugs
Wax Covering
White powdery or cottony, wax-like mass

Damage
Armored Scales

- Feed from plant cells of stems or leaves.
- Do not produce honeydew.
- Early signs are chlorosis of the foliage around feeding site.
- If high numbers of scale, may get browning and defoliate.
- If feeding on the woody tissue, may show slow dieback, leaf shedding and general decline.

Damage
Soft Scales and Mealybugs

- Feed on phloem sap
- Produce honeydew which is usually the first signs of feeding.
- General decline; unhealthy looking plant, less growth
- Environmental stress from excess or lack of water, high temperatures, etc. may intensify scale feeding injury

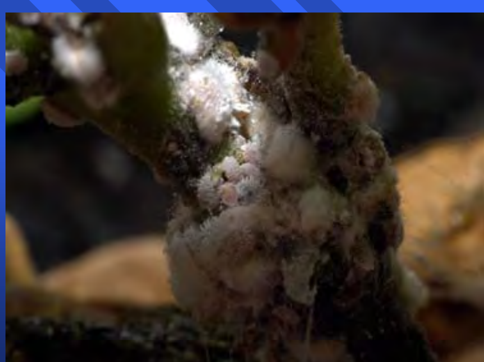
Host Plants
Scales and Mealybugs

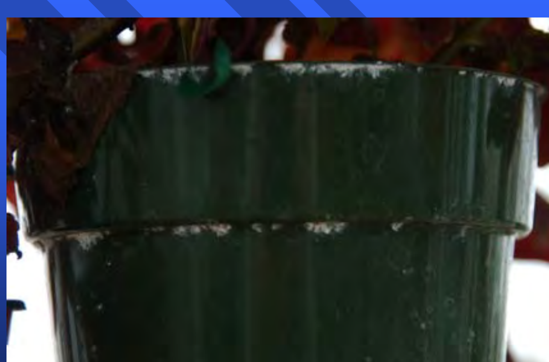
- Virtually every plant can be attacked by a scale insect
- Common plants attacked by mealybug include azalea, coleus, croton, cactus, rose, bedding plants and numerous foliage plants

Mealybugs

DIFFICULT TO FIND

DIFFICULT TO GET COVERAGE



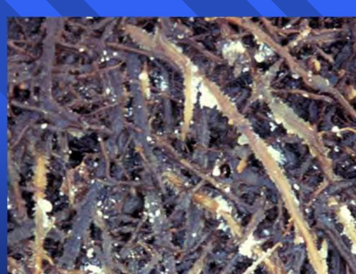


NEW MEALYBUGS

- ***Phenacoccus madeirensis*** ***Madeira mealybug***
- ***Trionymus lumpurensis*** **bamboo mealybug**
- ***Paracoccus marginatus*** **papaya or marginal mealybug**
- ***Maconellicoccus hirsutus*** **pink hibiscus mealybug**
- ***Rhizoecus hibisci*** **a root mealybug**
- ***Hypogeococcus pungens***

This is the Citrus mealybug, *Planococcus citri*. Notice the medium sized waxy filaments around the body, absence of long tails and the single dark stripe down the center of the body. This species produces an egg mass or ovisac.

P. madeiresis: Notice the short waxy filaments around the body, absence of long tails and the absence of a single dark stripe down the center of the body. This species produces an egg mass or ovisac.



INFESTATIONS ARE OFTEN OVERLOOKED UNTIL SEVERE AND WIDESPREAD, CAUSING REDUCED PLANT VIGOR, FOLIAR CHLORSIS AND SLOW PLANT GROWTH

Soft Scales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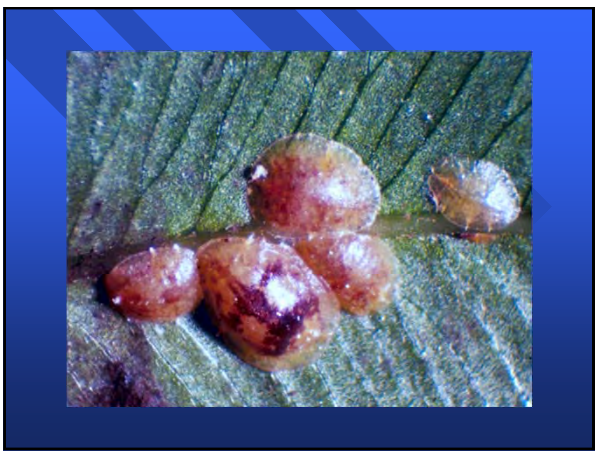


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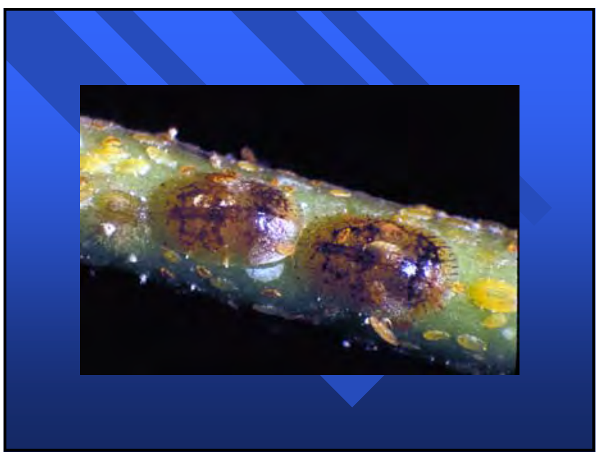

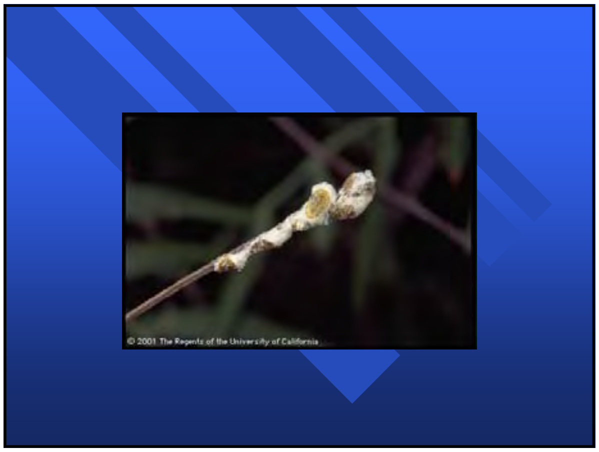
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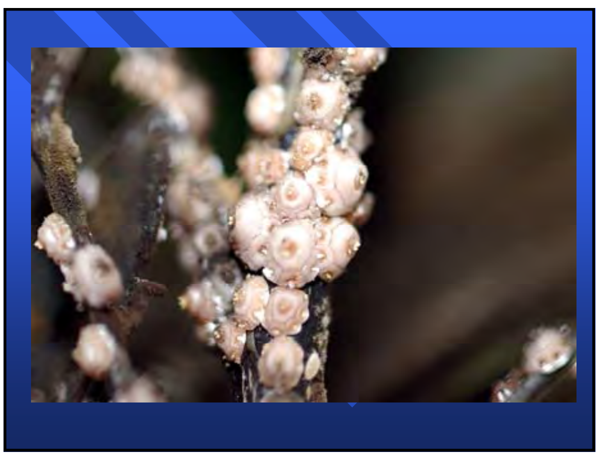
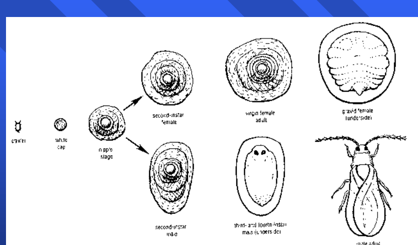



A. Hunsberger
UF/Miami-Dade Extension

Hard Scales


second-instar female
virgin female adult
gravid female (underside)
second-instar male
male adult

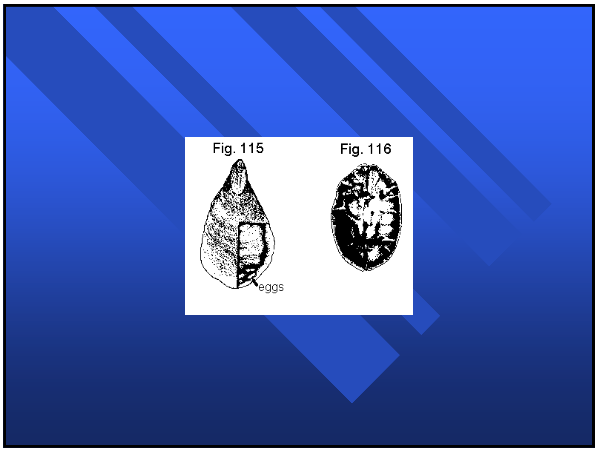
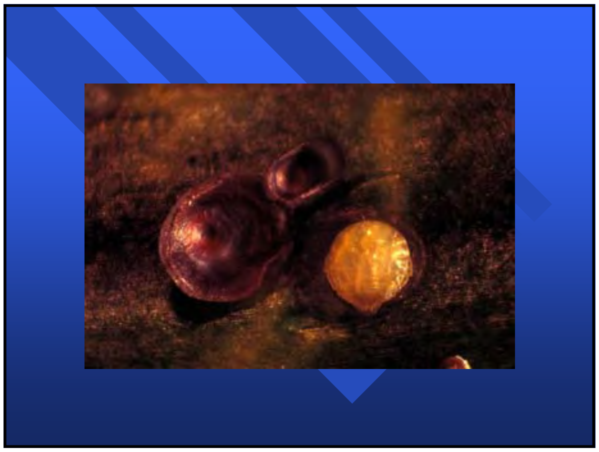
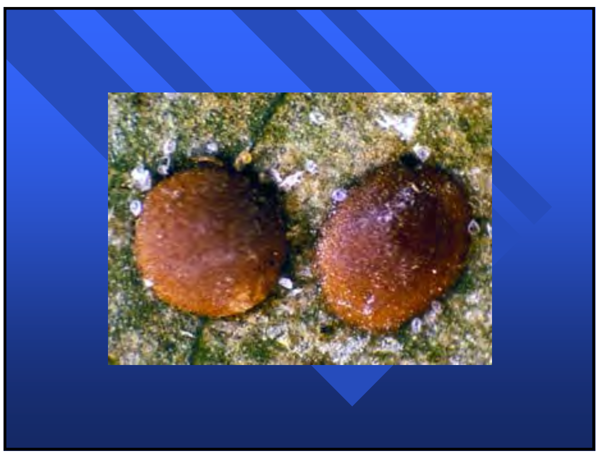
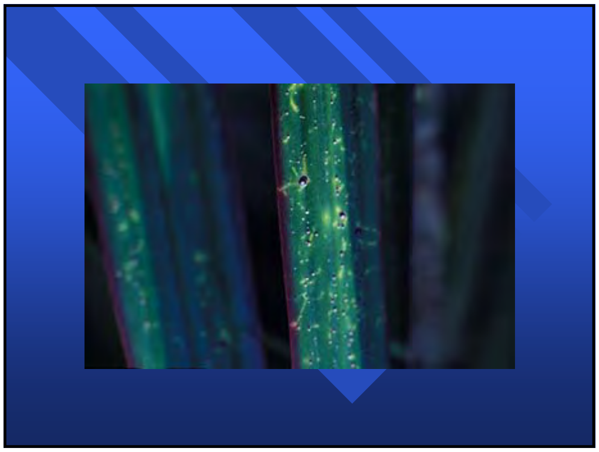
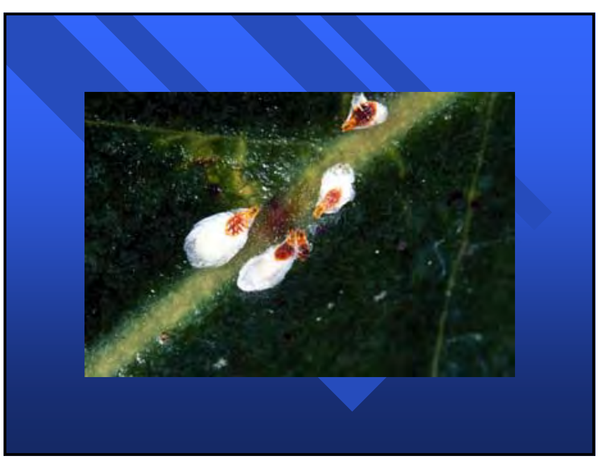


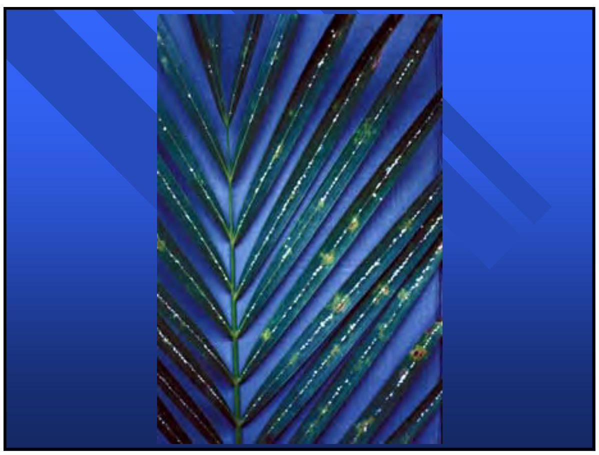
Fig. 115
Fig. 116
eggs

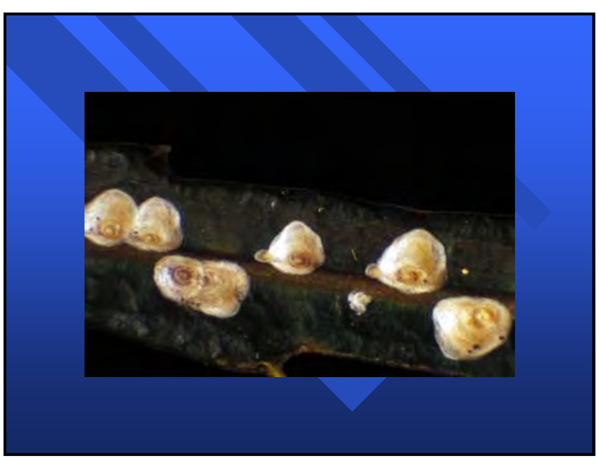


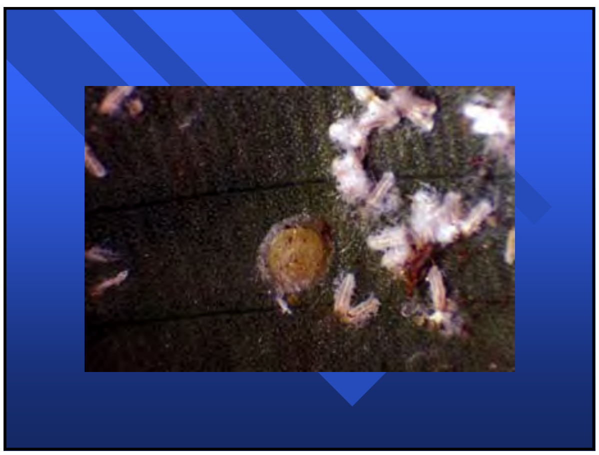


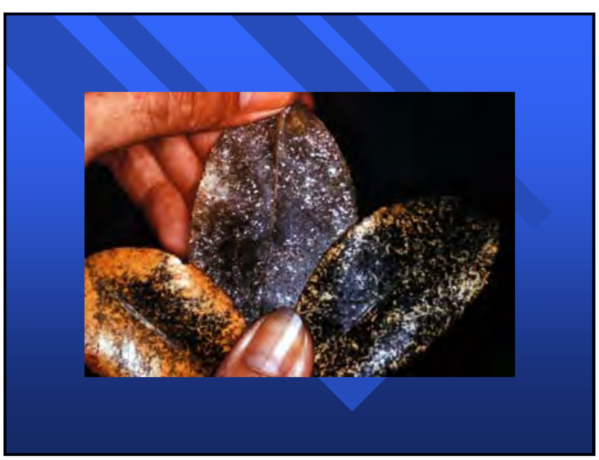


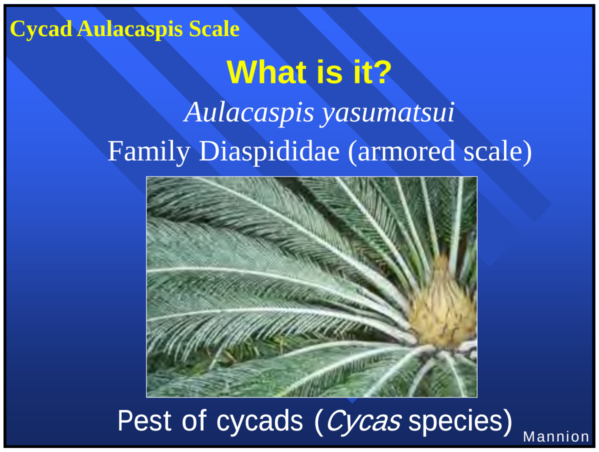


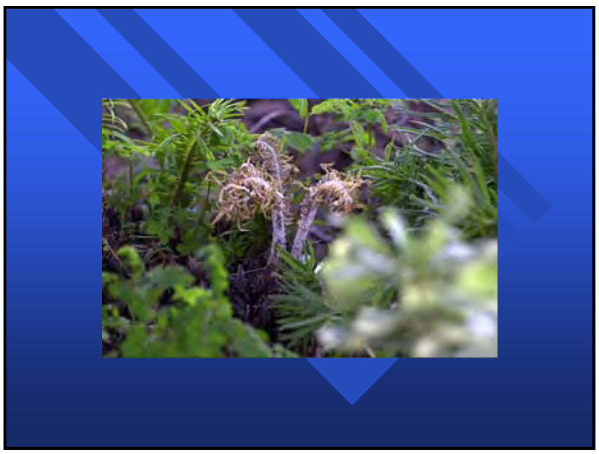


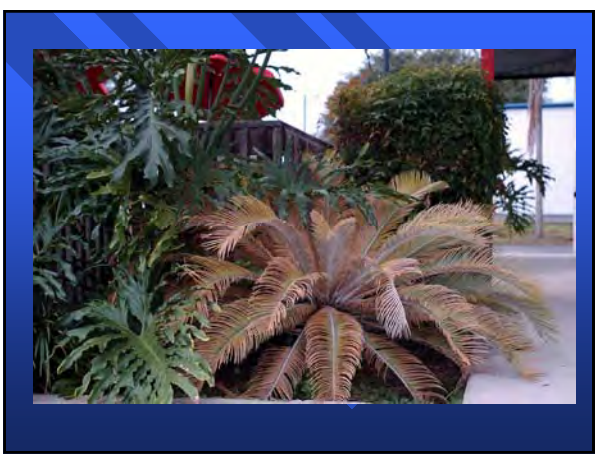


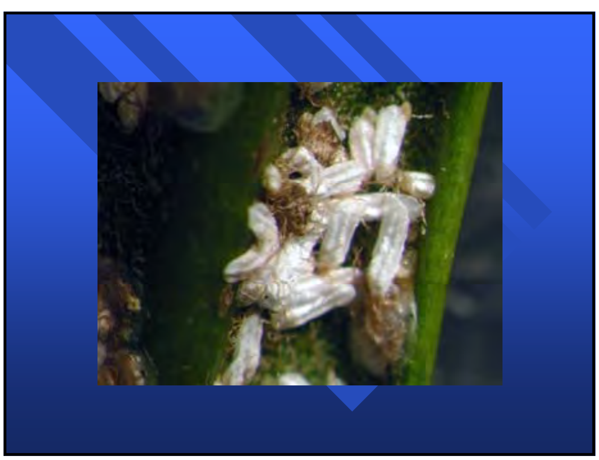


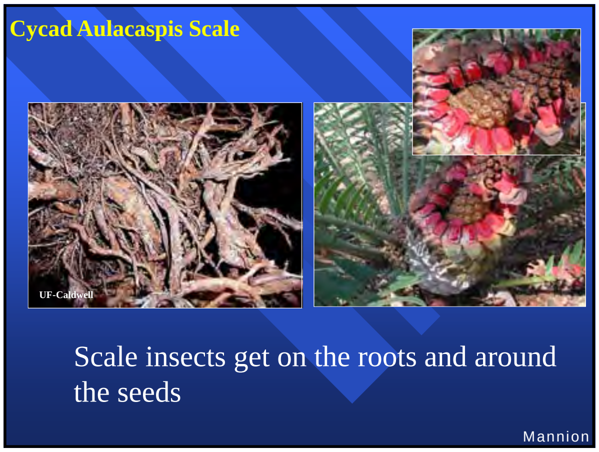


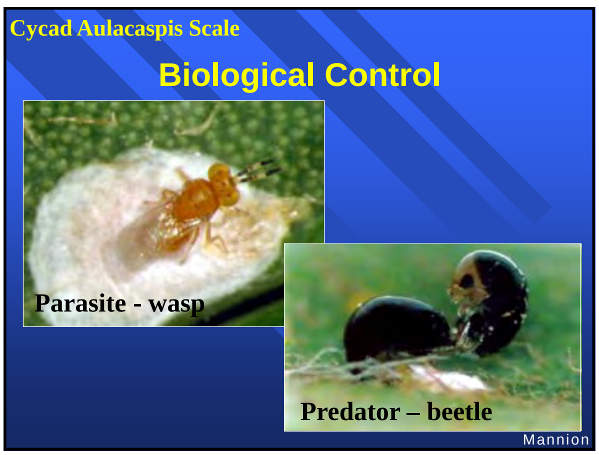

Cycad Aulacaspis Scale
What is it?
Aulacaspis yasumatsui
Family Diaspididae (armored scale)
Pest of cycads (*Cycas* species)
Mannion








Cycad Aulacaspis Scale
UF-Caldwell
Scale insects get on the roots and around the seeds
Mannion


Cycad Aulacaspis Scale
Biological Control
Parasite - wasp
Predator – beetle
Mannion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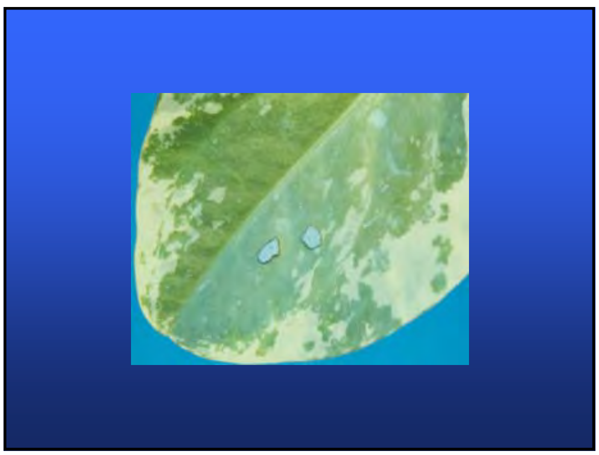
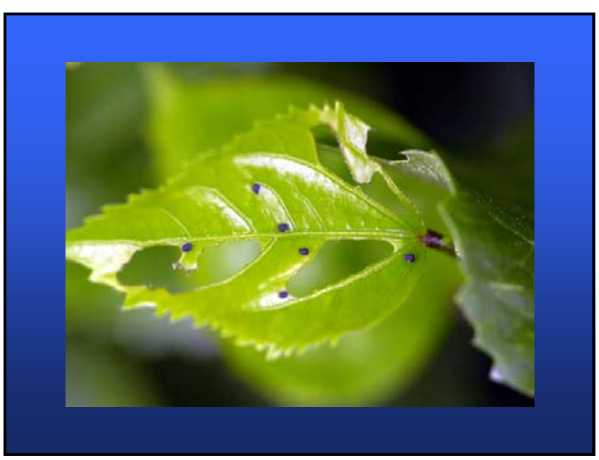
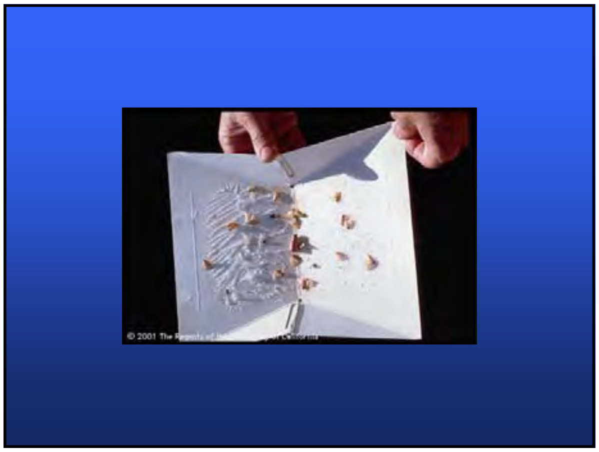
LEPIDOPTEROUS LARVAE



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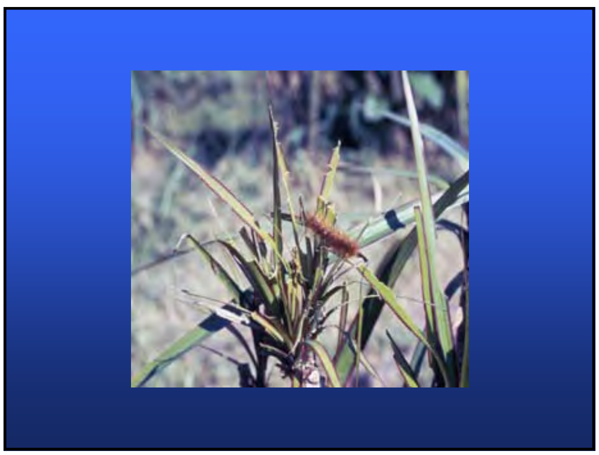
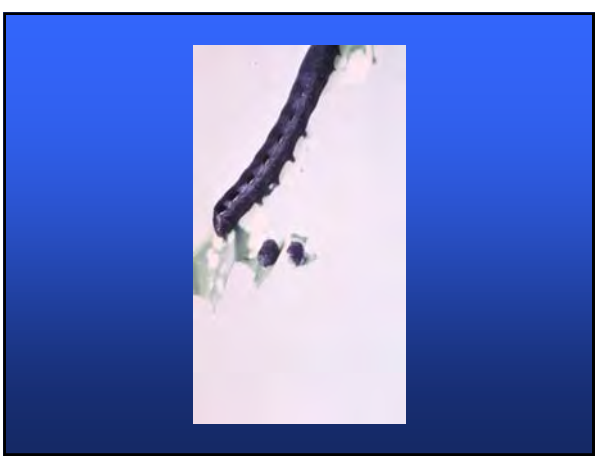
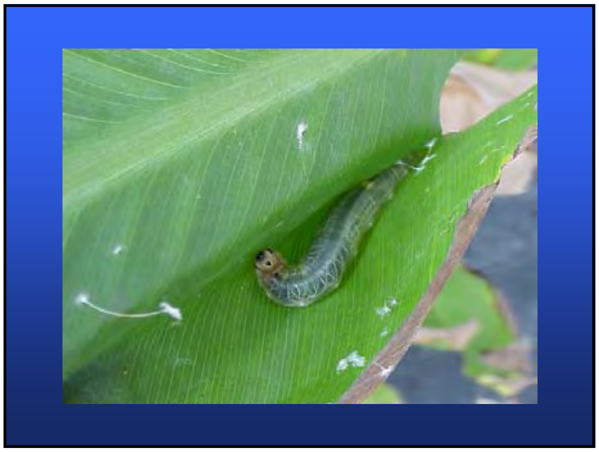
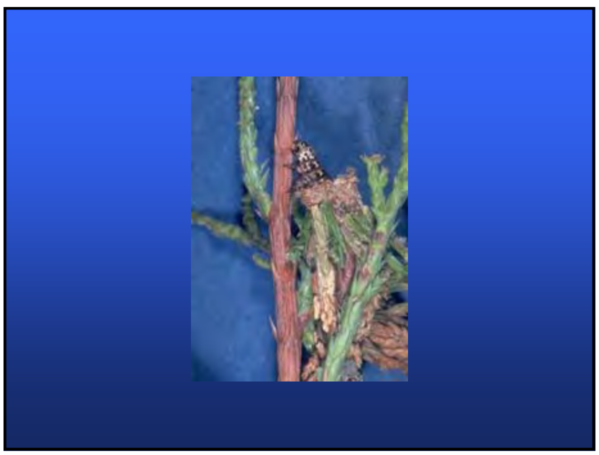
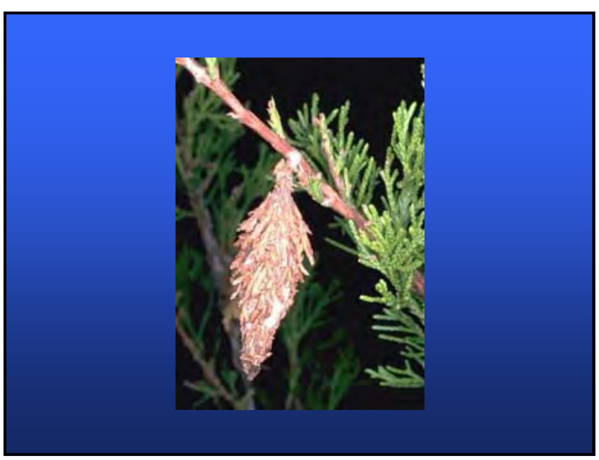










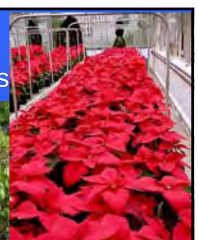
European pepper moth (EPM)

- Native to Mediterranean and Canary Islands
- Expanded its range to include Africa, the Middle East, Europe, Canada, and the United States
- Detected in San Diego in 2004 and again in 2010
- Detected in Florida in the fall of 2010
- aka Southern European marshland pyralid

Positive States

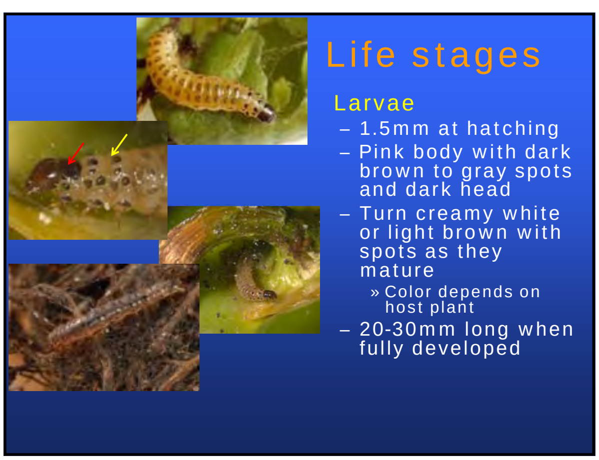
Alabama	New York
Arizona	North Carolina
California	Oklahoma
Colorado	Oregon
Florida	South Carolina
Georgia	Tennessee
Maine	Texas
Mississippi	Washington

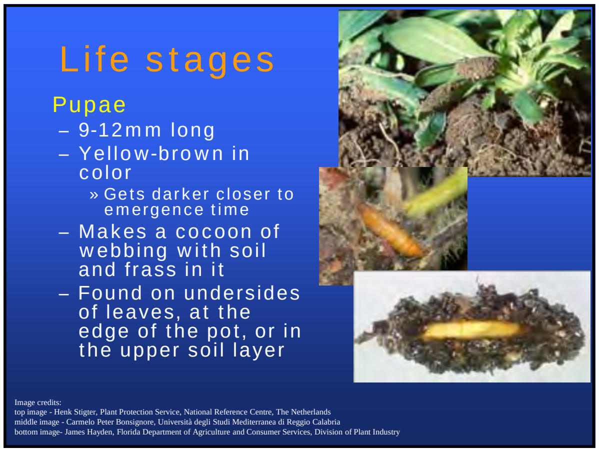
Pest of many herbaceous ornamentals and field crops



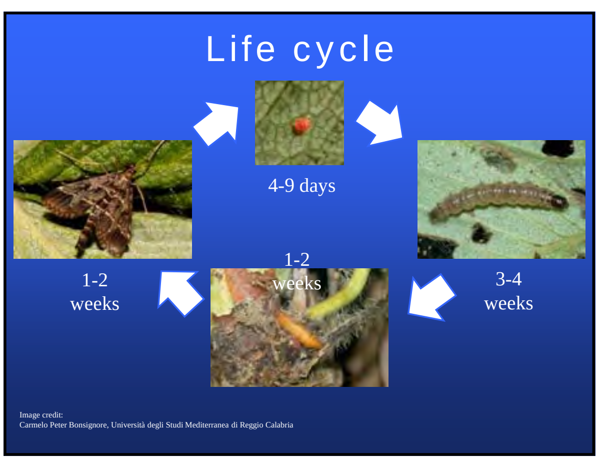

Damage


Life stages
Eggs
– 0.5mm by 0.7mm
– Whitish green turning pink, then red, then brown as the egg gets closer to hatching
– Laid singly or in groups of 3-10
» Overlapping like tiles
– Mostly found on undersides of leaves, on the stems, at the base of the plant, in the upper soil layer


Life stages
Larvae
– 1.5mm at hatching
– Pink body with dark brown to gray spots and dark head
– Turn creamy white or light brown with spots as they mature
» Color depends on host plant
– 20-30mm long when fully developed


Life stages
Pupae
– 9-12mm long
– Yellow-brown in color
» Gets darker closer to emergence time
– Makes a cocoon of webbing with soil and frass in it
– Found on undersides of leaves, at the edge of the pot, or in the upper soil layer
Image credits:
top image - Henk Stigter, Plant Protection Service, National Reference Centre, The Netherlands
middle image - Carmelo Peter Bonsignore, Università degli Studi Mediterranea di Reggio Calabria
bottom image- James Hayden, Florida Department of Agriculture and Consumer Services, Division of Plant Industry


Life stages
male
female


Life cycle
4-9 days
3-4 weeks
1-2 weeks
1-2 weeks
Image credit:
Carmelo Peter Bonsignore, Università degli Studi Mediterranea di Reggio Calabria

Hibernation and Dispersal

- Not known to undergo hibernation or any length of diapause
- In colder climates – it is primarily a pest of greenhouses
- In warmer climates – it is usually found in the field
- Dispersal
  - Movement of plant material spreads this pest
  - They are also good fliers

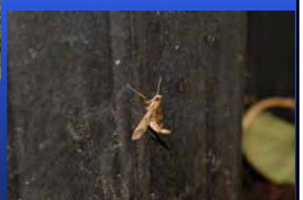
Monitoring

Image credit:
Dr. Peter van Deventer, Plant Research International, Wageningen, The Netherlands

Inspection

Inspection


Inspection

Chemical Control

- Targeted spraying may be best
  - Shape of plants, spacing of plants, and caterpillar behavior determines efficacy of the chemical control
- Monitoring populations to determine spraying schedule is also good


Image credits:
Top - Carmelo Peter Bonsignore, Università degli Studi Mediterranea di Reggio Calabria
Bottom - Jim Bethke, Department of Entomology, University of California, Riverside

Biological Control

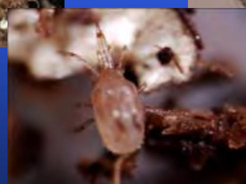
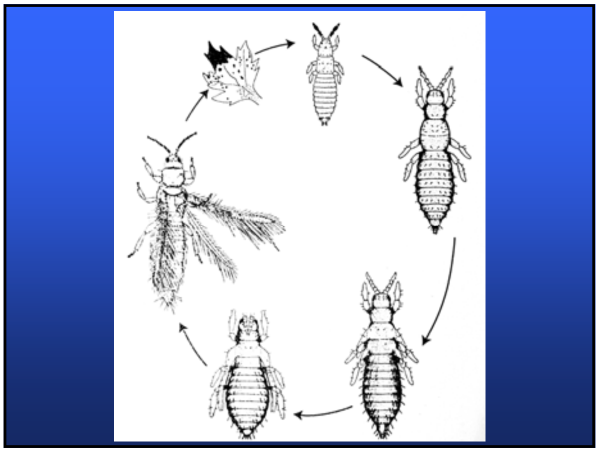
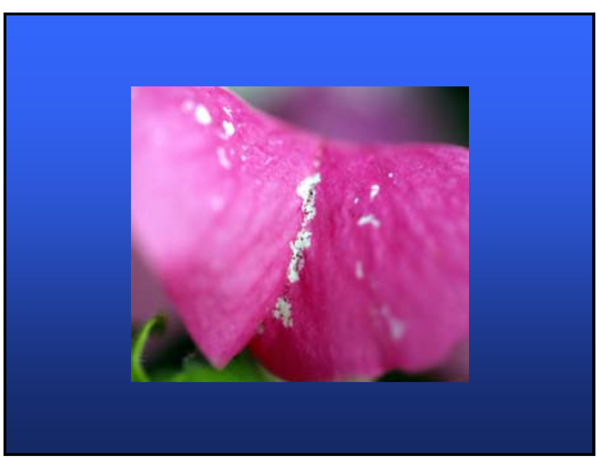
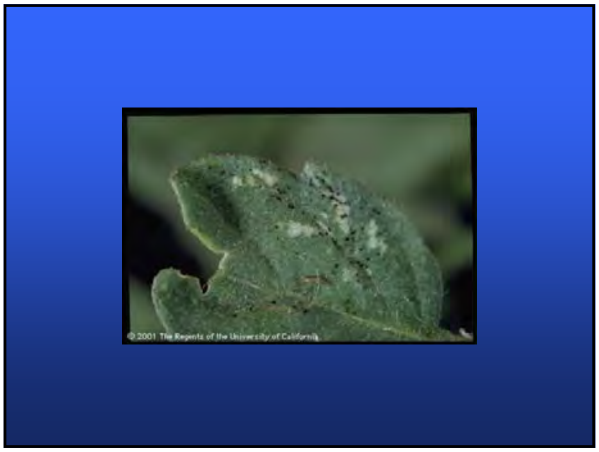


Image credit:
Beetle: David Cappaert, Michigan State University, www.bugwood.org, #5403465
Nematodes: Tesfamariam Mengistu, Department of Entomology and Nematology, University of Florida
Mites: Lance Osborne, Mid-Florida Research and Education Center, University of Florida

THRIPS



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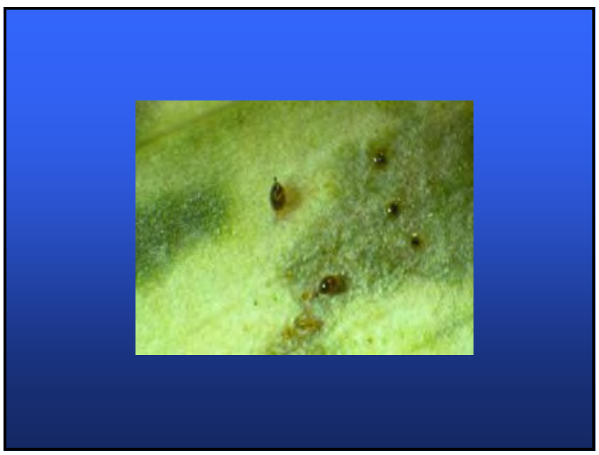

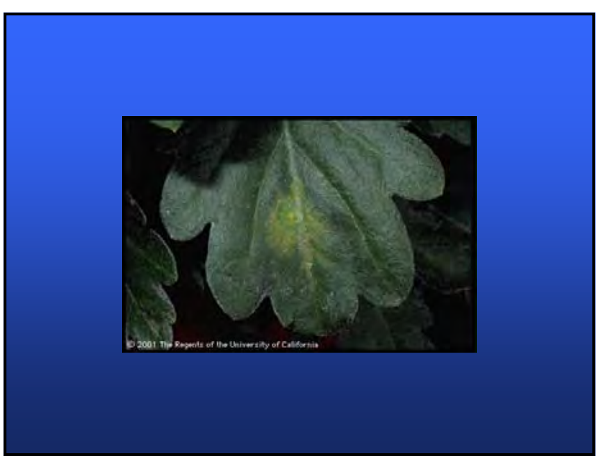
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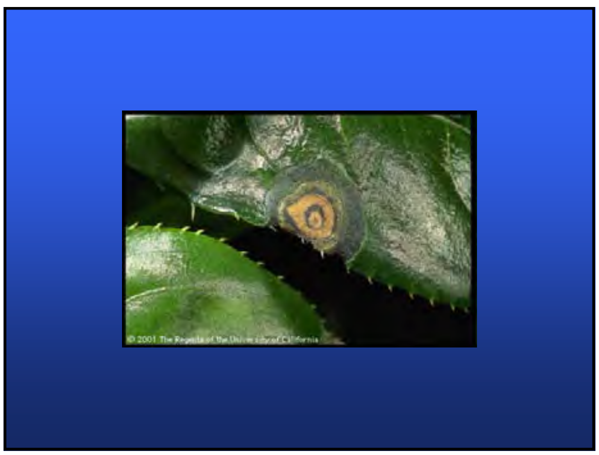
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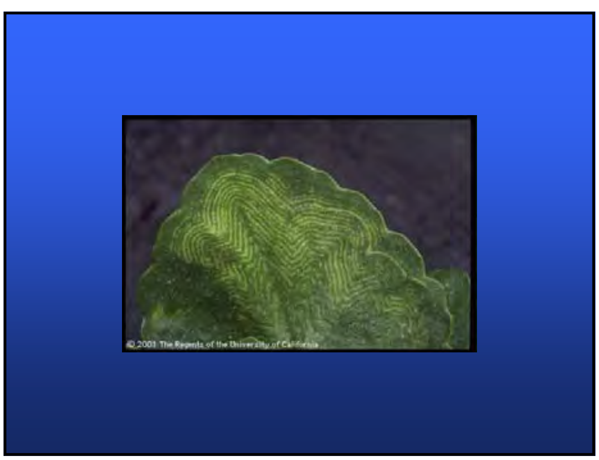
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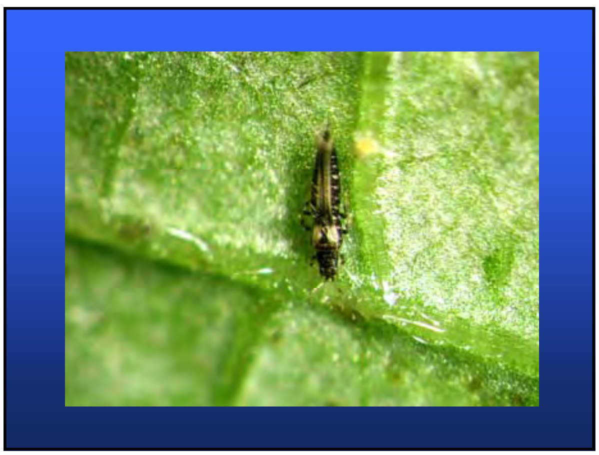
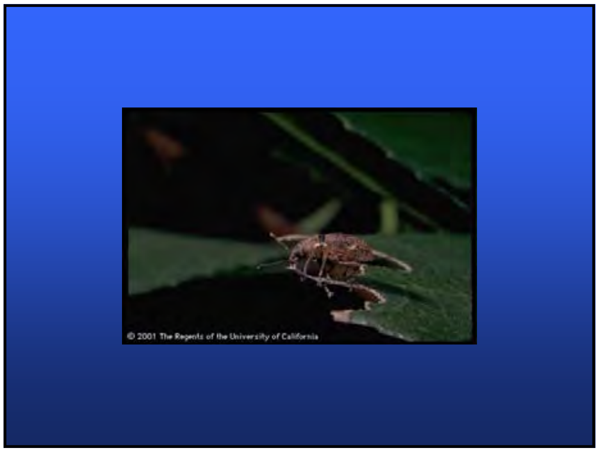


BEETLES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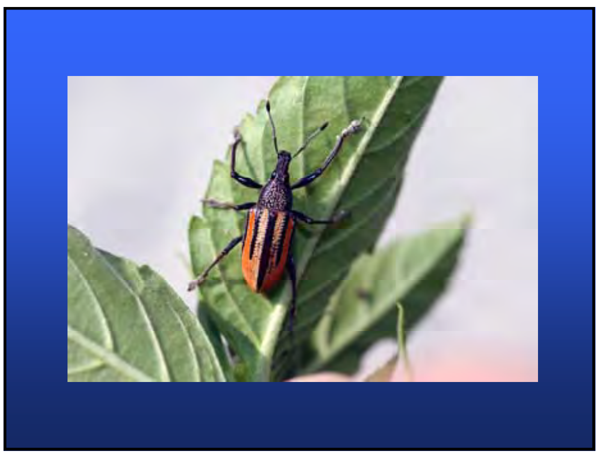


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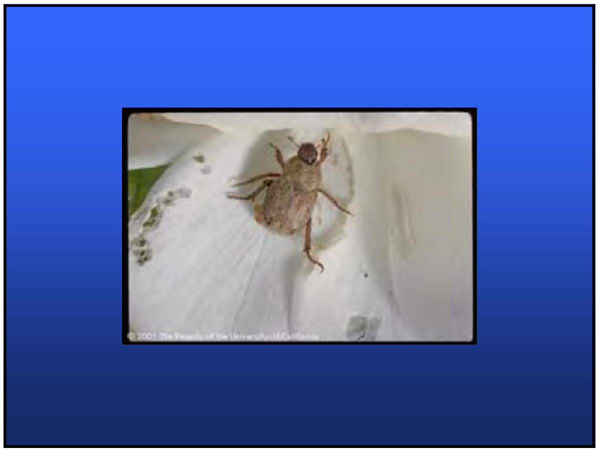
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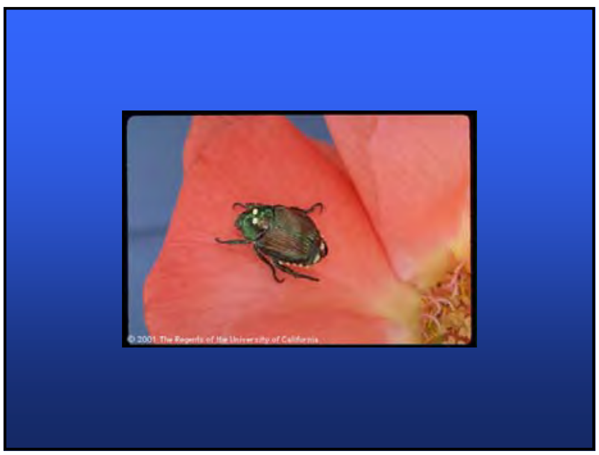
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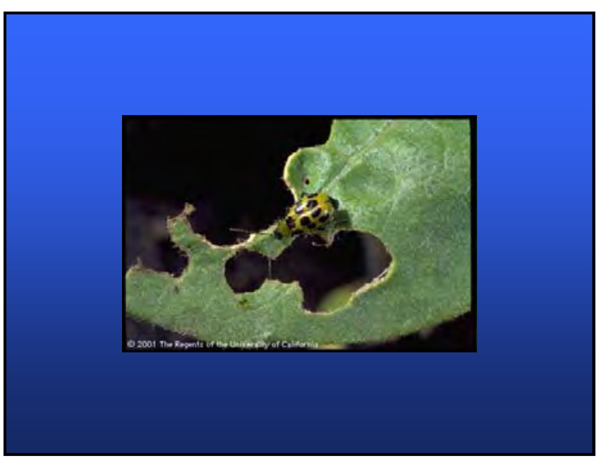
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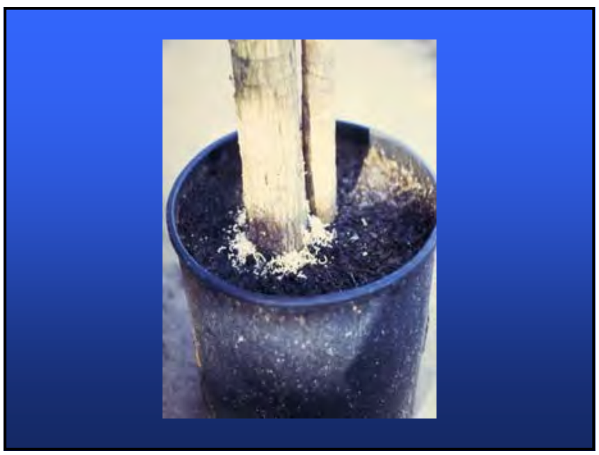

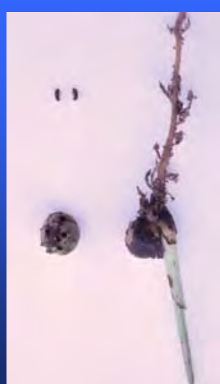

Flies


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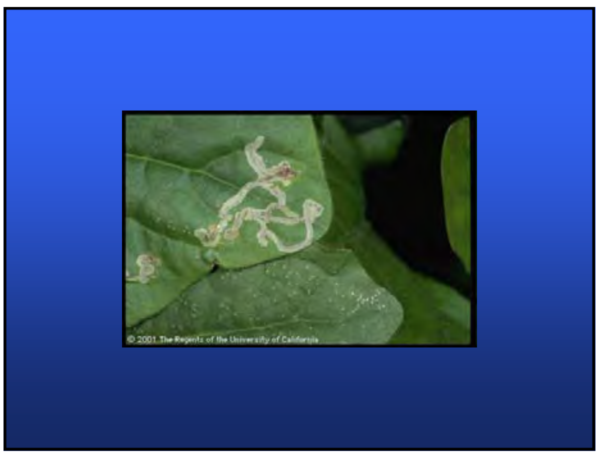
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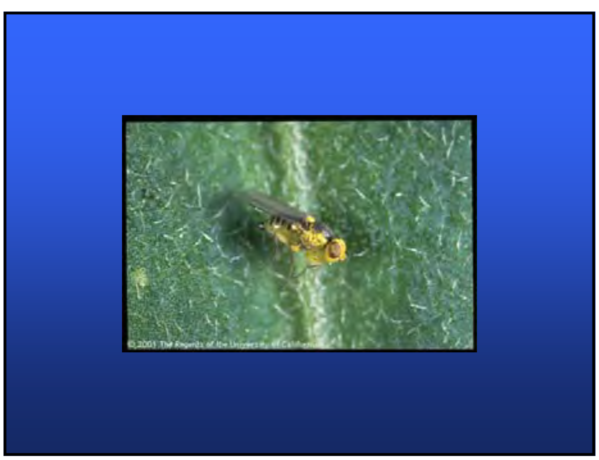
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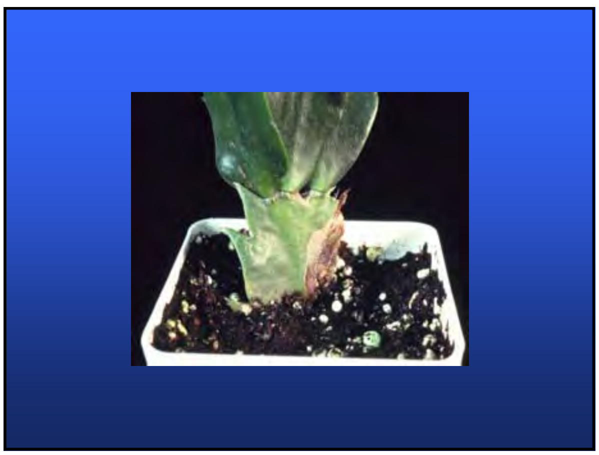


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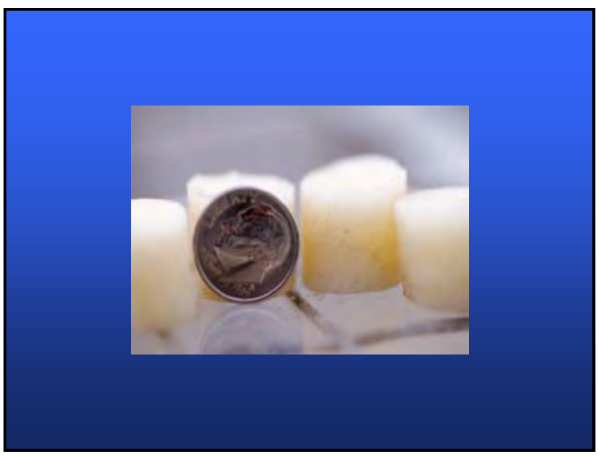

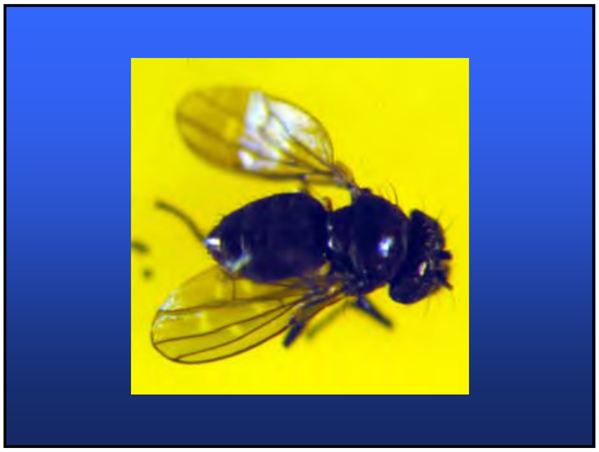


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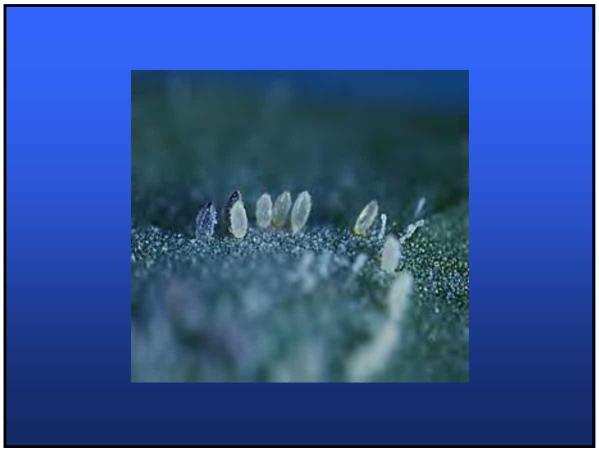
WHITEFLY

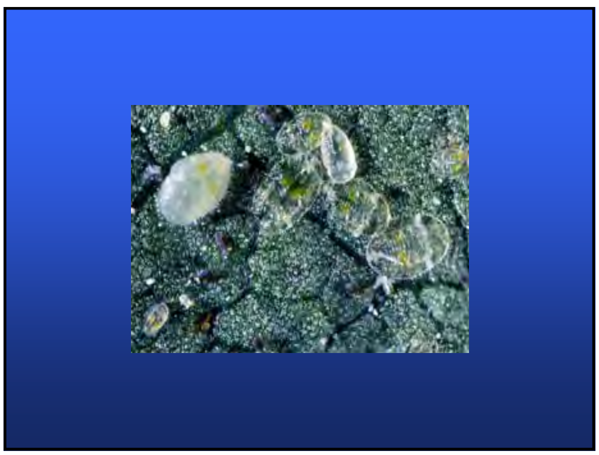
WHITEFLY

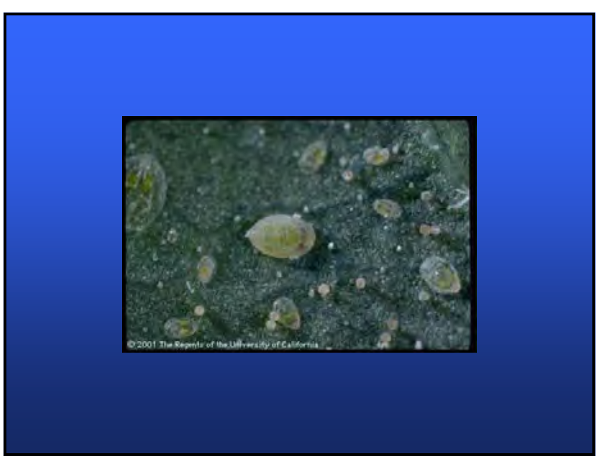
NEW WHITEFLIES

Aleyrodes lonicerae
Aleurodicus dispersus
Aleurodicus rugioperculatus
Aleuroplatus cococolus
Aleurotrachelus trachoides
Aleurotuberculatus aucubae
Paraleyrodes bondari
Singhiella simplex
Siphoninus phillyreae

Bemisia



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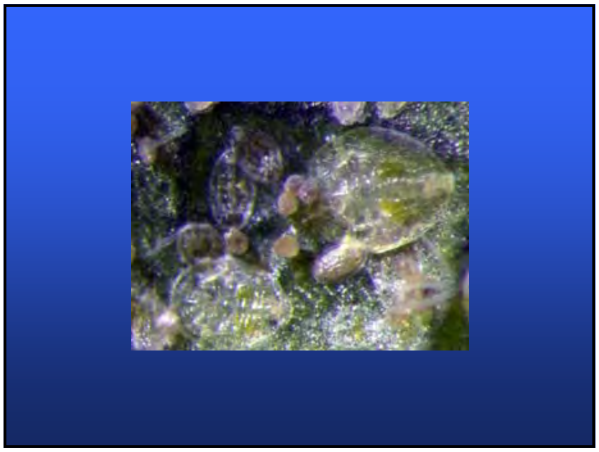
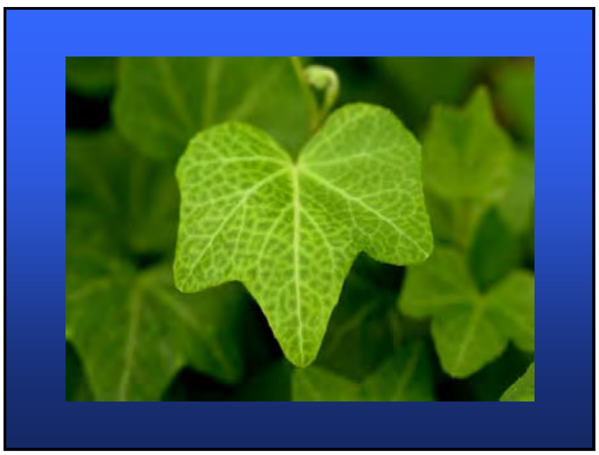
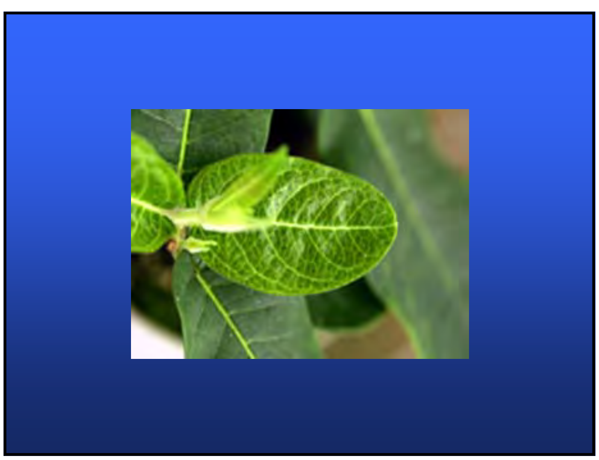






Bondar's Nesting, Ficus, and Rugose Spiraling Whiteflies

- Tropical pests
  - Distribution limited by temperature)
- Ficus whitefly
  - In south and central Florida; along coasts
  - Limited to where ficus grows
- Rugose spiraling whitefly
  - Moving northward particularly along coasts
- Bondar's nesting whitefly

Ficus Whitefly 2007	Rugose Spiraling Whitefly 2009	Bondar's Nesting Whitefly 2011

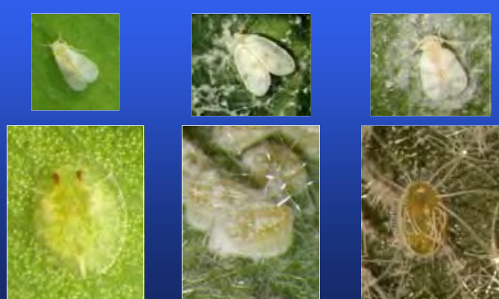
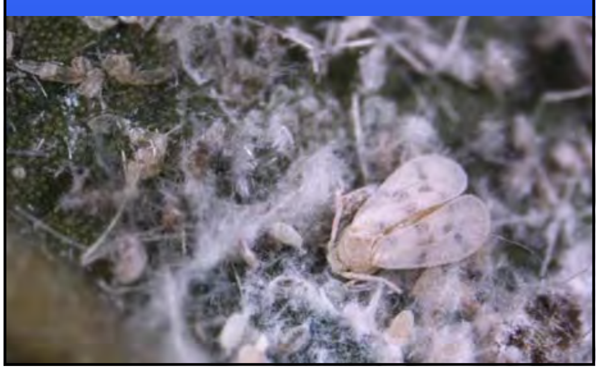


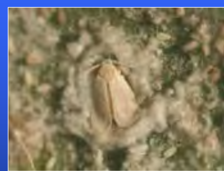
Photo: H. Glenn,, UF/IFAS

Bondar's Nesting Whitefly



Bondar's Nesting Whitefly

- Not known as economic pest
- Often seen with other whiteflies
- Other species known in Florida



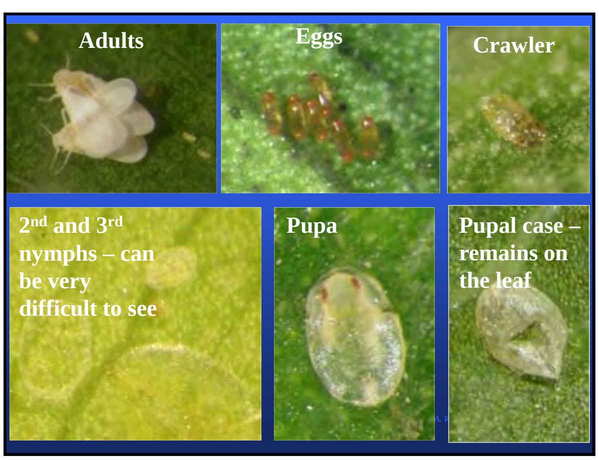
Bondar's Nesting Whitefly

Ficus Whitefly

Ficus Whitefly

Photos: W. Schall, Palm Beach County Extension


Ficus
Whitefly
Photo: H. Glenn, UF/IFAS


Adults
Eggs
Crawler
2nd and 3rd nymphs – can be very difficult to see
Pupa
Pupal case – remains on the leaf


November 2009
November 2010
November 2011
November 2012


Rugose Spiraling Whitefly


Rugose Spiraling Whitefly
Aleurodicus rugioperculatus
Adult
Image credits:
H. Glenn, UF/IFAS, Tropical Research and Education Center

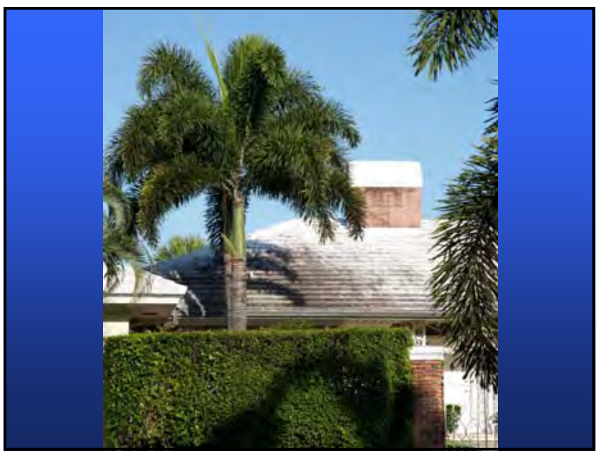
Rugose Spiraling Whitefly Host Plants

- >90 different host species reported
- Not all serve as a good host plant
- Need to look for development

Favorites:

- Gumbo limbo (17%)
- Coconut (10%)
- Calophyllum spp. 10%)
- Avocado (9%)
- Black olive (5%)
- Pigmy date palm (3%)
- Bird of Paradise(2%)
- Christmas palm (2%)
- Mango (2%)


• Excessive honeydew
• Excessive sooty mold




GIANT WHITEFLY

Biological Controls

Whiteflies

Parasites

Predators

Pathogens

Encarsia noyesi

Biological Controls

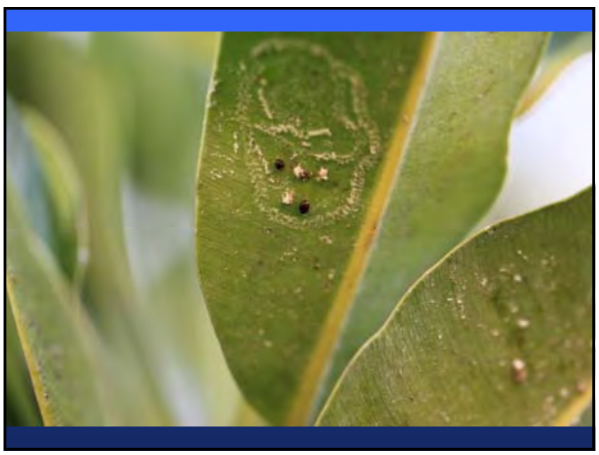
Whiteflies

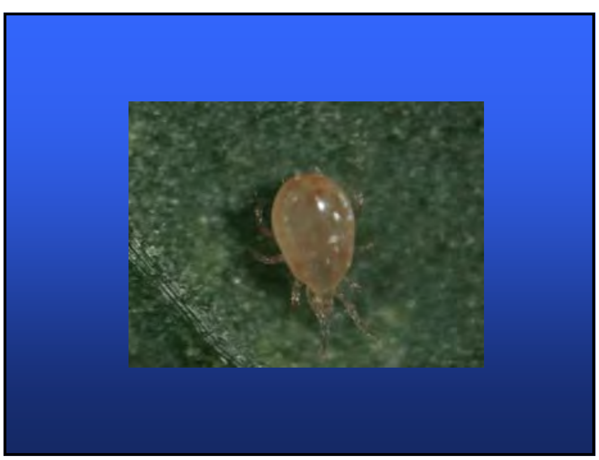
Parasites

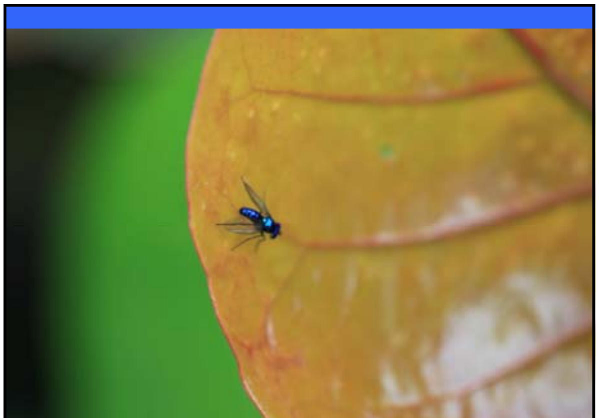
Predators

Pathogens


Nephaspis







Biological Controls

Whiteflies

Parasites

Predators

Pathogens

Isaria fumosorosea growing on adult

Mites

MITES

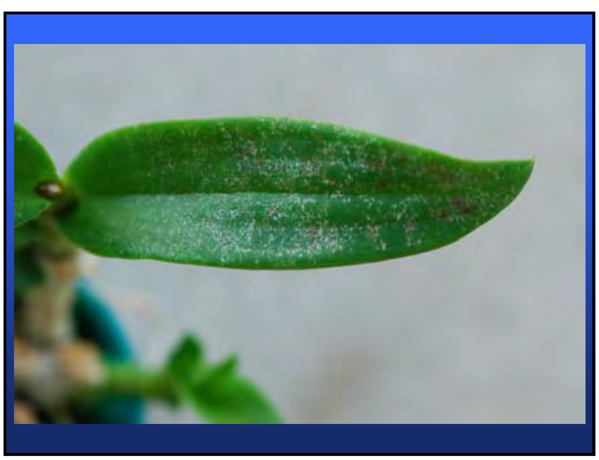
Mites are the KEY pest in many systems.

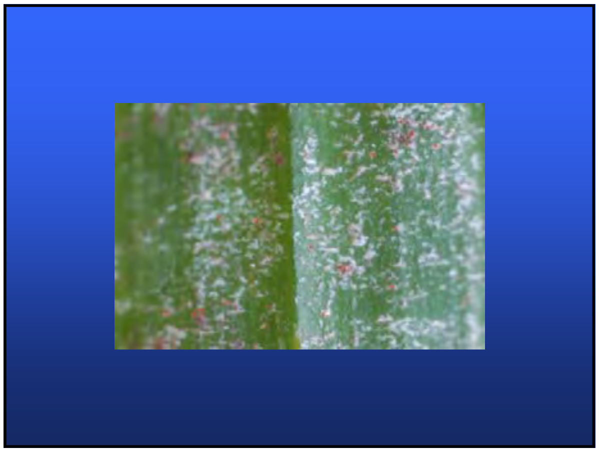
In the United States, 34% of all pesticides applied to ornamentals were for mite control (1996).

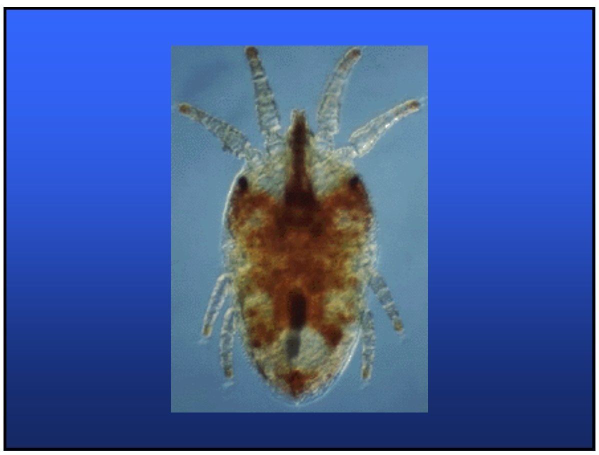
Tenuipalpidae

Brevipalpus spp.

FLAT MITES





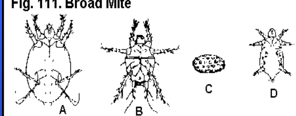


Tarsonemidae

Broad Mite
or
Polyphagotarsonemus latus

Broad Mite

Fig. 111. Broad Mite

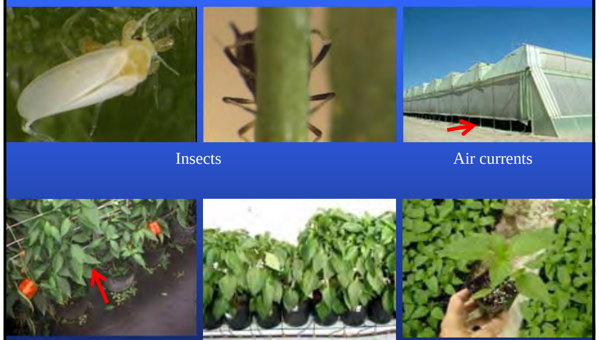


A, Adult female. B, Male. C, Egg. D, Nymph.

Fig. 110

Broad Mite

How do broad mites get into the greenhouse?



Insects

Air currents

Crawling and contact

Infested transplants

BIOLOGICAL CONTROL

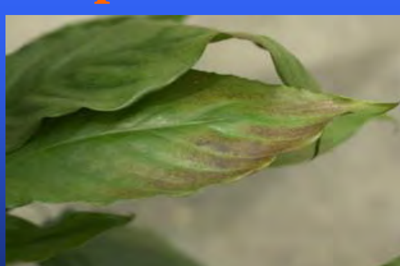
Amblyseius swirskii
Amblyseius cucumeris
Neoseiulus californicus

A. swirskii

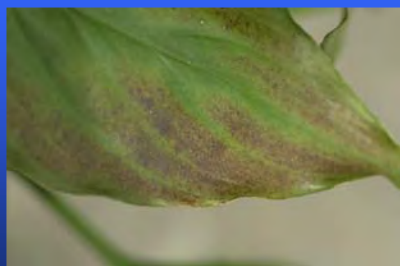
Eriophyoidea

New Pest

Purple Tea Mite

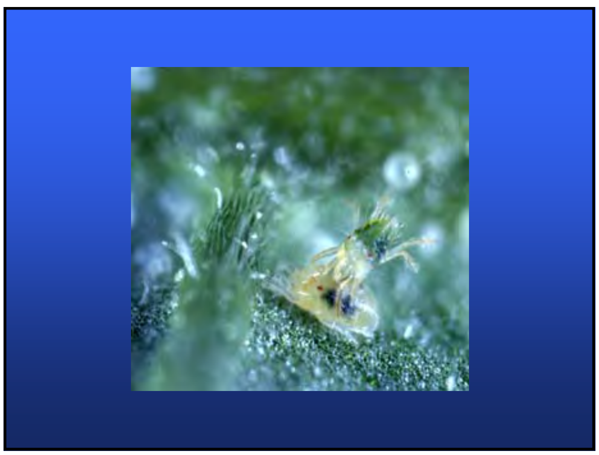


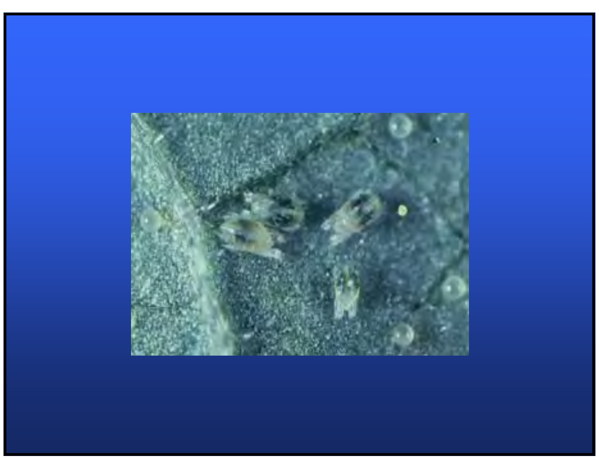
Purple Tea Mite

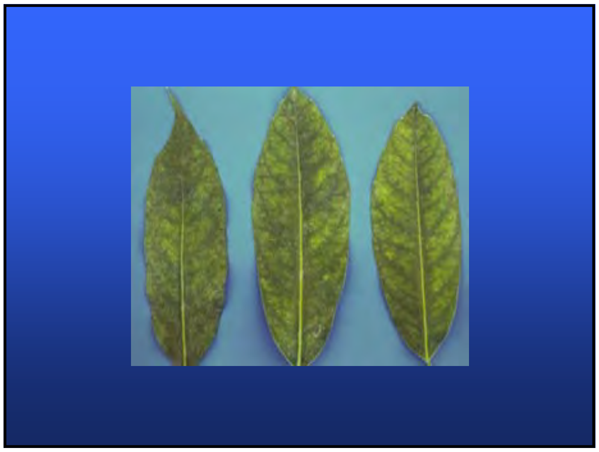


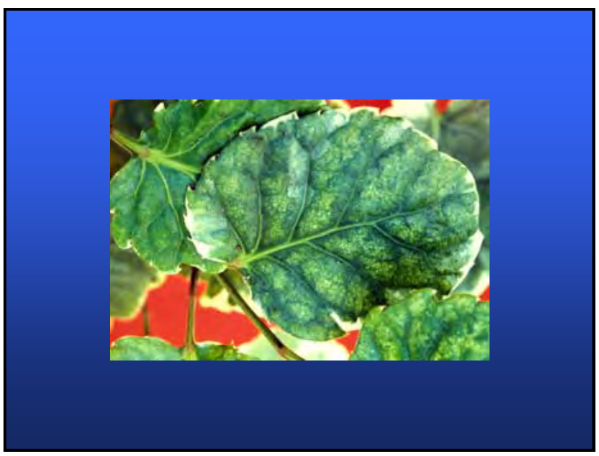
Jutarus benjaminae

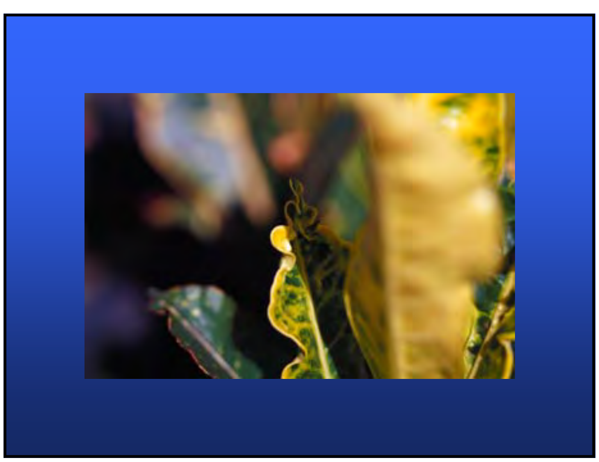
Tetranychidae

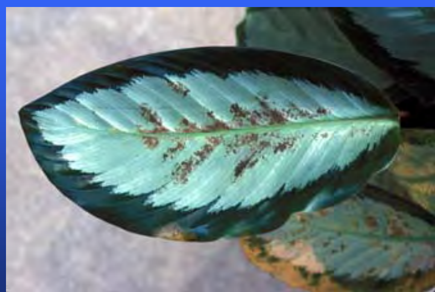




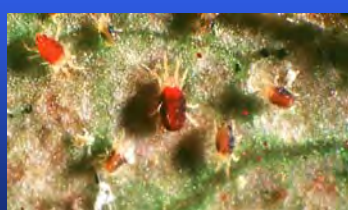








TUMID MITE



TUMID MITE

T. gloveri = red eggs
T. tumidus = white & red eggs

BIOLOGICAL CONTROL

Feltiella acarisuga
Phytoseiulus persimilis
Phytoseiulus macropilus
Neoseiulus californicus

Phytoseiulus persimilus

N. californicus

Thank you!

Questions?

RESEARCH SUPPORTED BY:

Floriculture & Nursery Research Initiative

American Floral Endowment

the IR-4 Project

Biological Control

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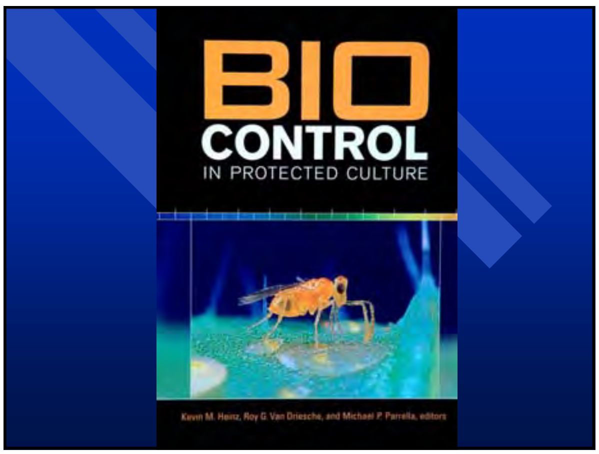
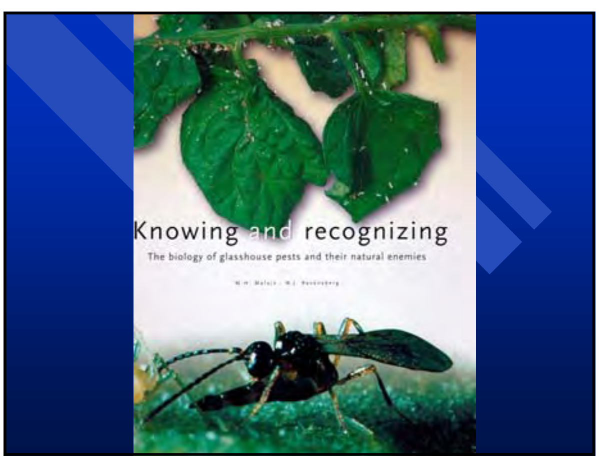




MAJOR PESTS

- Aphids
- Lepidoptera Larvae
- Mealybugs
- Mites
- Scales
- Thrips
- Whitefly

Why Biological Control?

- Relatively inexpensive
- The pest rarely exceeds economic injury levels
- Reduced pesticide residues
- Can be very effective in more permanent ecosystems
- May be the only economically viable solution

Definition:

"Biological control is the use of parasitoid, predator, pathogen, antagonist, or competitor populations to suppress a pest population, making the pest less abundant and less damaging than it would be in the absence of the biocontrol agent."

The Concept:

Biological control does not cause immediate reduction in target pest populations.

The Concept (cont.):

Biological control may only achieve partial suppression of the target pest, as a residual pest population is necessary to maintain natural enemies. However, there are cases where eradication is attempted.

Biological Controls

Parasites

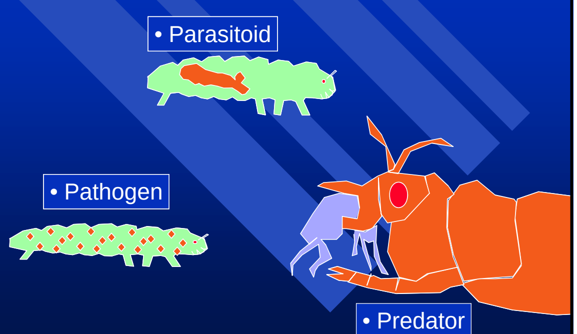
Predators

Pathogens

Natural Enemies-the " Whom "

- **Predator-** consumes more than one prey item during its development
  - Lady beetle
- **Parasitoid-** lives in / on body of one host eventually killing it
  - Parasitic fly or wasp
- **Entomopathogen-** disease causing organism
  - Nematode, bacterium, fungus, protozoan, virus

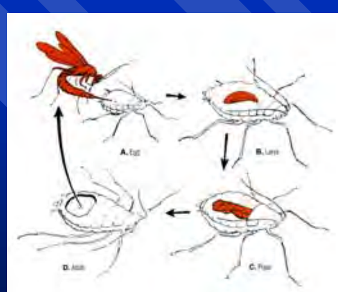
Natural Enemies



Biological Controls

Parasites

Predatory Wasp



Parasitized Aphids

Parasitized Aphids (aphid mummies)

Biological Controls

Predators

Syrphid Fly


Syrphid Fly Eggs
© 2001 The Regents of the University of California


Syrphid Fly Larva
© 2001 The Regents of the University of California


Lacewing adults

Lacewing larva

Ladybugs

Ladybug Eating Aphids

Ladybug Eggs

Ladybug Larva

Ladybug Pupa

Mealybug Destroyer Larva

Mealybug Destroyer Adult

Biological Controls

Pathogens

Naturally Occurring Orange Fungus

Paecilomyces fumosoroseus (PFR-97 Apopka)

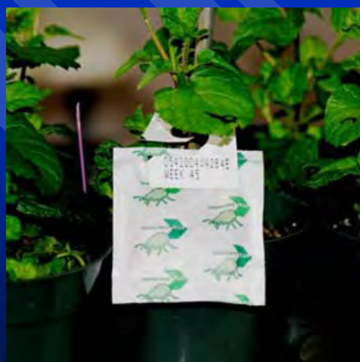
Releases

Classical Biological Control

(usually targeted at an alien pest and self-sustaining)

- Release predatory mites
- Release lacewing larvae

A sachet contains bran and the predatory mite **A. swirskii**.

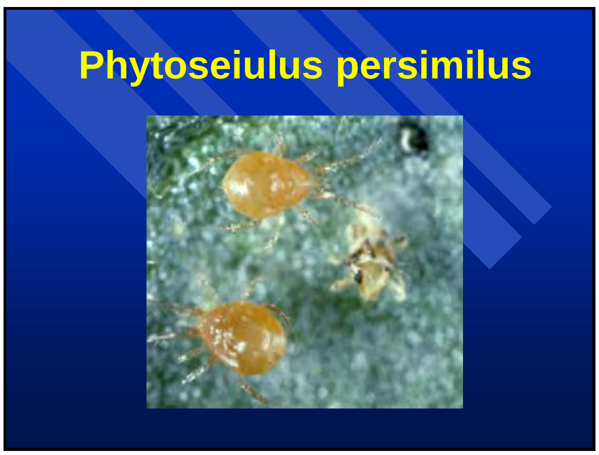


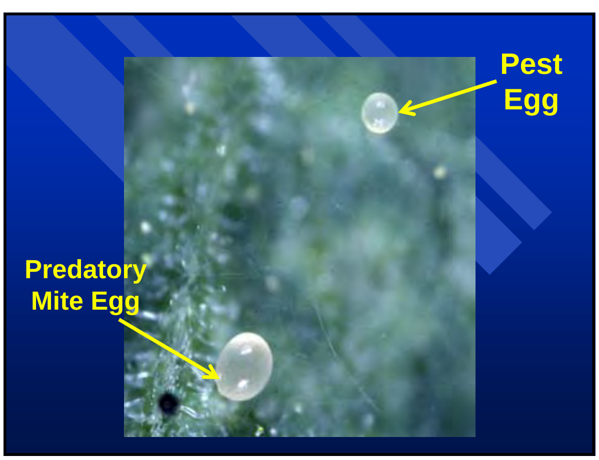
Predatory Mites

- *Amblyseius swirskii*
- *Neoseiulus californicus*
- *Phytoseiulus persimilis*

Amblyseius swirskii


Neoseiulus californicus


Phytoseiulus persimilus


Pest
Egg
Predatory
Mite Egg

CRITICAL NEEDS

- Scouts
- Sources
- Plan
- Manager
- Patience
- Budget

PLAN

- Chose a plant/pest to start with
- Establish commercial partner
- Know what pests to expect
- Start with one pest …have plan for others
- Start as clean as possible
- Isolate small trial
- Begin receiving shipments

PLAN

- MONITOR!!!
- Begin to prepare for larger trial
- Take notes
- When comfortable with this…try another pest


PATIENCE
START SLOW AND WORK YOUR WAY TOWARD A GOAL


IMPORTANT LINKS
MREC.IFAS.UFL.EDU/LSO
Or search GOOGLE
IPM Foliage Plants


Thank you!

Scouting Strategies

Grantly Ricketts
Adapted from: Juanita Popenoe

Hot Spots

Containers/Field Nurseries

- Near weedy areas, ditches, roads, wet spots, dry spots, other crops
- Direction of prevailing winds



Reasons for Monitoring

- To determine if a pest species is present, and if so, then its abundance and distribution.
- Also obtain site-specific information about natural enemies, plant growth, & environmental conditions.
- This information is used to justify pest management decisions.
- It helps minimize plant damage and reduces unnecessary pesticide use.

Preliminary Scouting

- Determine presence or absence of pests or damage
- Use indicator plants
- Know "key plants – key pests"
- This is faster, but less precise

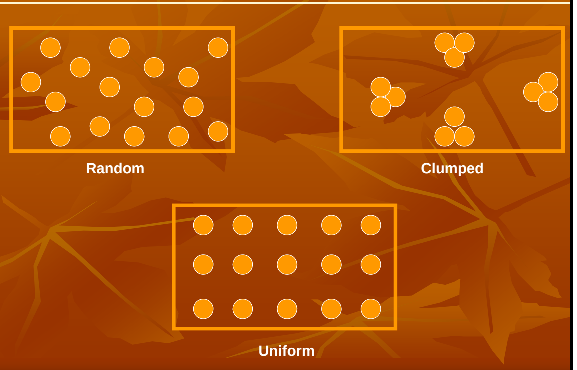
Types of Samples

- **Absolute samples:**
  - Measure the total pest population in an area.
  - Very accurate, but very time consuming
  - Example: counting all weeds in pots of poinsettias in a greenhouse
- **Relative samples:**
  - Estimate the total population by sampling a portion of the population
  - Not time consuming, but accuracy varies
  - Examples: counts of pests caught in beating sheets, sweep nets, damage within a sampling frame

Sampling Patterns

- **Random Sample** – Most common sampling pattern (avoids unbiased estimates)
  - Samples are taken at randomly selected intervals (e.g., walk 5 steps to take first sample and 10 steps to take second sample, etc.
- **Stratified Sample** – Used when there is great inconsistency in the sampled area (e.g., soil type, topography, cardinal direction)
  - Divide area to be sampled into equal sized units, depending on traits, and sample each independently
- **Systematic Sample** – Every sampling unit is chosen methodically from a randomly chosen starting point (e.g., collect 1 leaflet every 10 plants)

Pest Distribution Patterns



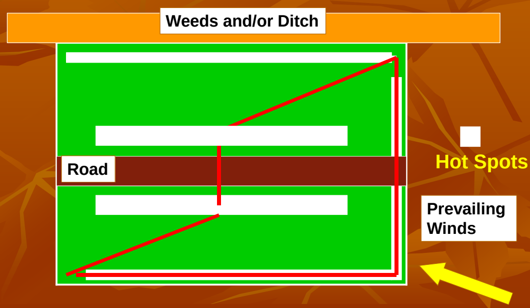
Making Maps

Hot Spots – Container and Field Nurseries

Scouting Patterns

- Walk through production blocks (PMU) in a zigzag pattern
- Make random selections of plants, but also inspect plants that appear to be less healthy
- As a rule of thumb, spend at least 10 minutes inspecting 20 or more plants for each 1000 square feet of production area being surveyed - initially

Scouting Patterns – Container and Field Nurseries



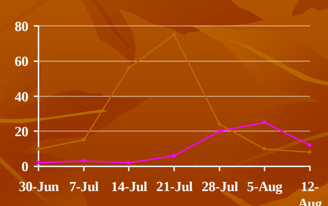
Keep track of:

- When
- Where
- How Many
- Natural Enemies

Sample Frequently

Thresholds

Keep Records!



ECONOMIC INJURY LEVEL (EIL): The lowest pest density at which economic losses occur. Economic damage is the amount of injury which will justify the cost of control measures. Varies by pest, commodity, location, season, market values.

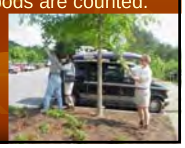
ECONOMIC THRESHOLD (ET): a.k.a "The action threshold." Pest density at which some management decision must be made to prevent an increasing pest population from reaching damaging levels and preventing economic loss (the EIL).

Common Sampling Techniques

***In Situ* Counts** - Direct observation and counts of an insect within its habitat (no special equipment is needed).

•If insect numbers are low and plants are small, all insects on the plant may be counted. If organisms are too scattered to be counted, a selected number of organisms within an area may be sampled. Equipment (e.g., piece of square metal) can be used to assist with counting. For large plants, known numbers of leaves, stems, flowers, buds or pods are counted.

* The most widely used method of sampling plants



1) *In Situ* Counts

Yellow Sticky Card Data

Location	Card No.	Date Placed	Whitefly	Aphids	Thrips

UTAH PESTS fact sheet

UtahState UNIVERSITY extension

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Using Degree Days to Time Treatments for Insect Pests

Marion S. Murray, IPM Project Leader

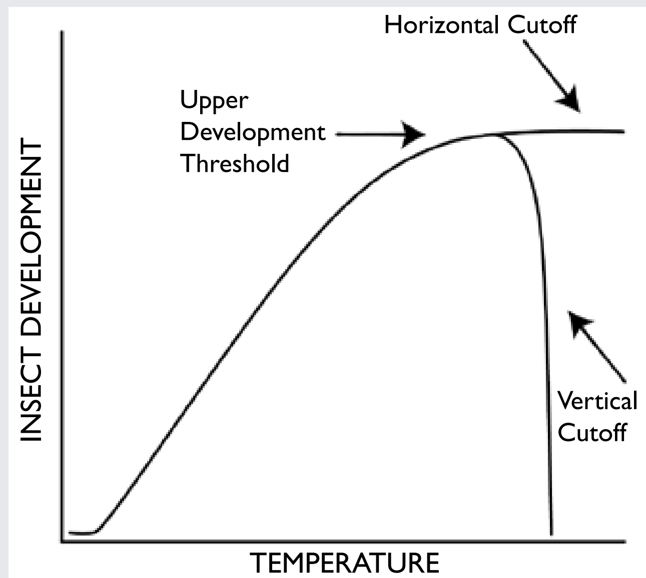
Insecticides that are applied for a perennial insect pest based on a calendar date often result in poor insect control and a waste of resources. Insect activity varies from year to year depending on weather. For example, in Logan, Utah, eggs of the apple pest codling moth began hatching on May 15 in 2005, May 5 in 2006, and April 30 in 2007. If apples grower always spray on May 1, they are not making the most effective insecticide treatment in most years. As long as accurate weather data can be obtained, using degree days to time treatments is more reliable than a calendar date and allows growers to pinpoint a specific treatment date each year.

Degree days (often referred to as "growing degree days") are accurate because insects have a predictable development pattern based on heat accumulation. Insects are exothermic ("cold-blooded") and their body temperature and growth are affected by their surrounding temperature. Every insect requires a consistent amount of heat accumulation to reach certain life stages, such as egg hatch or adult flight. Degree day values interpret that heat accumulation. When used to determine treatment timing, they are an important component of an Integrated Pest Management program, providing a cost effective tool to reduce insect feeding damage.

CALCULATING DEGREE DAYS

Simply put, a degree day (DD) is a measurement of heat units over time, calculated from daily maximum and minimum temperatures. Degree days are based on the rate of an insect's development at temperatures between upper and lower limits for development (see Figure 1). The minimum temperature at which insects first start to develop is called the "lower developmental threshold", or baseline. The maximum temperature at which insects stop developing is called the "upper developmental threshold," or cutoff. The lower and upper thresholds vary among species, and have been determined for many, but not all, major insect pests. For those whose exact values are unknown, including most landscape insect pests, a baseline temperature of 50˚F is used. Some insects do not have an upper development threshold.

Figure 1. An insect's development follows a predictable progression based on temperature. When insects reach their upper threshold, development of some species levels off (horizontal cutoff), and for other species, stops (vertical cutoff).



Although degree days are usually calculated for a 24-hour time period, it is the number of accumulated degree days from a starting point, called a biofix, that is most useful. The biofix can be a biological event, such as the date at which moth flight begins, or a calendar date, such as March 1. In northern Utah, we start accumulating degree days for insect pests, such as codling moth, that have a baseline of 50˚F on March 1, because there is typically no insect development before that time.

No matter how it is calculated, the degree day value for a 24-hour period is added to the prior day's values, and so on. For an average growing season in northern Utah, areas will accumulate approximately 2500-3500 degree days (with a baseline of 50˚F).

Average Method

In general, degree days can be calculated using a simple formula for the average daily temperature, calculated from the daily maximum and minimum temperatures, minus the baseline (lower developmental threshold):

[(daily maximum temperature + daily minimum temperature)/2] – baseline temperature.

For example, a day where the high is 72˚F and the low is 44˚F would accumulate 8 degree days using 50˚F as the baseline:

Example 1: [(72 + 44)/2] – 50 = 8.

When temperatures do not exceed 50, zero degree days have accumulated. This calculation method is the simplest and least precise.

Modified Average Method

The problem with the average method is that it does not take into account the length of time that the daily temperature may exceed the baseline temperature. In Example 1, results could be skewed if the minimum temperature of 44˚ F occurred for only 30 minutes out of the 24-hour day while the rest of the time the temperature was above 50˚ F. Given this, the accumulated degree days using the above calculation would be less than the actual value. To account for situations when the daily minimum temperature is less than the baseline, or the daily maximum temperature is greater than the cutoff, the formula needs to be modified. When either occurs, the lower threshold is used instead of the daily minimum, or the upper threshold is used instead of the maximum. For the above example, we would use 50˚F as the daily minimum temperature in the formula instead of 44˚F:

Example 2: [(72 + 50)/2] – 50 = 11.

And for a day with a maximum temperature of 102˚F, and a low of 70˚F, we would replace the 102 with the upper threshold temperature, if known. We know that it is 88˚F for codling moth, so the degree days would be:

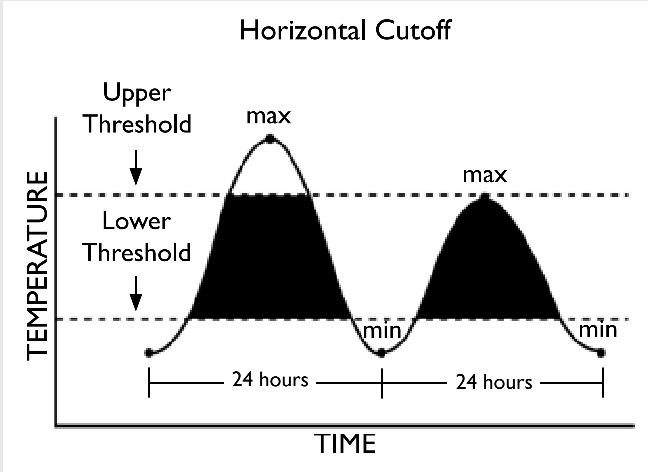
Example 3: [(88+70)/2] – 50 = 29.

Sine Wave Method

A more precise and method of calculating degree days is called the sine wave method. This method still uses the daily minimum, maximum, and baseline temperatures (lower threshold), but also incorporates the upper threshold temperature into the calculation. It is based on the assumption that temperatures of a 24-hour day follow a sine wave curve. The number of degree days is then calculated as the area under this curve within the lower and upper temperature thresholds (see Figure 2).

Because of the somewhat complicated calculus involved, the sine wave formula is not shown here. Degree days calculated using this method are usually determined by a computer.

Figure 2. This diagram is a visual representation of degree days using the sine wave method of calculation, with a horizontal cutoff. The area in black under the curve represents the number of degree days that fall between a lower and upper threshold, for each 24-hour period.



USING DEGREE DAYS

Scouting

Accumulated degree days are useful in timing scouting events such as when to place traps, when to look for damage, when to sample, etc. As an example, codling moth pheromone monitoring traps are placed in the apple orchard at 100 degree days after March 1 in northern Utah to determine initiation of adult moth flight.

Using Insect Models

Scientists have studied biological development over time (phenology) of insects in correlation to accumulated degree days, discovering information on key physiological events, such as egg hatch, adult flight, etc. This predictive information is known as an insect model. Insect models are useful in timing insecticide treatment because the entire life cycle (or certain important events) of the insect is known. Models have been developed for a number of insect pests (see Table 1).

Predicting Treatment Timing

With the development of more targeted, reduced risk insecticides, timing of application is becoming more and more important. Certain life stages of insects are more susceptible to insecticide treatment such as young larvae or scale crawlers. Degree days are used to predict when those life stages will occur (see Table 2). Degree days are "projected" into the future for a given site using either forecasted daily highs and lows or 30-year average highs and lows. This information is only an approximation of a future event, but is highly useful in planning.

Table 1. A partial list of insect pests that occur in Utah for which we have temperature thresholds and degree day models. Those with an asterisk have been validated for Utah.

Target Insect		Lower Developmental Threshold (F)	Upper Developmental Threshold (F)	Availability of Model
Common Name	Scientific Name			
Alfalfa weevil	*Hypera postica*	50	87	yes
Armyworm	*Pseudaletia unipuncta*	50	84	yes
Black cutworm	*Agrotis ipsilon*	50	86	yes
Cabbage maggot	*Delia radicum*	40	86	yes
Codling moth*	*Cydia pomonella*	50	88	yes
Corn earworm*	*Helicoverpa zea*	55	92	yes
European pine shoot moth	*Rhyacionia bouliana*	28	---	yes
European red mite	*Panonychus ulmi*	51	---	yes
Greater peachtree borer	*Synanthedon exitiosa*	50	87	no
Lilac/ash borer*	*Podosesia syringae*	50	---	yes
Obliquebanded leafroller*	*Choristoneura rosaceana*	43	85	yes
Peach twig borer*	*Anarsia lineatella*	50	88	yes
Pear psylla	*Cacopsylla pyricola*	41	-	no
San Jose scale*	*Quadraspidiotus perniciosus*	51	90	yes
Strawberry root weevil	*Otiorhynchus ovatus*	40	103	yes
Variegated cutworm	*Peridroma saucia*	45	80	yes
Walnut husk fly*	*Rhagoletis completa*	41	130	yes
Western cherry fruit fly*	*Rhagoletis indifferens*	41	130	yes

*Insect model has been validated for Utah
Threshold and model information from: UC-Davis IPM Web site: http://www.ipm.ucdavis.edu/MODELS/index.html

Table 2. A partial list of degree day (GDD) accumulations for selected landscape pests that occur in Utah. "DD Min" is the earliest timing for appearance, and "DD Max" is the latest timing.

Common Name	Scientific Name	Life Stage*	DD Min	DD Max
Black pineleaf scale	*Dynaspidiotus californica*	E	1068	
Bronze birch borer	*Agrilus anxius*	A	440	800
Cankerworms	*Alsophila sp.*	L	148	290
European fruit lecanium scale	*Parthenolecanium corni*	C	800	
European pine shoot moth	*Rhyacionia bouliana*	L A E	50 700 900	220 800 1000
Honeylocust plant bug	*Diaphnocoris chlorionis*	N, A	58	246
Lilac/Ash borer	*Podosesia syringae*	L	148	299
Lilac root weevil	*Otiorhynchus meridionalis*	A	500	950
Locust borer	*Magacyllene robiniae*	L, A	2271	2805
Oystershell scale	*Lepidosaphes ulmi*	C C	363 1600	707 1700
Pine needle scale	*Chionaspis pinifoliae*	C C	298 1388	448 1917
Spruce spider mite	*Oligonychus ununguis*	E,L E,L,A E,L,N,A	7 192 2375	121 363 2806
Western tent caterpillar	*Malacosoma californicum*	L	100	500
Western spruce budworm	*Choristoneura occidentalis*	L	200	300

*E (eggs), N (nymph), C (crawler), L (larvae), A (adults)
Degree day values determined by: Dr. Warren T. Johnson, Department of Entomology, Cornell University.

The most widely used insect model in Utah is for codling moth (see Table 3). For this pest, it is important to know when 220 degree days after biofix will occur, because this point corresponds to first generation egg hatch, when fruit should begin to be protected.

Table 3. Example of an insect model for **codling moth** showing method of calculation and degree days required for development.

Developmental Thresholds
Lower: 50 F
Upper: 88 F

Calculation Method: Single Sine

Cutoff Method: Horizontal

Set out Traps: 100 DD after March 1

Biofix: First consistent (2+ in a single trap) catch of adults in the pheromone trap

Degree-Day Accumulations Required for Each Stage of Development

Event	DD
Generation Time (egg to egg)	880
Generation Time (50% egg hatch to same)	1096
1% egg hatch (1st gen)	220
20% egg hatch (1st gen)	360
50% egg hatch (1st gen)	484
75% egg hatch (1st gen)	610
95% egg hatch (1st gen)	800
5% Adult emergence (2nd gen)	1000
7% egg hatch (2nd gen)	1260
30% egg hatch (2nd gen)	1460
50% egg hatch (2nd gen)	1580
75% egg hatch (2nd gen)	1750
95% egg hatch (2nd gen)	2000

OBTAINING DEGREE DAYS

Whether you are calculating your own degree days, or using information from an instrument or Web site, it is important to know how the degree days were calculated for the target insect, and that your calculation method matches, or is modified to match. There are a variety of ways to acquire degree days:

1. To calculate your own degree days, you will need a thermometer that records maximum and minimum temperatures in a location that closely matches the temperatures that your target pest(s) would encounter. Max-Min thermometers are inexpensive, easily available, and record in digital or mercury. Some digital models will store up to seven days of readings. The thermometer should be calibrated at the start of each season, and placed away from direct sunlight, ideally in a white shelter box. Obtain degree days in one of the following ways:
   - Calculate them daily using the average or modified average method.
   - Use a degree day look-up table. Degree day values for high and low temperatures are available for certain insects in a look-up table (see Table 4 for example).
   - Enter daily maximum and minimum temperatures into a computer spreadsheet that is set up to calculate the values.

2. Biophenometers are instruments that calculate degree days every few minutes based on temperatures and are highly accurate. Many brands allow you to manually input the target pest's upper and lower thresholds. They can be purchased as a stand-alone, or in conjunction with a weather station. Minor setbacks include price ($300-$1000), and the fact that the instruments' degree day calculation method provides different results than the modified sine wave method. Typically, the degree days that researchers determined for insect models were calculated using the sine wave method, so values calculated from the biophenometers would be slightly less. They may need to be compared to the values from the sine calculation for one season and readjusted accordingly.

3. USU Extension weekly pest reports (http://utahpests.usu.edu/ipm/htm/advisories) provide accumulated and predicted degree days for a variety of sites across northern Utah. Your local county Extension office can also help you with this information.

4. An Internet search for "degree day calculator" can often turn up sites where you can enter your own data, or select a location.

LIMITATIONS OF DEGREE DAYS

The primary limiting factor in using degree days is obtaining accurate temperature readings. If a thermometer, biophenometer, or weather station location is not representative of the environment in which the target insect occurs, the resultant degree days will not mirror the actual insect development. In addition, temperatures at one site may not be reflective of conditions in another site several miles away. This is particularly true of Utah, where mountains, lakes, and deserts result in a wide variety of microclimates.

Table 4. Example of a degree day look-up table for peach twig borer and codling moth (base 50°F) (not a complete table).

Maximum Temperature (˚F) \ Minimum Temperature (˚F)	48	51	54	57	60	63	66	69	72	75	78	81
52	1	2										
58	2	3	5									
61	5	6	8	9	11							
64	6	8	9	11	12	14						
70	9	11	12	14	15	17	18	20				
73	11	12	14	15	17	18	20	21	23			
76	12	14	15	17	18	20	21	23	24	26		
79	14	15	17	18	20	21	23	24	26	27	29	
82	15	17	18	20	21	23	24	26	27	29	30	32
85	17	18	20	21	23	24	26	27	29	30	32	33
88	18	20	21	23	24	26	27	29	30	32	33	35
91	19	21	22	24	25	27	28	30	31	32	34	35

GLOSSARY

Baseline: Equivalent to "lower developmental threshold."

Biofix: A date that signals the start of growing degree day accumulations ("biological fix"). The date can be represented by a biological event, such as first moth flight, or a calendar date.

Degree days: A measurement of heat units over time, equivalent to the number of degrees that the average temperature is above a baseline value. Also known as "growing degree days" (GDD) to differentiate this value from "heating degree days" or "cooling degree days," which are used to estimate energy demand.

GDD (50), DD (50), GDD_{50}, DD_{50}, DD (base 50), etc: Terminology used to describe a value of degree days, using 50° F as the baseline temperature.

Lower Developmental Threshold: A temperature at which insect development begins (also known as "baseline"); determined by laboratory studies.

Phenology: The study of periodic biological events, such as plant flowering, insect development, etc., in relation to environmental factors, such as temperature (translated as: "knowledge of phenomena").

Upper Developmental Threshold: A maximum temperature of insect development where development levels off or slows down; determined by laboratory studies.

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UPPDL, 5305 Old Main Hill, Logan UT 84322-5305 T: 435.797.2435 F: 435.797.8197 www.utah pests.usu.edu

Scouting Record Sheet (Side 1)

Location ____________________________________

Date ____________________ Plant ____________________

Scout Name ____________________ Pot Size ____________________

Time In ____________________ Time Out ____________________

Biased Sampling Comments:

Plant	Symptom (% Plant Damage)	# Lvs. w. Adult Pests	# Lvs. w. Immatures	% Pests Parasitized	Beneficial Pres./Abs.	Beneficial Type
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						
19						
20						
%*						

*** Percent of symptoms in plants in bench or bed**

COMMENTS:

Scouting Record Sheet (Side 2)

IF SAMPLE TAKEN:

________________ Disease ❑ Insects/Mites ❑ Nematodes ❑ Salts/pH ❑ Fertility T/M ❑ **
________________ Disease ❑ Insects/Mites ❑ Nematodes ❑ Salts/pH ❑ Fertility T/M ❑
________________ Disease ❑ Insects/Mites ❑ Nematodes ❑ Salts/pH ❑ Fertility T/M ❑
________________ Disease ❑ Insects/Mites ❑ Nematodes ❑ Salts/pH ❑ Fertility T/M ❑
________________ Disease ❑ Insects/Mites ❑ Nematodes ❑ Salts/pH ❑ Fertility T/M ❑

** T/M = Tissue / Media analysis

SYMPTOM CODES:				PEST CODES:		BENEFICIAL CODES:	
Angular Spots	= AS	Root Galls	= RG	Aphids	= A	Assassin Bugs	= AB
Blight	= B	Root Lesions	= RL	Borer	= B	Emergence Holes	= EH
Dead Leaves	= DL	Root Rot	= RR	Broad Mite	= BM	Lacewings	= LW
Dead Plant	= DP	Rust	= R	Caterpillar	= C	Lady Beetles	= LB
Distortion	= D	Scorch	= S	Eriophyid Mites	= EM	Predaceous Mites	= PM
Fasciation	= F	Silvering/Russeting	= S/R	Foliar Nema.	= FN		
Galls	= G	Sooty Molds	= SM	Lacebugs	= LB		
Holes	= H	Spots	= SP	Leaf Miner	= LM		
Leaf Drop	= LD	Streak	= SK	Mealybugs	= MB		
Mines	= M	Stunt	= ST	Root-knot Nema.	= RK		
Mosaic/Mottle	= MO	Tip Dieback	= TD	Root Mealybugs	= RM		
Powdery Mildew	= PM	Wilt	= W	Scales	= S		
Ring Spot	= RS	Witches' Broom	= WB	Thrips	= TH		
		Yellowing	= Y	Whiteflies	= WF		

Pesticide Application Log

Date	Pesticide			Time		Target pest*	Crop	Dilution rate ml/L	Quantity spray mix used	Application rate	Area/ No. pots	Applicator's initials
	Trade Name	Active Ingred. %	Regist. No.	Start	End							

* WF = Whiteflies APH = Aphids THR = Thrips SF = Shore flies FG = Fungus gnats SM = Spider mites OTH = Other (identify)

Sticky Card and Tape Data Form

Sticky Card Data *										Sticky Tape Data	
Plant/Location	Card No.	Date Placed	Date Inspected	Whiteflies	Thrips	Aphids	Leafminer flies	Male scales	Other	Scale crawlers	Other

* Approximate number in a 1-inch vertical column

Incoming Plant Material Inspection Sheet

Nursery ____________________

Location ____________________

Plant / Variety	Number Received	Date Received	Pot Size(s)	Date Inspected	Number Inspected	Comments

Scouting Record Sheet (Side 1)

Location ______________________________

Date ______________ Plant ______________

Scout Name ______________ Pot Size ______________

Time In ______________ Time Out ______________

Biased Sampling Comments:

Plant	Symptom (% Plant Damage)	# Lvs. w. Adult Pests	# Lvs. w. Immatures	% Pests Parasitized	Beneficial Pres./Abs.	Beneficial Type
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						
19						
20						
%*						

* Percent of symptoms in plants in bench or bed

COMMENTS:

Scouting Record Sheet (Side 2)

IF SAMPLE TAKEN:

________________ Disease ❑ Insects/Mites ❑ Nematodes ❑ Salts/pH ❑ Fertility T/M ❑ **
________________ Disease ❑ Insects/Mites ❑ Nematodes ❑ Salts/pH ❑ Fertility T/M ❑
________________ Disease ❑ Insects/Mites ❑ Nematodes ❑ Salts/pH ❑ Fertility T/M ❑
________________ Disease ❑ Insects/Mites ❑ Nematodes ❑ Salts/pH ❑ Fertility T/M ❑
________________ Disease ❑ Insects/Mites ❑ Nematodes ❑ Salts/pH ❑ Fertility T/M ❑

** T/M = Tissue / Media analysis

SYMPTOM CODES:				PEST CODES:		BENEFICIAL CODES:	
Angular Spots	= AS	Root Galls	= RG	Aphids	= A	Assassin Bugs	= AB
Blight	= B	Root Lesions	= RL	Borer	= B	Emergence Holes	= EH
Dead Leaves	= DL	Root Rot	= RR	Broad Mite	= BM	Lacewings	= LW
Dead Plant	= DP	Rust	= R	Caterpillar	= C	Lady Beetles	= LB
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Fasciation	= F	Silvering/Russeting	= S/R	Foliar Nema.	= FN		
Galls	= G	Sooty Molds	= SM	Lacebugs	= LB		
Holes	= H	Spots	= SP	Leaf Miner	= LM		
Leaf Drop	= LD	Streak	= SK	Mealybugs	= MB		
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Mosaic/Mottle	= MO	Tip Dieback	= TD	Root Mealybugs	= RM		
Powdery Mildew	= PM	Wilt	= W	Scales	= S		
Ring Spot	= RS	Witches' Broom	= WB	Thrips	= TH		
		Yellowing	= Y	Whiteflies	= WF		

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* Approximate number in a 1-inch vertical column

Incoming Plant Material Inspection Sheet

Nursery ______________________

Location ______________________

Plant / Variety	Number Received	Date Received	Pot Size(s)	Date Inspected	Number Inspected	Comments

Scouting Record Sheet (Side 1)

Location ______________________________

Date ______________ Plant ______________

Scout Name ______________ Pot Size ______________

Time In ______________ Time Out ______________

Biased Sampling Comments:

Plant	Symptom (% Plant Damage)	# Lvs. w. Adult Pests	# Lvs. w. Immatures	% Pests Parasitized	Beneficial Pres./Abs.	Beneficial Type
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						
19						
20						
%*						

*** Percent of symptoms in plants in bench or bed**

COMMENTS:

Scouting Record Sheet (Side 2)

IF SAMPLE TAKEN:

# ____________	Disease ❑	Insects/Mites ❑	Nematodes ❑	Salts/pH ❑	Fertility T/M ❑ **
# ____________	Disease ❑	Insects/Mites ❑	Nematodes ❑	Salts/pH ❑	Fertility T/M ❑
# ____________	Disease ❑	Insects/Mites ❑	Nematodes ❑	Salts/pH ❑	Fertility T/M ❑
# ____________	Disease ❑	Insects/Mites ❑	Nematodes ❑	Salts/pH ❑	Fertility T/M ❑
# ____________	Disease ❑	Insects/Mites ❑	Nematodes ❑	Salts/pH ❑	Fertility T/M ❑

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Mosaic/Mottle	= MO	Tip Dieback	= TD
Powdery Mildew	= PM	Wilt	= W
Ring Spot	= RS	Witches' Broom	= WB
		Yellowing	= Y

PEST CODES:

Aphids	= A
Borer	= B
Broad Mite	= BM
Caterpillar	= C
Eriophyid Mites	= EM
Foliar Nema.	= FN
Lacebugs	= LB
Leaf Miner	= LM
Mealybugs	= MB
Root-knot Nema.	= RK
Root Mealybugs	= RM
Scales	= S
Thrips	= TH
Whiteflies	= WF

BENEFICIAL CODES:

Assassin Bugs	= AB
Emergence Holes	= EH
Lacewings	= LW
Lady Beetles	= LB
Predaceous Mites	= PM

Pesticide Application Log

Date	Pesticide			Time		Target pest*	Crop	Dilution rate ml/L	Quantity spray mix used	Appli-cation rate	Area/ No. pots	Appli-cator's initials
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Incoming Plant Material Inspection Sheet

Nursery ____________________________

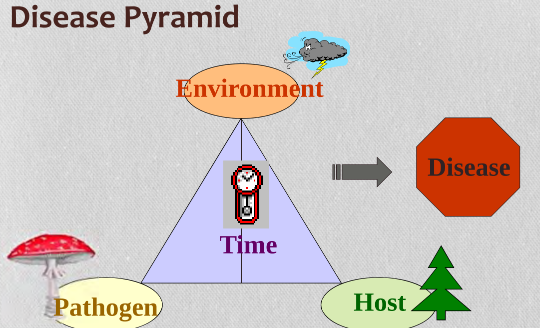
Location ____________________________

Plant / Variety	Number Received	Date Received	Pot Size(s)	Date Inspected	Number Inspected	Comments

IPM SCOUTING FOR DISEASE

Adapted from Phil & Carrie Harmon, UF/IFAS
Presented by Liz Felter, Ph.D.
UF/IFAS Extension

Disease Pyramid



Diseases and Disorders

- Disease occurs when
  - Pathogen
  - Host
  - Environment
- Disorders lack pathogens
  - Plant
  - Environment

Diagnosis is Critical

- Incorrect changes to cultural management can make problems worse.
- Fungicides only work on fungal diseases.
- The applicator needs to know if plant damage is disease, if the disease is caused by a fungus, and which fungus is involved.

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Disease Diagnosis

Questions to ask:

- What pathogen structures (signs) occur when and where?
- What symptoms develop over time?
- What is the pattern of dispersal?
  - field signature or distribution
  - abiotic vs. biotic
- What are the known diseases associated with this host?

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Disease Diagnosis

- Injury and disorders often:
  - occur "suddenly"
  - may affect all or many plant species
  - may have regular, uniform pattern
    - follow equipment patterns, boundaries
    - look at pattern of problem in relation to other items in the area – driveways, construction activities, etc.

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Pathogen Dispersal

- Wind
- Water splash and soil movement
- Human activities
  - Pruning
  - Brushing past plants
- Animals and insects
- Move under their own power
- Combinations

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Symptoms and Signs

Symptoms: Changes in growth or appearance of a plant in response to a damaging factor

Sign: Evidence of the damaging factor

Syndrome: Combination of signs and symptoms

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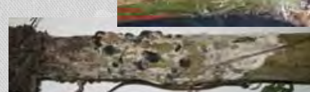
Signs of the Pathogen

- Mycelium or mold growth
- Conks and mushrooms
- Fruiting bodies
- Sclerotia
- Rusts
- Bacterial ooze



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Types of Disease Symptoms

- Underdevelopment of tissues or organs
- Overdevelopment of tissues or organs
- Necrosis or death of plant parts
- Alteration of normal appearance

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Koch's Postulates

- Pathogen always found with syndrome
- Pathogen isolated from diseased plant
- Pathogen inoculated onto healthy plant reproduces same syndrome
- Pathogen re-isolated from inoculated plant matches pathogen isolated before

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Limitations to Koch's Postulates

- Syndromes overlap
- Won't work with obligate pathogens
- Overlooks possibility of pathogens in gangs or sequence
- Latent disease may have a very prolonged symptom expression period

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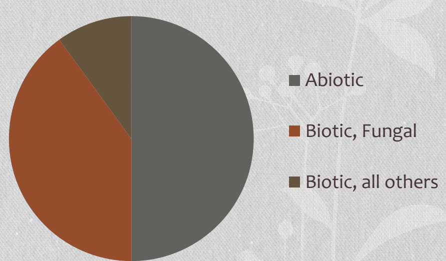
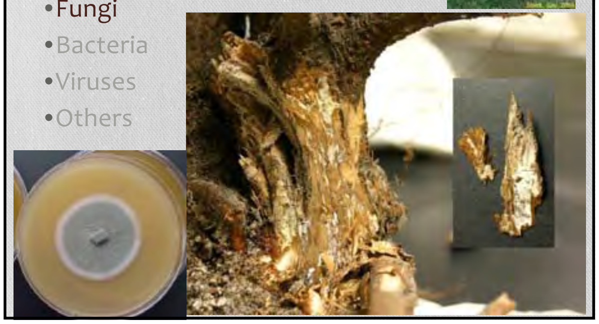
Proportions of Disease Agents



Main Types of Pathogens

- Fungi
- Bacteria
- Viruses
- Others



Fungi

- Cause majority of all plant disease
- Molds, mildews and mushrooms
- Small
- Generally microscopic
- Usually filamentous, branched
- Spore-bearing
- Lack chlorophyll
- Only about 8% plant pathogens

Fungi

Spread by:

- Water
- Wind
- Touch

Powdery Mildew

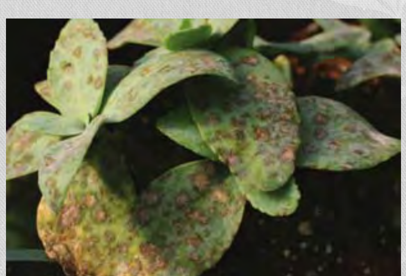


Photo from Nursery Management

Daylily Rust

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Rusts

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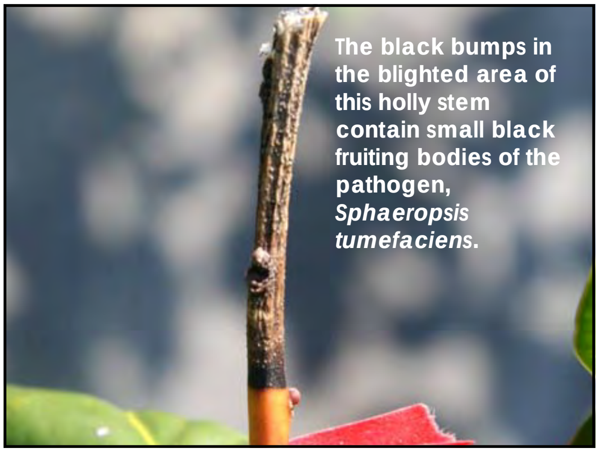
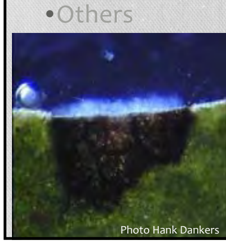
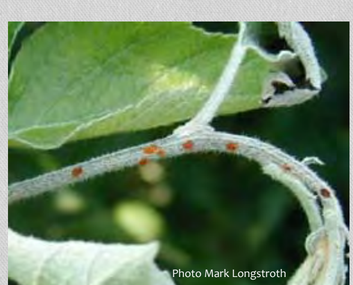


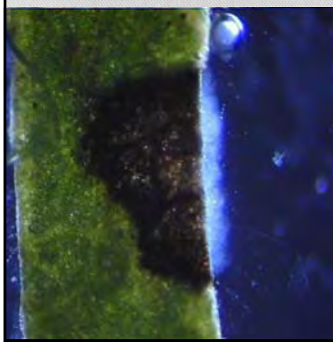
Main Types of Pathogens

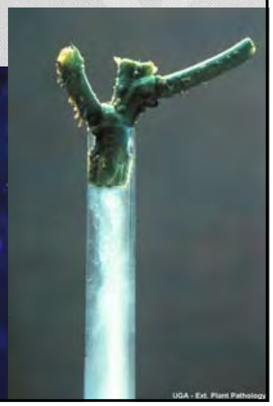
- Fungi
- Bacteria
- Viruses
- Others





Bacterial Ooze





Bacteria

Spread by:
- Wound, touch
- Water for dispersal

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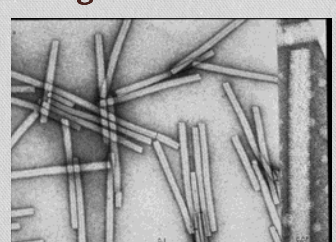
Main Types of Pathogens

- Fungi
- Bacteria
- Viruses
- Others



Micrograph by Carl Wetter

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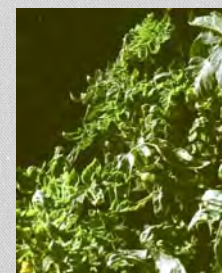
Viruses



Spread by:
- Touch
- Insect and other vectors

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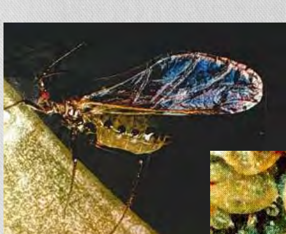
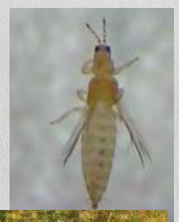
Virus Vectors





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Viral Symptoms

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Main Types of Pathogens

- Fungi
- Bacteria
- Viruses
- Others

Mycoplasma-Like-Organism (MLO)
Ex. Coconut Palm Lethal Yellowing

Incidence vs. Severity

Incidence: Percent of the crop affected

Severity: a measure of impact on a plant or the crop

Common Disease Symptoms: Galls

Peach leaf curl, caused by *Taphrina deformans.*

Courtesy R.L. Forester

Crown gall of Euonymous by *Agrobacterium tumefaciens.*

Common Disease Symptoms: Wilting

Used by permission of M.Williamson

Stem wilt from INSV infection

- Biotic factors
- Root, crown or stem rots
- Vascular wilts
- Root crown or stem damage from insects or animals

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Common Disease Symptoms: Leaf Spots

Sycamore anthracnose

Black spot of rose

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Cercospora leaf spot of crinum lily (symptoms no signs)


Entomosporium leaf spot on Indian Hawthorne


Common Disease Symptoms:
Cankers and Diebacks
Nectria canker on apple
Sycamore anthracnose canker
Citrus canker
Photo A.L. Jones
Photo Dean Gabriel
UF IFAS Extension
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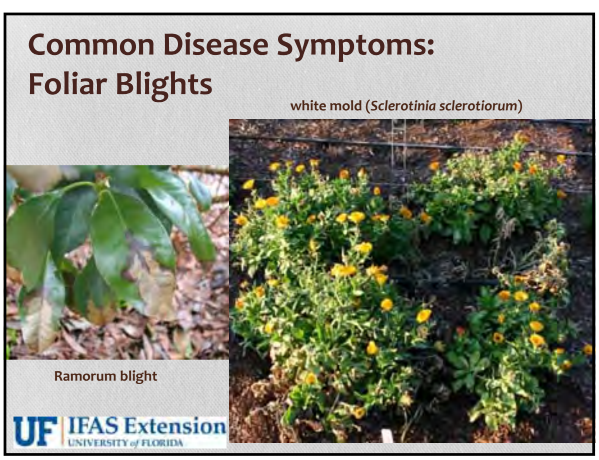
Stem canker caused by
Botryosphaeria dothidea


Sphaeropsis tumefaciens
Photo: Celeste White


Common Disease Symptoms:
Foliar Blights
white mold (Sclerotinia sclerotiorum)
Ramorum blight
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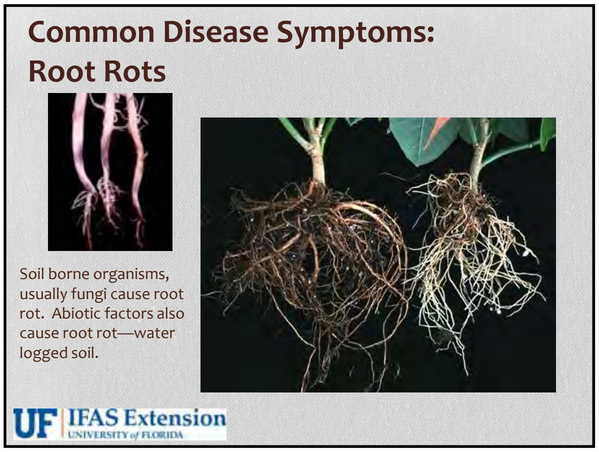

Common Disease Symptoms:
Root Rots
Soil borne organisms, usually fungi cause root rot. Abiotic factors also cause root rot—water logged soil.
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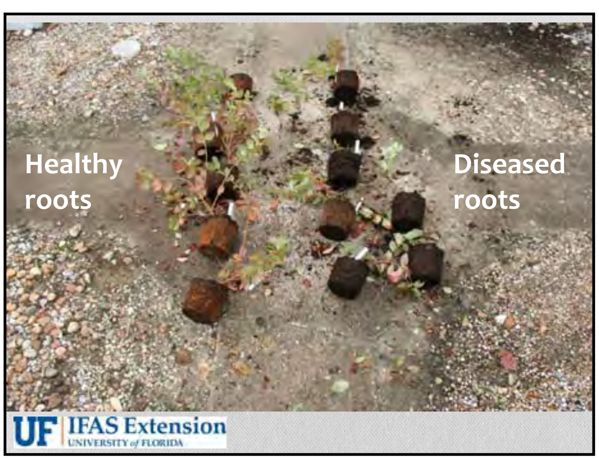
Healthy roots
Diseased roots



Healthy roots
Diseased roots
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Common Disease Symptoms: Viral Disease

Photo by W. Witcher

Photo by R.O. Hampton

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Unknown ringspot virus symptoms on phalenopsis orchids

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Rose mosaic symptoms

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A Five Step Process…

1. Determine that a 'REAL' problem exists.
2. Look for PATTERNS, in the community, on an individual plant and on an individual plant part.
3. Determine the TIME development of the damage pattern.
4. Ask QUESTIONS.
5. SYNTHESIZE the information.

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'REAL' Problem?

- Identify the plant
- Know normal characteristics
- Determine normal vs abnormal
- Look for symptoms and signs
  - Symptoms: Changes in growth or appearance
  - Sign: Evidence of the damaging factor

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Look for Patterns…

- In the plant community
  - Is the damage on more than one plant?
  - Is the damage on more than one species?
- On an individual plant
  - Is the damage on the entire plant or certain parts?
  - Is the damage on certain age of growth?
- On an individual plant part

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Patterns of damage…

Non-uniform, expanding damage patterns → living factors such as movement of feeding sites, life cycles, and population increases and decreases.

Uniform, non-expanding damage patterns → non-living factors such as chemical injuries, temperature changes, and mechanical damage.

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Woody container plants with chemical injury

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Rhododendron displaying symptoms of Nitrogen Deficiency.

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Damage patterns on an individual plant part…

Douglas Fir with Rhabdocline Needlecast

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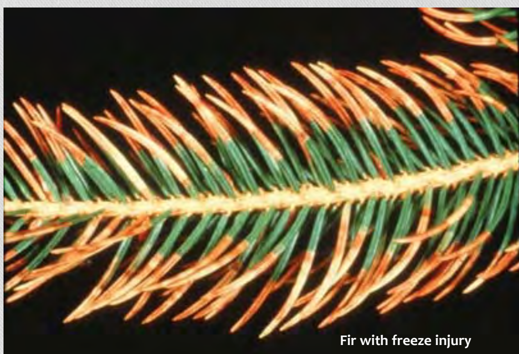

Fir with freeze injury

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Downy mildew of Buddleia caused by *Peronospora harotii*.

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TIME Development of Damage Pattern…

- Progressive spread with time to other areas is characteristic of living factors
- Intensification of symptoms where damage first occurred but no spread to new sites is characteristic of non-living factors

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Ask QUESTIONS…

- History of the problem & site
- All pesticides and fertilizers applied
- Environmental conditions
- Obvious symptoms and signs
- Look at roots
- Secondary insects and pathogens
- Be patient & avoid jumping to conclusions

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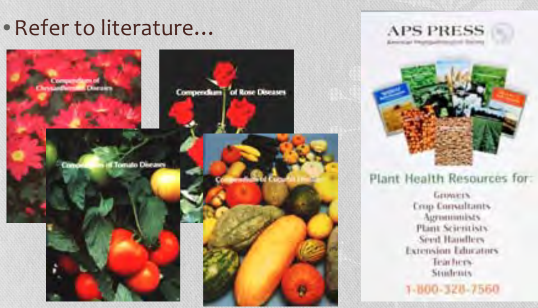
SYNTHESIZE the information…

- Refer to literature…



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Send a Sample to the Plant Disease Clinic

UF/IFAS MREC Plant Clinic
2725 S. Binion Rd.
Apopka, FL 32703
407-884-2034

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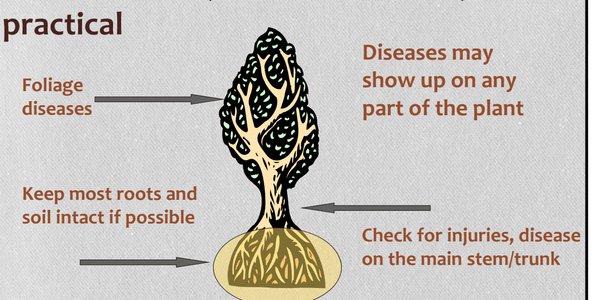
Samples Must Contain the Right Material: an Entire Plant, or Several Plants, if practical



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Dead Plants Tell No Tales

- Avoid dead plants
- Show a range of symptoms: moderate to severe

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Disease Management

- Know the hosts and their diseases
- Prevent disease
- Watch for disease
- Control disease spread

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Disease Management

- Know the hosts and their diseases
  - Experience
  - Extension specialists
  - University publications
  - Other professionals
  - Host Index
  - Keep records
- Correct diagnosis first step

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Disease Management

- Sanitation – clean materials, equipment
- Cultural manipulation – irrigation, mulch
- Host eradication – weed control
- Crop rotation
- Resistant varieties
- Quarantine / regulatory methods
- Chemical

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Disease Management

- Prevent disease
  - Inspect plants before the purchase
    - Check for diseases from the source
    - Buy resistant cultivars if available
  - Match plants with conditions
  - Good horticultural practices
    - Appropriate fertility program
    - Good irrigation practices
    - Proper trimming and pruning

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Sanitation

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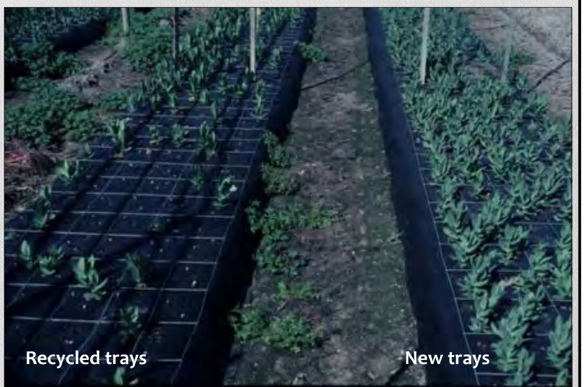

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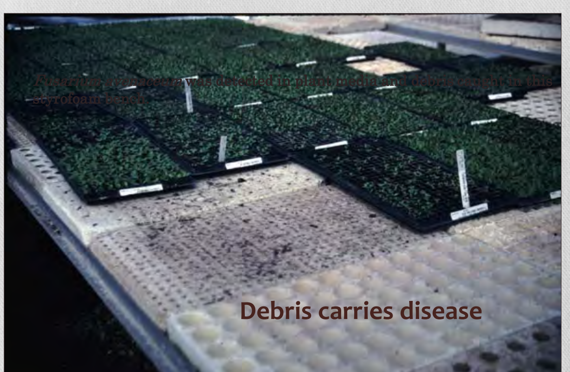

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Control Recommendations

- For specific disease control recommendations, consult your local county agent, or university extension specialist.
- Look for fact sheets at University of Florida extension publications:
  http://edis.ifas.ufl.edu/

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Diagnostic Check Sheet

Sample	symptoms:								Can you identify the disease?
	blight	chlorosis	dieback	canker	abiotic	rust	leaf spot	witches' broom	
1									
2									
3									
4									
5									
6									
7									
8									
9									
10									
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12									
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19									
20									
21									
22									
23									
24									
25									

Scouting for Abiotics

Liz Felter, Ph.D., UF/IFAS Extension

Adapted from Juanita Popenoe, Ph.D., UF/IFAS Extension Lake County

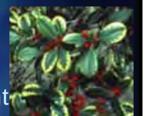
Abiotic Disease or Disorder

- Not caused by living organisms
- Not contagious
- Equal to or exceeds diseases caused by living organisms

Abiotic Disorder Caused by:

- Unfavorable environmental conditions & cultural practices
- Not bacteria, fungi, nematodes, or viruses

☞ Define the Problem



- Know the crop
- Check for patterns, time-development
  - Biotic –
    - Usually not widespread, uniform pattern of symptoms
    - Spread from one small area or edges
  - Abiotic –
    - Generally appear all at once
    - Does not continue to spread
    - Maybe widespread to surrounding plant community
  - Complex

Abiotic Symptoms

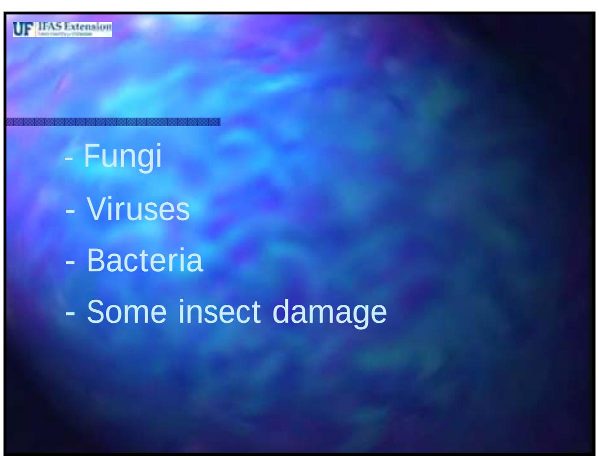
- Abnormal tissue discoloration
- Defoliation
- Decay and or necrosis

Abiotic Symptoms

- Wilt
- Abnormal increase in tissue size
- Die back


Abiotic Symptoms
Stippled, yellow, bleached or bronzed foliage
Chewed or tattered foliage or flowers
Dwarfing, stunting, or distortion


Unfortunately these Abiotic symptoms are also symptoms of…


- Fungi
- Viruses
- Bacteria
- Some insect damage

Mistaken Identities

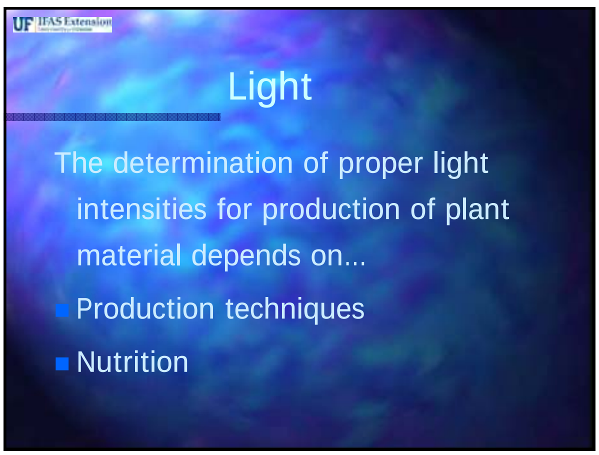
Are you sure?

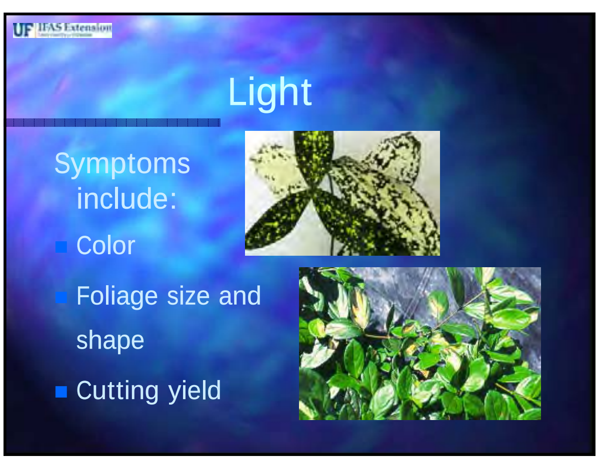
Mistaken Identities

Environmental Problems

- Light
- Temperature
- Relative Humidity


UF IFAS Extension
Cultural Problems
Phytotoxicity
Mineral Deficiencies
Mechanical Injury


UF IFAS Extension
Light
The determination of proper light intensities for production of plant material depends on…
Production techniques
Nutrition


UF IFAS Extension
Light
Symptoms include:
Color
Foliage size and shape
Cutting yield

Temperature

For maximum growth, proper temperature regimes are needed to:

- Maximize carbohydrate production during the day
- Control carbohydrate consumption by respiration at night

Temperature Symptoms

- Growth rate (ideal day/night temperatures are 90° / 70°)
- Sudden temperature fluctuations causes blackened leaves & leaf drop

Temperature Symptoms

Relative Humidity

Affects:
- Plant-water relations
- Greenhouse condensation
- Disease incidence

Relative Humidity

Symptoms include:
- Low relative humidity - desiccation
- High relative humidity - increased disease problems

Relative Humidity

Phytotoxicity

Plant injury occurs from improper:

- Chemicals
- Fertilization
- Plant growth regulators

Phytotoxicity

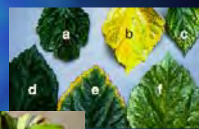
- Adverse environmental conditions
- Material is applied improperly
- Material runoff or drift
- Persistent residues accumulate

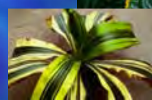
Phytotoxicity Symptoms

- Necrosis of succulent tissues
- Stunting or delayed plant development
- Distorted plants or leaves

Phytotoxicity Symptoms

- Bronzing of leaves
- Yellow or necrotic tips or margins
- Yellow or necrotic flecks on leaves





Phytotoxicity

Other clues to consider:

- No signs of pathogens
- Dead spots uniform
- Injured leaf tissue sharply defined

Phytotoxicity

Other clues to consider:

- Crop history - spray records
- Injury occurs in brief time & does not spread from plant to plant
- Certain age tissue shows damage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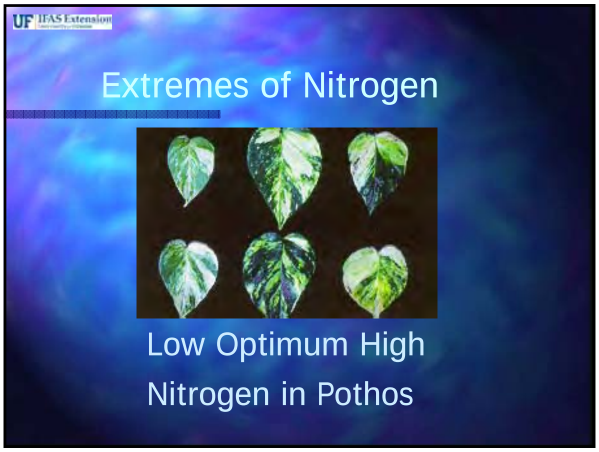
Mineral Problems
Fertilizer programs must be adjusted to:
Type of plants grown
Environmental conditions
Cultural conditions


UF IFAS Extension
Mineral Problems
Symptoms vary:
From cultivar to cultivar
With each mineral


UF IFAS Extension
Mineral Deficiencies
Nitrogen, potassium, magnesium, sulfur, & boron are all soluble in the soil…
Leached by irrigation


UF IFAS Extension
Extremes of Nitrogen
Low Optimum High
Nitrogen in Pothos


UF IFAS Extension
Soluble Salts Burn
Excessive fertilizer causes:
Tip burn
Desiccation and death
Same symptoms as drought


UF IFAS Extension
Fluoride and Chlorine Toxicity
Marginal/leaf tip necrosis
Symptoms on older leaves first and most severely

UF IFAS Extension

Iron Deficiency Symptoms

hibiscus

gerbera daisy

- Results from high soil pH
- Alkaline irrigation water

UF IFAS Extension

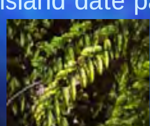
Iron Deficiency Symptoms

- Prominent green veins
- iron fixed within leaves... new growth chlorotic

UF IFAS Extension

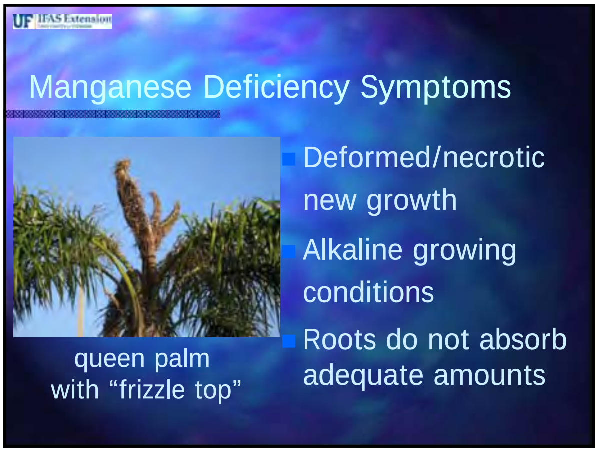
Magnesium Deficiency Symptoms

canary island date palm

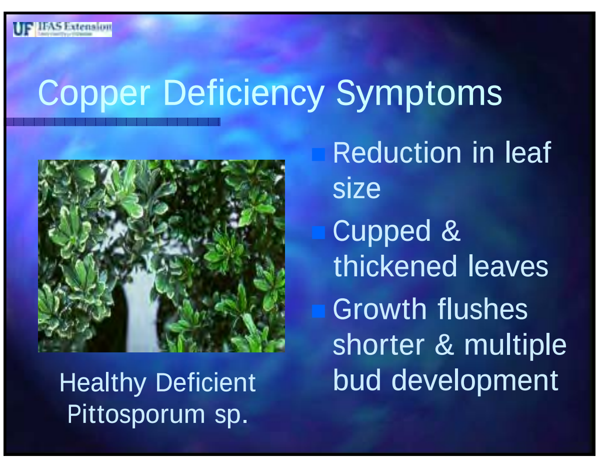


jasmine

- Tip chlorosis on older leaves
- Works back towards the trunk
- Reallocation of Mg from old fronds to new


UF IFAS Extension
Manganese Deficiency Symptoms
Deformed/necrotic new growth
Alkaline growing conditions
Roots do not absorb adequate amounts
queen palm
with “frizzle top”


UF IFAS Extension
Boron Deficiency Symptoms
Spathiphyllum sp.
“evergreen”
New growth distortion
Downward curl of leaf margins & bent leaf tips


UF IFAS Extension
Copper Deficiency Symptoms
Reduction in leaf size
Cupped & thickened leaves
Growth flushes shorter & multiple bud development
Healthy Deficient
Pittosporum sp.

Potassium Deficiency Symptoms

Ficus elastica

Pygmy Date Palm

- Interveinal chlorosis
- Followed by necrosis in older leaves
- Shortened petioles & stems
- May develop terminal & lateral bud necrosis

Zinc Deficiency Symptoms

Loquat

- Shortened internodes
- Leaf chlorosis
- Distorted leaf margins
- Reduced flowering
- Meristem necrosis

Minor Element Deficiency Complex

- Symptom overlap of one or more micro-element
- Alkaline media or water use
- Slow growth, lighter color

Mechanical Injury

- Wind
- Rainfall
- Hail
- Improper handling

Wind damage on palm

Abiotic Scouting

Distinguishing noncontagious from contagious diseases...

Abiotic Clues

Several unrelated genera/species of plants are often affected...

- rarely is it the case with disease caused by pathogens

Abiotic Clues

Recent cultural history of plants

- Application of fertilizer
- Pesticides
- Irrigation
- Origin of the plants

Abiotic Clues

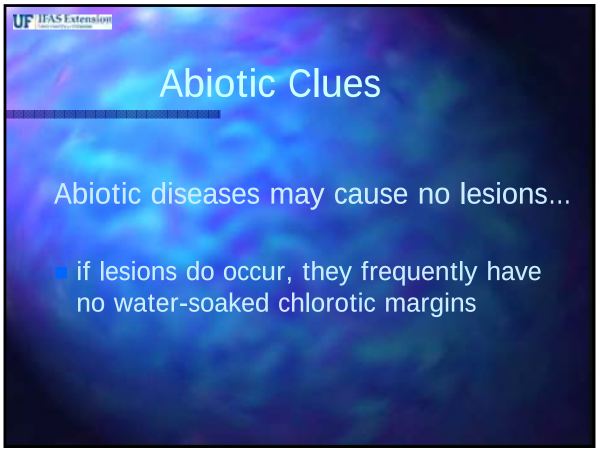
Environmental factors...

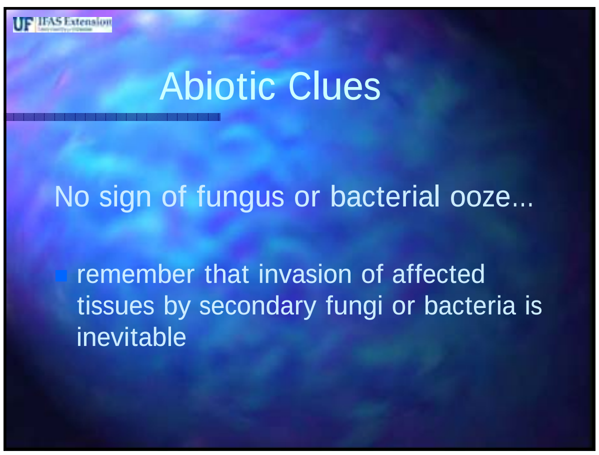
- Frost
- Strong winds
- Hail
- Flooding
- Lightning

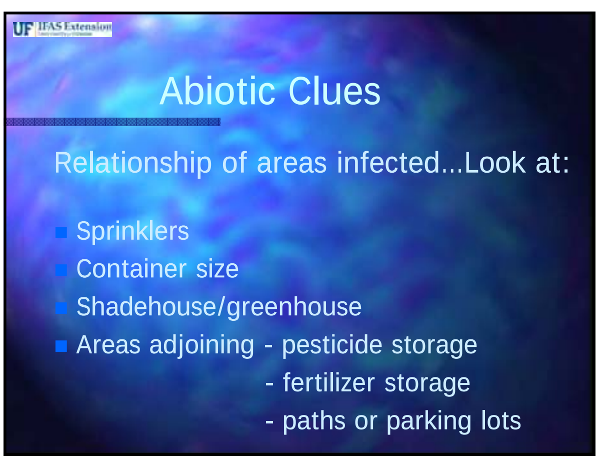
Abiotic Clues

Symptoms appear suddenly and are evenly distributed...

- diseases often spread from one small area or edges where weed hosts occur


UF IFAS Extension
Abiotic Clues
Abiotic diseases may cause no lesions...
if lesions do occur, they frequently have no water-soaked chlorotic margins


UF IFAS Extension
Abiotic Clues
No sign of fungus or bacterial ooze...
remember that invasion of affected tissues by secondary fungi or bacteria is inevitable


UF IFAS Extension
Abiotic Clues
Relationship of areas infected...Look at:
Sprinklers
Container size
Shadehouse/greenhouse
Areas adjoining - pesticide storage
- fertilizer storage
- paths or parking lots

Abiotic Scouting

- Requires you to have records
- Requires you to look beyond the obvious
- Requires you to use all your knowledge

Example 1

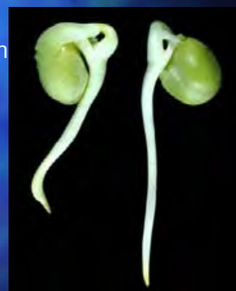
- Nursery block of viburnum o.- all plants in one corner have tip dieback and marginal leaf scorch
- Appear to have developed all at same time
- Fertilizer application a week before symptoms
- Slight rainfall after application then dry, sunny
- Affected field corner is higher and drier

Example 1

- Plant Pattern – tip dieback and marginal scorch
- Crop Pattern – only one corner of field
- Time frame – all at once
- Management – fertilizer
- Environmental – slight rain, sunny dry
- Site/soil factor – drier in that corner (predominant wind blows irrigation)
- Plant characteristic – Viburnum sensitive to drought
- Diagnosis – Soluble Salts/irrigation – check both

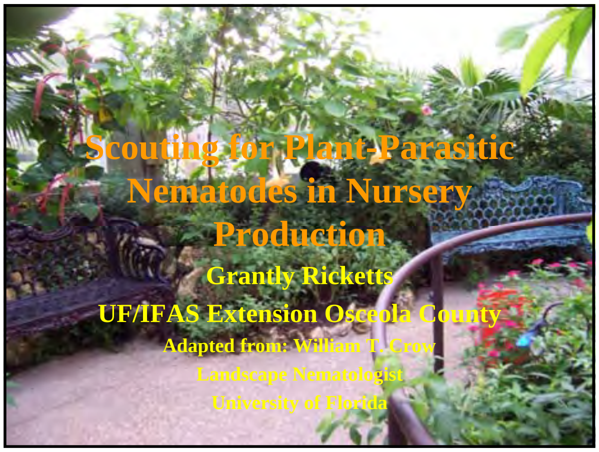
Example 2

- Uneven seed germination
  - Poor planting practices
  - Poor seed quality
  - Insect injury
  - Cold soil
  - Water stress
  - Disease
  - Plant characteristic



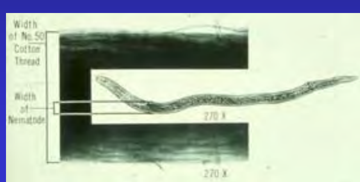
Example 2

- Plant Pattern – poor germination
- Crop Pattern – ?
- Time frame – ?
- Management – ?
- Environmental – ?
- Soil factor – ?
- Plant characteristic – ?



What are nematodes?

- Unsegmented roundworms
- Aquatic
- Small



“Good”-vs-“Bad” nematodes

- Bacterial feeders
- Fungal feeders
- Predators

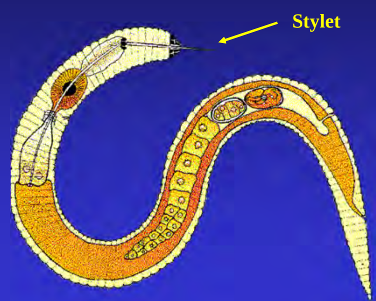
} “Good guys”

- Animal-parasites
- Plant-parasites

} “Bad guys”

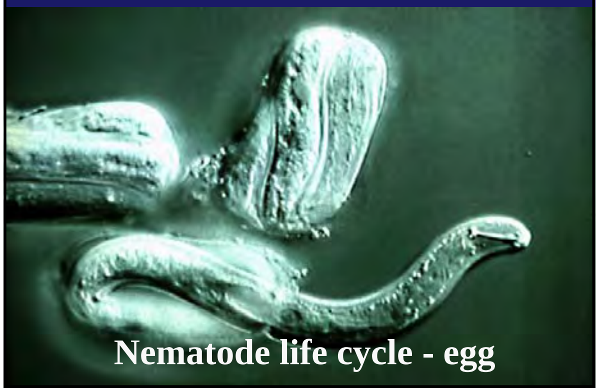
Entomopathogenic nematodes

Plant-parasitic nematodes



Plant-parasitic nematodes

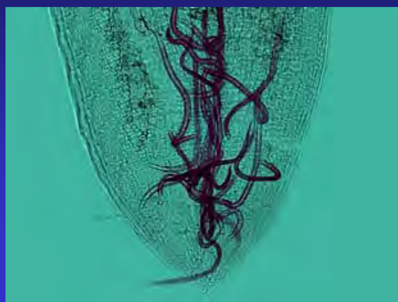
- Ectoparasites – outside roots
- Endoparasites – inside roots

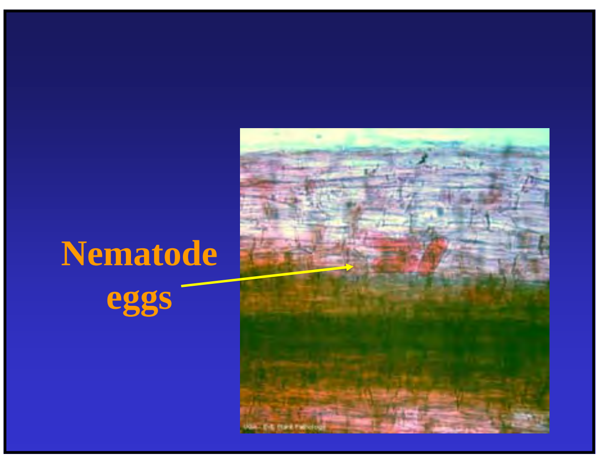


Ectoparasites- feeding

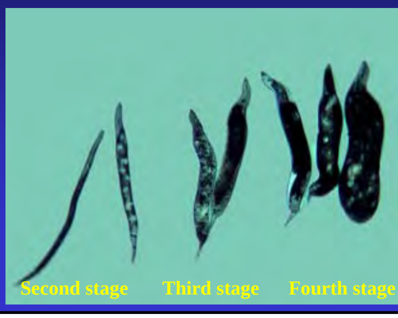
Ectoparasites- feeding

Endoparasites





Root-knot nematode 2nd, 3rd, 4th stage juveniles



Above-ground symptoms of root nematodes

- Wilting
- Yellowing
- Stunting
- Thinning
- Death

Above-ground symptoms

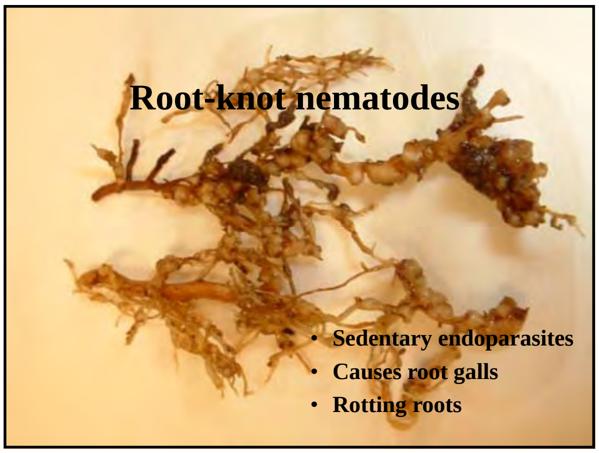
Above-ground symptoms

Above-ground symptoms

Sparse canopy

Major nematodes in Florida nurseries

- Root-knot
- Reniform
- Lesion
- Burrowing
- Foliar



Root-knot nematodes

- Sedentary endoparasites
- Causes root galls
- Rotting roots

Root-knot nematode galls on asparagus fern

Root-knot nematode galls on ligustrum

Root-knot nematode galls on wax myrtle

Root-knot nematode galls

Root-knot nematode galls

Mycorrhizal Fungi

Mycorrhizal Fungi

- For some plant species, the association with mycorrhizal fungi is indispensable.
- Plants with thick roots, poorly branched and with few root hairs, are usually more dependent on mycorrhizae for normal growth and development.
  - onions, grapes, citrus, cassava, coffee, and tropical legumes

Galls –vs- nodules

Other sedentary endoparasites

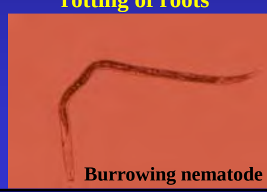
- Reniform, citrus, and cyst nematodes
- General lack of roots
- Soil may "stick" to roots
- Discoloration and rotting of roots

Reniform nematodes

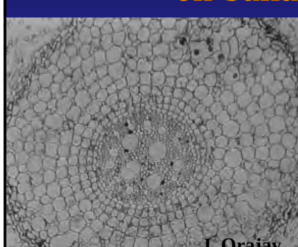
Reniform nematode damage to roots

Migratory endoparasites

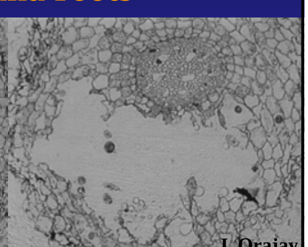
- Lesions on roots and belowground structures
- Discoloration and rotting of roots



Effect of burrowing nematode on banana roots

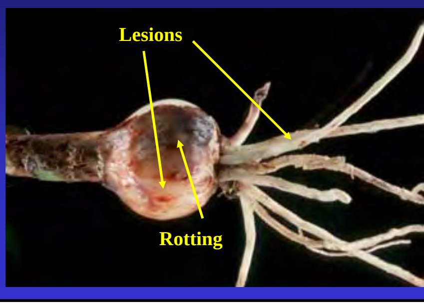


Healthy

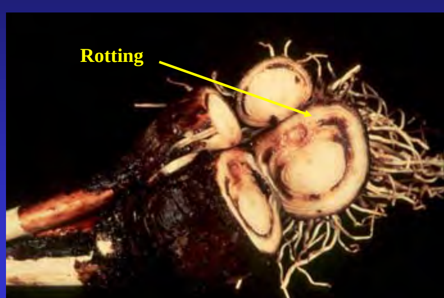


With burrowing nematodes

Amaryllis with lesion nematodes



Lesion nematodes on Easter lily



Burrowing nematodes on palms

Burrowing nematodes on banana

Burrowing nematodes on anthurium

Foliar nematodes

- Migratory endoparasites
- Angular leafspots, distorted buds
- Damage most common in nurseries

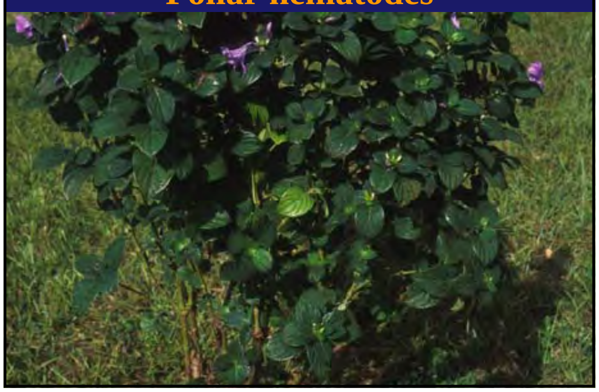
Foliar nematodes on Philippine violet

Angular lesions that resemble bacterial leafspots

Foliar nematodes on chrysanthemum

Foliar nematodes on fern

Foliar nematodes



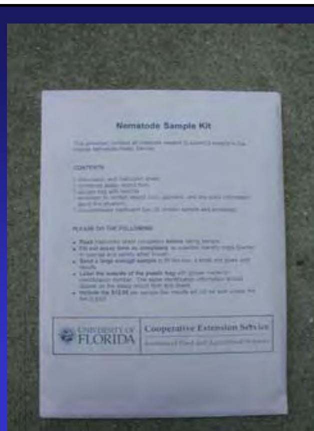
Nematode diagnosis

- The only way to determine if nematodes are a problem is with a nematode assay
- This is usually a separate test, and must be submitted separately from a standard disease sample

University of Florida Nematode Assay Lab

Building 970, Natural Area Dr.
PO Box 110820
Gainesville, FL 32611-0820
$20 Per Sample

Nematode Sample Kit



Nematode management

- **Sanitation – "an ounce of prevention is worth a pound of cure"**
- **Plant parasitic nematodes are moved in infested planting material, soil, or water.**
  - **Nematodes have been found in shallow wells.**

Nematode management in container production
- Sanitation -

- Use sterile potting media
- Keep media off of the ground
- Clean equipment after use
- Grow on raised benches

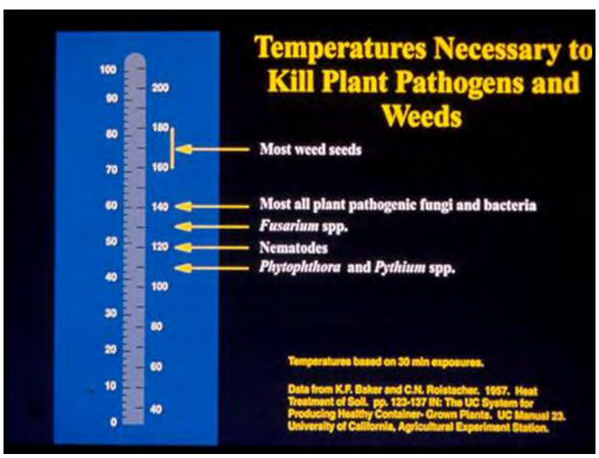
Nematode management
- Sanitation -

Nematode management
- Sanitation -

- Avoid using infested planting material
- Tissue culture > cuttings >bare-root

Nematode management
- Steam -

- The soil temperature needs to be raised to >180°F for 30 minutes in order to reach pasteurization temperature.
- This can be accomplished with boiler steam or with portable boilers.




Liriope muscari


Liriope muscari


Nematode management
- Sanitation -
Pot with rotted bottom

Nemataode management

- Sanitation -

Avoid contact with soil and water

Nematode management

- foliar nematodes -

- Avoid overhead irrigation
- Space plants apart
- Remove litter and debris
- Weed management

Nematode management

- Sanitation -

Leaf litter is inoculum source for foliar nematodes

Nematode management
-Chemicals-

- **Postplant nematicides**
  - Nemacur (Supplemental label for commercial ornamentals in FL)
  - Pylon (Foliar nematodes in greenhouses only)
- **Preplant soil fumigation**
  - Methyl bromide
  - Metam sodium
  - 1,3-D + chloropicrin
  - Dazonet (Granular)

Woody ornamental plants that are commonly damaged by root-knot nematodes in Florida

- Butterfly bush
- Hibiscus
- Boxwood
- Gardenia
- Pittosporum
- Ixora
- Japanese holly
- Rose
- Lantana

Firespike (*Odontonema cuspidatum)*

Immune to 4 species of root-knot nematode

Croton (*Codieaum variegatum)* 'Gold Dust'

Immune to 4 species of root-knot nematode

Oakleaf Hydrangea

Immune to 3 species of root-knot nematode

Anis (*Illicium parviflorum*)

Immune to 3 species of root-knot nematode

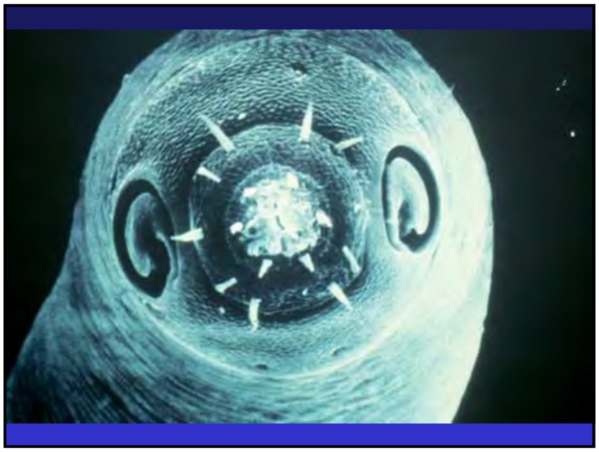
Sweet pepper bush (*Clethra alnifolia*)

Immune to 3 species of root-knot nematode

Walter Viburnum (*Viburnum obovatum*)

Immune to 3 species of root-knot nematode

Biological control of root-knot nematodes on gardenia



UF UNIVERSITY of FLORIDA
IFAS Extension

NEMATODE ASSAY FORM

Nematode Assay Laboratory
P.O. Box 110820
Building 970 Natural Area Drive
University of Florida
Gainesville, FL 32611-0620
Phone: **(352) 392-1994**
E-mail: nemalab@ifas.ufl.edu

GROWER/OWNER NAME AND ADDRESS

Name ______________________________

Address ______________________________

City/State ________________ Zip __________

Phone (____) __________ Fax (____) __________

E-mail ______________________________

COUNTY Select One **EXT AGENT** __________

DATE COLLECTED ______________________

CONSULTANT, PEST CONTROL COMPANY, etc:

Name ______________________________

Address ______________________________

City/State ________________ Zip __________

Phone (____) __________ Fax (____) __________

E-mail ______________________________

Send Results To: ☐ Grower ☐ Pest Control/Consultant

By: ☐ Mail ☐ E-mail ☐ FAX

Information Needed for Correct Interpretation of Assay Results:

IS THIS SAMPLE FOR:

☐ Diagnosis of problem of existing crop/plant
☐ Advice for a future planting
☐ Experimental data

PLANT/CROP - species and variety if known:

Present ________________ Age ________________

Previous ________________ Future ________________

SYMPTOMS: (✓) terms which describe the crop

Plant - ☐wilted ☐stunted ☐ yellow ☐ decline ☐dead

Root - ☐galls ☐stunted roots ☐ root rot ☐pod rot

SITUATION (✓): ☐ Commercial ☐ Residential ☐ Public

(✓) **ONE OF THE FOLLOWING:**

☐Field ☐Grove ☐Nursery ☐ Golf Course ☐ Lawn ☐ Garden ☐ Park ☐ Playing Field ☐Landscaping

☐Containerized/Interior Ornamental ☐ Other ______________________________

MAIN SOIL TYPE (✓): ☐Sand ☐Clay ☐ Muck ☐ Artificial Mix ☐ Marl

Size of crop area ______________________________

Recent nematicide use, prior history of nematodes, other pertinent information

____

Lab Sample No. ________________ Date Received ________________

Sample Status: ☐ Paid ☐ IFAS Service ☐ Other (explain) ______________________________

List Multiple Samples Here

Grower Identification ***Examples:*** **Fairway 1** **Soccer Field** **Front Yard**	**Plant/Crop** **(Species & Variety)** ***Examples:*** **Petunia - Purple Haze** **St. Augustine - Floratam** **Corn - Silver Queen**	**Lab Sample #** **(Lab Use Only)**

Water Quantity and Quality

Liz Felter, Ph.D.
UF/IFAS Extension
Regional Specialized Agent Central Florida
Food Systems & Ornamental Horticulture

UF IFAS Extension
UNIVERSITY of FLORIDA

Water Quantity Factors

- Crop
- Time of year
- Container size
- Plant size
- Humidity
- Substrate

No Fixed Rules!

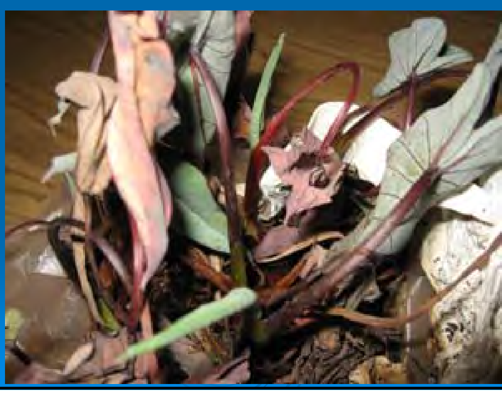
Overwatering

- Pythium
- Rhizoctonia
- Oedema
- Root & Crown rots

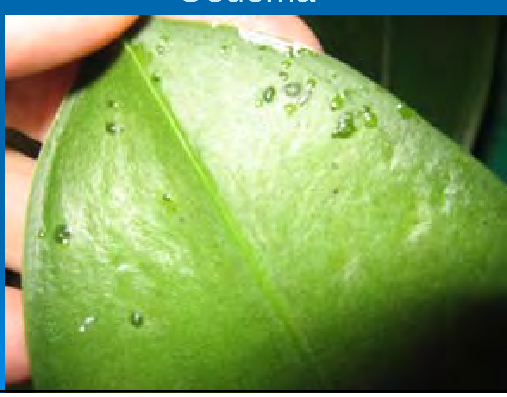
Photo: http://www.monumentaloutdoor.com/watering-tips/

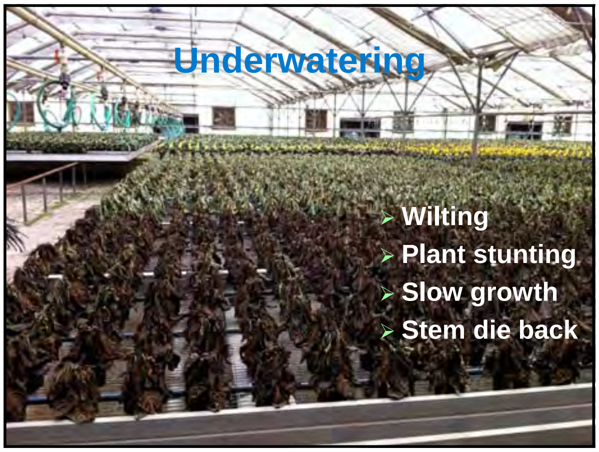
Pythium

Rhizoctonia



Oedema





Water Quality Properties

- Physical
  - Suspended solids
  - Temperature

Photo: https://www.linkedin.com/pulse/turbidity-total-suspended-solids-water-clarity-ehsan-mousavi

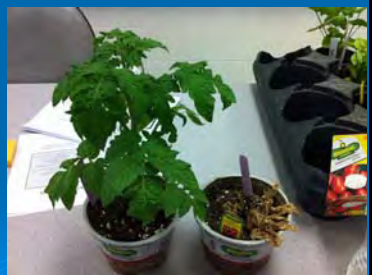
Water Quality Properties

- Biological
  - Disease causing organisms
  - Algae
  - Microbes

Photo: https://pace.oregonstate.edu/courses/phytophthora/best-management-practices-continued-1

Water Quality Properties

- Chemical
  - Soluble salts
  - pH
  - Specific ions



Soluble Salts

- Soluble salts
  - Measured by EC
  - Direct toxicity
  - Impede water uptake
  - Foliar spotting

pH 3.5, EC 3.5

pH

- pH-Measure of hydrogen ion concentration
  - Influence solubility of nutrients
  - Impacts pesticides

Micro-Nutrients

- Na (sodium)
- Cl^- (chloride)
- Fe (Iron)
- B (Boron)
- F^- (Fluoride)
- Zn (Zinc)
- Cu (Copper)

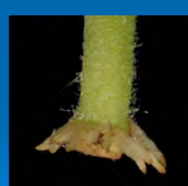
Scenario:

Cutting Production/Water Management

1. Stages of Irrigation: (A) Mist phase

(Stages 0 – 2): Initial sticking, callus, and root initials. Moderate light, high humidity.





Goal: Keep cuttings hydrated while minimizing excess moisture.

Sanitation

Delays in Sticking – Dehydration of Cuttings

Delays in Transportation and Sticking – Warm Temperatures in Box

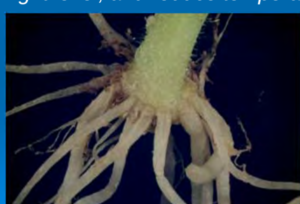
(B) Transition phase

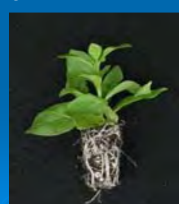
(End of Stage 2): Weaning the crop off mist. Increasing light level. Begin fertilization.

Goal: Minimize stress on poorly rooted plants.

(C) Finishing phase

(Stages 3 & 4): Root and shoot growth through to shippable plug. Begin wet-dry cycles. Use water to harden off cuttings and for growth control. Increase light level, and reduce temperature.





Goal: Produce compact, well-branched and rooted plant.

2. How much water should be applied?

Under watering

Overwatering

Disease

Overwatering

Algae, Shore flies, Fungus gnats, Slip Hazard

Photo: https://projects.ncsu.edu/cals/plantbiology/ncsc/deployed/sliks/Nostoc_sp.htm

Photo: http://forums.gardenweb.com/discussions/3484785/are-these-fungus-gnats-christmas-cacti

Organize Crops by Mist Needs

Silver leafed and disease-prone plants on lower mist frequency or volume.

Leaching

- The loss of plant nutrients and other chemicals from media as a result of irrigation

Monitor Your Leachate

- Leachate volume and EC are measured at least once a year during mist and finished phases.
- Water management is adapted to reduce leaching.

How Much Leaching Is OK?

- Leaching is not all bad.
  - Evens out mist distribution
- Goal: no more than 0.5 gallons per tray,
  or one container capacity,
  is leached during a crop cycle (4-6 weeks)
- Once a container capacity is leached, most preplant nutrient is washed out.

Potting Media & Water

- Porosity determines space available for air, water and root growth.
- Porosity is affected by particle size, texture etc.
- Porosity decreases over time.

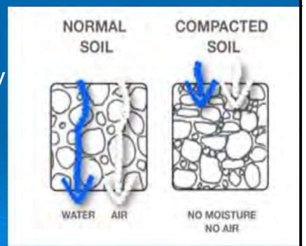


Photo: http://wmearthcare.com/everyday-soil-science-4-bulk-density-porosity/

QUESTIONS?

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UNIVERSITY of FLORIDA

Mailing Address (please print)

Name ______________________ Date ________

Address ______________________

______________ FL, Zip ________ Phone ____________

Email* ______________________
*Please provide an email address to receive your results faster.

Signature ______________________
(signature only required for UF personnel for approval of chartfield charges)

UF/IFAS Analytical Services Laboratories
Extension Soil Testing Laboratory
2390 Mowry Road/PO Box 110740/Wallace Building 631
Gainesville, FL 32611-0740
Email: soilslab@ifas.ufl.edu Website: http://soilslab.ifas.ufl.edu

WATER TEST FORM

Note: This lab only tests samples from Florida.

Direct any questions about this test or the interpretation of the results to your county UF/IFAS Extension agent.

NOTE: These tests will not determine if the water is suitable for human consumption. Bacteriological tests may be available from the county health department or select commercial laboratories.

Fill in all requested information, using one line per sample. Use additional forms for more than 9 samples.

Lab Use Only	Sample ID	County	Crops to be grown	Water Source Information					Water Use Information				Cost	
				Well	If well, specify location and depth			Surface ditch or pond	General Household Use	Irrigation			Irrigation and micro-irrigation	House-hold
				Check	Range	Town-ship	Sec-tion	Check		Household Overhead or seep	Overhead or seep	Micro-irrigation		
													$10	$9
													$10	$9
													$10	$9
													$10	$9
													$10	$9
													$10	$9
													$10	$9
													$10	$9
													$10	$9

NOTE ANY SPECIAL PROBLEMS HERE:

Check ○ **Money Order** ○ **Cash** ○ **Total** ________

Please enclose payment and this sheet in the same package as sample(s).
Please make checks and money orders payable to **UNIVERSITY OF FLORIDA.**
Samples will not be processed without payment. Do not send cash through the mail.

Instructions and Information for the Water Test Form

Taking a Representative Water Sample

Tools

1. A clean plastic bottle holding about 1 pint to collect the water sample. Do not use shampoo or detergent bottles because it is difficult to remove all residues. Glass bottles are not recommended.
2. A corrugated shipping box. These boxes (also used to mail soil samples) are available for free at your local county UF/IFAS Extension office.
3. Packing material. Use this material to pack the sample to avoid damage or leakage during shipment to the UF/IFAS Extension Soil Testing Laboratory.
4. This form. Use additional copies if you plan on sending more than 5 water samples.

Sampling

1. Allow the water source to run from the intended collection point for several minutes.

   For household samples, allow the water to flow for several minutes to ensure the water sample is directly from the well. Water standing in the house plumbing for some time is not a representative sample.

   For irrigation and microirrigation samples, sampling as close to the water source as possible will ensure that the sample represents the water source. If you are filtering the water, you may wish to sample the water both before and after filtration to assess the effect of the filtering operation. Filtration will only affect the physical characteristics (suspended solids) of the water.
2. Rinse the sample container and its lid several times in the flowing water. Do not use soap or detergent during this rinsing step.
3. Fill the container completely with the flowing water. Leave as little air as possible in the container. Tightly seal the lid immediately after filling the container to ensure against leakage.
4. Label the container and pack it carefully in the prelabeled shipping box.
5. Include in the shipping box:
   - ☐ Your labeled water sample(s)
   - ☐ This Water Test Form with all the requested information on page 1 completed
   - ☐ A check or money order payable to: **University of Florida**. Checks written to any other name will NOT be honored and will be returned, causing a delay in processing the samples.

Mail your sample to:

UF/IFAS Analytical Services Laboratories
Extension Soil Testing Laboratory
2390 Mowry Road, Wallace Bldg. 631
PO Box 110740
Gainesville, FL 32611-0740

Water Testing - An Aid to Problem Diagnosis

The physical and chemical determinations made by the UF/IFAS Extension Soil Testing Laboratory can be used effectively to diagnose potential problems in water. However, the lab does not test water suitability for human consumption. Bacteriological tests may be available from the county health department or commercial laboratories.

Test Results

The test report will be emailed/mailed to you in 5–10 days after your sample arrives at the Extension Soil Testing Laboratory. Contact your county UF/IFAS Extension office if you have questions about your results.

Potential Water Quality Problems

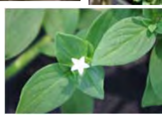
Tests	Irrigation (including microirrigation)	Household
Ca, Mg, and total carbonates	Liming potential/plugging problems	Hardness
Fe and Mn	Foliage stains/plugging problems	Staining, taste
Na and Cl	Salt water intrusion, plant damage	Salt water intrusion and landscape plant damage
Electrical conductivity	Plant damage from high salt content	Plant damage from high salt content
pH	Corrosion potential/plugging	Corrosion
Suspended solids	Plugging problems	N/A

Identifying and Controlling Common Weeds

Chris Marble and Matt Lollar
IFAS Extension







Why does weed ID matter?

- **Most important part of weed control**
- Weeds cause competition/aesthetic damage
- Help identify cultural problems at your site
  - Too wet = doveweed, eclipta
  - Dry/compacted areas – spurges
- Determines what control measures/herbicides will work


Joe Murray, Treebio.com, bugwood.org

Herbicide Selection

Contacts

- Localized injury to plants
- Thorough coverage needed
- Use where contact with ornamental is probable
- Most effective on annual weeds
- Ex. diquat (Reward), pelargonic acid (Scythe), paraquat (Gramoxone)

Translocated

- Move throughout the plant
- Ornamentals may not recover
- Use on perennial weeds
- Ex. Glyphosate (RoundUp), 2,4-D (many), triclopyr (Brush-B-Gone, Garlon)

What about combinations???

Herbicide Selection

Grass Selective Herbicides
- Sethoxydim – (Vantage, Segment, Poast)
- Clethodim – (Envoy)
- Fluaziflop butyl – (Fusilade II)

Broadleaf Selective Herbicides
- Triclopyr (Brush-B-Gone, Garlon, Crossbow, etc.)
- 2,4-D, dicamba, mecoprop

Nutsedge Herbicides
- Halosulfuron (SedgeHammer)
- Imazaquin (Image)
- Basagran T/O (bentazon)

Non-Selective Herbicides
- Glyphosate
- Diquat (Reward), Paraquat (Gramoxone), pelargonic acid (Scythe), glufosinate (Finale)

Preemergent Herbicide Selection

PRE Grass Herbicidces
- Surflan (oryzalin)
- Barricade (prodiamine)
- Pendulum (pendimethalin)
- Treflan (trifluralin)
- Dimension (dithiopyr)
- Pennant Mag (s-metolachlor)

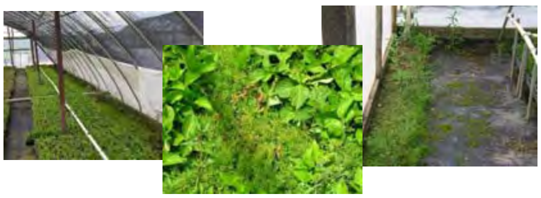
PRE Broadleaf Herbicides
- Princep (simazine)
- Goal (oxyfluorfen)
- SureGuard (flumioxazin)
- Ronstar (oxadiazon)
- Tower (dimethenamid-p)
- Gallery (isoxaben)**
  - New liquid formulation available

List of Ornamental PREs
http://edis.ifas.ufl.edu/wg058

Non-Chemical Tools in the Nursery

Greenhouse Weed Control

- Focus on prevention & sanitation
- POST herbicide options – diquat (Reward), glyphosate, clethodim (Envoy), fluazifop (Fusilade II), glufosinate (Finale), etc.
- New PRE option – indaziflam (Marengo)
  - Empty greenhouses
  - Plants can be introduced within 24 hrs.
  - Good tank-mix partner



Landscape Weed Control

- **Coarse** textured mulches @ 2-3 in.
  - Make 1st herbicide app. below mulch
  - Apply extra 0.25" to activate
- Inorganic mulch? Rubber?
- Landscape fabric?

Joe Murray, Treebio.com, bugwood.org

A. Koeser, Int. Soc. Arbor., bugwood.org

Non-Chemical Tools in the Landscape

Rebekah Wallace, UGA, bugwood.org

Joe Murray, Treebio.com, bugwood.org

Weed ID Basics

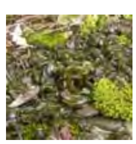
- Plant ID usually based on flowers/fruits
  - Sometimes can't wait this long to ID weeds
  - Try to use growth habit, color, smell, feel, season, placement (shade/sun, dry/wet, etc.) to ID
- Goal is to ID and control before seed develops

Weed Groups

- **Grass** (monocots) – round stems, parallel veined leaves, and have spikelets
- **Sedge** – triangular stems, sedges "have edges"
- **Broadleaf** (dicots) – net-veined, showy flowers, highly variable in appearance.

Primitive, Non-vascular weeds

- Algae (cyanobacteria), moss, and liverworts
- Mossy, slime like plants
- Reproduce sexually by spores, gemmae, or asexually
- Primitive plants – ID by appearance, color, reproductive structures (cup or umbrella like structures)



Know the Life Cycle

Annuals (The once a year guests)	Biennials (Few are far in between)	Perennials (The permanent residents)

Howard F. Shwartz, Colorado St. U., Bugwood.org

Other ID Methods….

- Height and lateral spread
- Branching, arrangement of branches on main stem
- Leaf size
- Leaf/stem color and shape
- Smell and taste (if you dare)

Steve Dewey, Utah St. U., bugwood.org

Easy Ways to ID Common Nursery/Landscape Weeds

Chamaesyce spp. (Spurges)


C. hirta (sandmat spurge)


C. hyssopifolia (Hyssop spurge)


C. maculata (Spotted spurge)

- **Life cycle:** summer annual
- **EZ ID:** milky sap, reddish stems, spotted leaves, seed clusters
- **Control:**
  - Handweed before seeding; Many herbicides
  - DNA's, less control with oxadiazon (Ronstar) or oxyfluorfen
  - Tower can control early POST

Eclipta prostrata (Eclipta)

- **Life cycle:** summer annual
- **EZ ID**: button-like green to black seed head
- **Control**: Many herbicides provide fair control – Marengo G works good

Phyllanthus spp. (Longstalk; Gripeweed)

- **Life cycle**: summer annual, tropical perennial
- **EZ ID:** "mini-mimosa"; longstalk leaves more round, fruit have longer petioles, gripeweed fruit are sessile, resemble legume
- **Control:** most PRE's offer poor to fair control, handweed when small, scout


P. tennellus


P. urinaria

Cardamine spp. (Bittercress)

- **Life cycle:** winter annual
- **EZ ID:** cigar-shaped fruit pop when mature
- **Control:** Most PREs – must stay on top due to prolific seed production; *corymbosa* spreads by stolons (potentially new weed problem); Gallery (isoxaben) controls Early POST



Leslie J. Mehrhoff, Univ. Conn., Bugwood.org

Oxalis spp. (Oxalis, woodsorrel)

- **Life cycle:** spring/summer annual, into fall and winter
- **EZ ID:** "tiny okra" fruit, heart-shaped leaves in 3's
- **Control:** Most Pre's; handweeding; Marengo takes it out early POST (up to 2-4 leaf stage)

O. stricta
James H. Miller & Ted Bodner, SWSS, Bugwood.org

Bruce Ackley, Ohio St. U., Bugwood.org

Bidens alba (Beggarticks)

- **Life cycle:** annual or short lived perennial
- **EZ ID:** "needle" like seeds, white 5 petal flowers with yellow center
- **Control:** Most broadleaf herbicides (2,4-D, dicamba, triclopyr, broad spectrum PREs);



Portulaca spp. (purslane)

- **Life cycle:** summer annual
- **EZ ID:** succulent stems and leaves; often hot-pink to yellow flowers
- **Control:** Most herbicides, control early due to prolific seed production

Portulaca pilosa (pink purslane, kiss-me-quick)

Portulaca amilis (Paraguayan purslane)

Richardia spp. (Florida, Brazilian pusley)

R. brasiliensis

R. scabra

- **Life cycle:** annual or perennial (Brazilian); annual (Florida)
- **EZ ID:** Florida pusley does not have thick, woody roots or stiff hairs on fruits, both have opposite leaves, white start shaped fruit, and small leaves by flowers
- **Control:** best controlled using broad-spectrum PRE herbicides

Stachys floridana (Florida betony)

- **Life cycle:** summer/fall perennial
- **EZ ID:** segmented tubers, square stems, triangular toothed margins
- **Control:** prevention is best, most PREs ineffective, dichlobenil (Casoron) can be effective; prodiamine (Barricade) will stunt plant; repeated apps of Rup or broadleaf herbicides will work

Cyperus spp. (Sedges)

C. croceus (Baldwin's flatsedge)

C. esculentus (Yellow Nutsedge)

C. rotundus (Purple nutsedge)

Control: glyphosate, halosulfuron (SedgeHammer), imazaquin (Image), bentazon (Basagran T/O); s-metolachlor (Pennant Magnum), dimethenamid-p (Tower); dichlobenil (Casoron 4G)

Digitaria spp. (Large, hairy, smooth crabgrass)

Joseph M. DiTomaso, UC Davis, bugwood.org

- **Life cycle:** summer annual
- **EZ ID:** 4 to 6 spike heads, hairy or smooth on both surfaces, roots at nodes
- **Control:** POST grass herbicides [Fluazifop (Fusilade), clethodim (Envoy), Sethoxydim (Vantage)], DNAs PRE, many others

Murdannia nudiflora (Doveweed)

John D. Byrd, Mississippi State, bugwood.org

John D. Byrd, Mississippi State, bugwood.org

- **Life cycle:** summer annual, in spiderwort family (not a grass)
- **EZ ID:** thick green leaves, rooting at nodes, thick clumps, what's left in the lawn after applying herbicide
- **Control:** difficult to control. Repeated applications of MSMA + 2,4-D post, Broadstar (flumioxazin), Pennant Magnum (s-metolachlor) and Tower (dimethenamid-P) controlled PRE (Walker et al., 2010)

Commelina benghalensis (Bengal Dayflower)



- **Life cycle:** perennial, can act as an annual
- **Leaves:** broadly ovate to lanceolate, entire margins, parallel veins, pubescent
- **Stems:** erect or prostrate along ground and can root at nodes, pubescent
- **Flowers:** often in clusters, funnel shaped, violet to light blue in color (other day flowers often have darker flower colors); can produce subterranean flowers/seeds
- **Roots:** fibrous
- **EZ ID:** white underground stems and flowers, parallel veins, wide leaves, violet flowers
- **Control:** Prevent, eradicate, eliminate. Inspect new shipments and sources of materials for presence of BDF. Noxious weed. Glyphosate tolerant. Flumioxazin (SureGuard/Broadstar) provides good PRE control

Fatoua villosa (Mulberry weed)



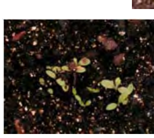
- **Life cycle:** summer annual
- **EZ ID:** looks like mulberry seedling growing in pots with flowers in leaf axils; pubescent all over
- **Control:** Most PREs – be diligent in non-crop areas; hand weed escapes due to prolific seed production

Emilia spp. (tasselflowers)

- **Life cycle:** summer annual
- **EZ ID:** dandelion seed head, clasping leaves, pink-red flowers
- **Control:** Most PREs should work, keep non-crop areas mowed




E. fosbergii (Florida Tasselflower)

E. sanchifolia (Lilac Tasselflower)

More information and resources…

- Florida EDIS weed management website: https://edis.ifas.ufl.edu/topic_guide_weed_management_guide
- Florida Extension Weed Science: weedext.ifas.ufl.edu
- Center for Aquatic and Invasive Plants: plants.ifas.ufl.edu
- Florida Department of Agriculture and Consumer Services Division of Plant Industry: http://www.freshfromflorida.com/Divisions-Offices/Plant-Industry
- Alternatives to invasive ornamentals: edis.ifas.ufl.edu/ep467
- Florida Invasive species partnership: www.floridainvasives.org
- Florida exotic plant pest council: www.fleppc.org
- Weeds of container nurseries in U.S.; NCSU: www.cals.ncsu.edu/plantbiology/ncsc/containerweeds/

Contact Information

Chris Marble
407-410-6960
marblesc@ufl.edu

Nursery Scout Training – Weed Identification

Matching Game

1. *Digitaria sanguinalis* – Crabgrass

a. 

2. *Portulaca sp*.

b. 

3. *Commelina benghalensis* – Benghal dayflower

c. 

4. *Oxalis corniculata* – Creeping woodsorrel

d. 

5. *Richardia sp.* – Florida pusley

e. 

6. *Bidens alba* – Beggerticks

f. 

7. *Fatoua villosa* – Mulberry weed

a.

8. *Pectis prostrata* – Spreading cinchweed

b.

9. *Emilia fosbergii* - Florida tasselflower

c.

10. *Emilia sonchifolia* – Cupid’s shaving brush

d.

11. *Youngia japonica* – Hawksbeard

a.

12. *Eclipta prostrata* – False daisy

b.

13. *Phyllanthus tenellus* – Longstalked phyllanthus

c.

14. *Cyperus croceus* – Baldwin's flat sedge

d.

Monitoring for pH, EC, and Media Problems

Presented by: Hannah Wooten UF/IFAS Extension Seminole County
Created by: Juanita Popenoe
UF/IFAS Extension Lake County

UF IFAS Extension

Identifying Major Media Problems

- Media Fertility and pH
- Salinity
- Compaction

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Nutrient Deficiency/Toxicity

Potassium
Deficiency → Toxicity

Manganese Deficiency

Low pH vs. High pH

Copper Toxicity

UF IFAS Extension

What is pH?

pH = a measure of the concentration of hydrogen ion in solution = - log (H^+) = acidity

pH	(H^+)	(H^+)
4	0.0001 M	10^{-4} M
5	0.00001 M	10^{-5} M
6	0.000001 M	10^{-6} M
7	0.0000001 M	10^{-7} M
8	0.00000001 M	10^{-8} M
9	0.000000001 M	10^{-9} M

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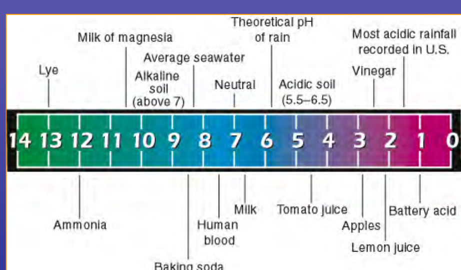
The pH Scale



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Why pH is important?

- Directly affects plant growth by root injury or physiological drought
- Indirectly affects plant growth by changing nutrient bioavailability
- Affects nutrient holding capacity of soil or media
- Affects microbial associations with roots

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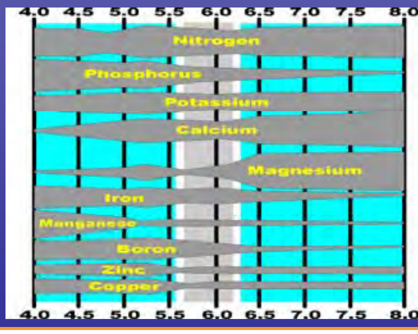
pH and Nutrient Availability



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Soil Testing for pH & Nutrients

- Field kits test for nutrients colorimetrically
  - No micronutrients
  - Variable cost/accuracy
  - Results on-the-spot
- Send sample away for comprehensive analysis
  - UF ESTL (pH and Macros)
  - Cost $7-$10/sample
  - Results take time

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UF Soil Lab

Tissue Analysis

- Be sure to collect the proper plant part at the recommended time
- If no standards, need good tissue to compare


PLANT TISSUE TEST

Dolomite to Raise Media pH*

Beginning pH	50% peat/ 50% sand	50% peat/ 50% bark	100% peat
5.0	1.7	2.5	3.5
4.5	3.7	5.6	7.4
4.0	5.7	7.9	**11.5**
3.5	7.8	**10.5**	**15.5**

*Dolomite (pounds per cubic yard) needed to raise pH of indicated medium to about 5.7

**More than 10 pounds of dolomite per cubic yard often causes micronutrient deficiencies

Sulfur to Reduce Media pH*

Beginning pH	50% peat/ 50% sand	50% peat/ 50% bark	100% peat
7.5	1.7	2.0	3.4
7.0	1.2	1.5	2.5
6.5	0.8	1.0	2.0

*Sulfur (pounds per cubic yard) to lower pH of indicated medium to about 5.7

Electrical Conductivity (EC)

- EC is a measure of the ability of a solution to conduct electricity.
- As salts in water increase, the EC increases.
- EC indicates the relative salt level, but not which salts are there.
- Often called soluble salts (SS) reading

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What Does EC Mean?

- Does not tell deficiency or toxicity of individual nutrient elements
- Does offer information on the nutrient status of potting media
- Provide guide for nutrient management in production
- Be aware - misleading if fertilizers do not contain complete nutrients
- Be aware of plant species difference in soluble salts sensitivity

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Media Salinity

- High media salt content
  - Salty irrigation water (reclaimed?)
  - Excessive fertilization
- High salinity can cause:
  - Soil structure problems
  - Mg and/or K deficiency
  - Chloride toxicity (leaf burn)
  - Necrosis

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Photo: http://www.salinitymanagement.org/Salinity%20Management%20Guide/le/le_2.html

Symptoms of Salinity Problem

- Early symptoms
  - Leaves are bluish-green and darker than normal
  - Leaves are smaller than normal
  - Stems with short internodes
  - Stunted growth
  - Chlorosis
  - Burned leaf tips

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Photo: http://www.scielo.br/scielo.php?pid=S1677-04202008000200003&script=sci_arttext

Field Measurements of EC

Solutions

Direct Soil Measurement

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Methods of Extracting for EC

- 1:2 dilution by volume
- 1:5 dilution by volume
- Pour-through (PT) method
- Saturated media extract (SME)
- Direct measurement

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Dilution Methods for EC

- Mix X part soil with X parts distilled water
- Allow to stand for 4 hours
- Filter the extract
- Measure EC of extract

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Pour-through Extraction Procedures

- Pots adjusted to be near saturated with water (media just wet to touch), and wait for at least 30 minutes
- Container placed under each pot
- Deionized water is evenly poured onto surfaces until 30-50 mL of leachate collected
- EC is measured using a conductance meter and pH is measured using a selective ion analyzer
- Video

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Cautions for Pour-through Method

- Randomly select 3 to 5 pots of the same species from each fertilizer program
- Be sure media near saturated with water, and wait at least for 30 minutes (Equilibrium)
- Water poured evenly onto medium surfaces
- If tap water is used, be sure to take EC reading of the water and subtract the water reading from all media readings

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EC of irrigation water

Class of water	EC, dS/m
Excellent	< 0.25
Good	0.25 to 0.75
Permissible	0.76 to 2.00
Doubtful	2.00 to 3.00
Unsuitable	> 3.00

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Desired &Acceptable Ranges of media EC and pH?

Analysis	Liquid fertilizer only or liquid & CRF	CRF only
pH	5.0 to 6.0	5.0 to 6.0
EC (dS/m)	0.8 to 1.5	0.5 to 1.0

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Desired &Acceptable Ranges of EC and pH?

- pH range acceptable 5 to 7.5 depending on species
- pH is the **direct** reading regardless of extraction method
- EC measurement is the **indirect** reading - depends on extraction methods
- During the winter, keep EC around 1 dS/m

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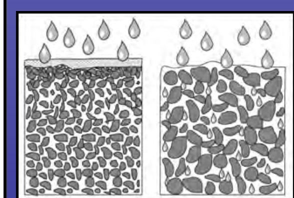
Conversions

- mS/cm – Chen's rule 1, 2, 3
- µS/cm – Chen's rule 1000, 2000, 3000
- 1 dS/m = 1 mS/cm = 1000 µS/cm
- 1 Siemens = 1 mhos
- 1 dS/m = 1 mS/cm = 1 mhos/cm = 1000 µhos/cm

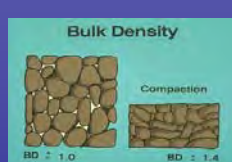
Root substrate-Porosity



- Water is held in and around particles
  - Larger particles = less water holding capacity
  - Smaller particles = more water holding capacity
- Pore spaces = air
  - Small pores = poor root growth and higher incidence of disease
  - After watering, ideally 10-20% of substrate should be occupied by air

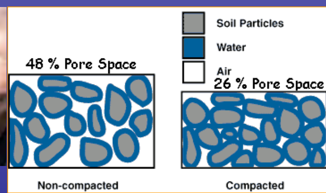
Root substrate-Compaction

- Porosity is the most important factor
- If not enough soil moisture holding capacity, water more frequently
- If media does not have enough air, you can not add



Soil Compaction

Gavin Kingcome Photography/Taxi/Getty Images



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Media Compaction Symptoms

- Ornamental quality declines
- Less growth
- Unexplained/unexpected nutrient deficiencies
- More severe drought stress

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Root substrate-Compaction

- If a mix is too compacted?
  - slow to dry out
  - Lower ability of plant to take up nutrients
  - Increases root rot (*Pythium*)
  - Low aeration will prevent deep root penetration

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Measuring Soil Compaction

- Measure bulk density
  - Weight of potting media/volume (g/cm^3, lbs/ft^3)

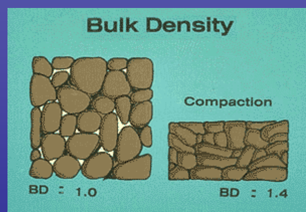

Image: Pennsylvania State University

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Bulk Density and Compaction

Soil texture	Bulk density
Fine	1.0-1.6 g/cm^3 (65-100 lbs/ft^3)
Coarse	1.2-1.8 g/cm^3 (75-110 lbs/ft^3)
Very compact	2.0 g/cm^3 (125 lbs/ft^3)

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To Purchase pH and EC Meters

- Milwaukee Instruments, Inc. (about $60-$200) (www.milwaukeetesters.com)
  - MW802 offers both pH and EC readings
  - Sharp EC Pocket Tester
  - Sharp pH Pocket Tester
- Hanna (1-800-895-8307)
  - pH, ppm, and EC, three meters in one (about $200).
- Spectrum (1-800-248-8873) (about $250-$400)
  - Economy pH/EC Meter
  - Direct Soil EC Probe/Meter

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Mailing Address (please print)

Name ________________________________ Date ________

Address ____

____________________ FL, Zip _______ Phone _____________

Email* ____
*Please provide an email address to receive your results faster.

Signature ____
(signature only required for UF personnel for approval of chartfield charges)

UF/IFAS Analytical Services Laboratories
Extension Soil Testing Laboratory
2390 Mowry Road/PO Box 110740/Wallace Building 631
Gainesville, FL 32611-0740
Email: soilslab@ifas.ufl.edu Website: http://soilslab.ifas.ufl.edu

PRODUCER SOIL TEST FORM

Note: This lab only tests samples from Florida.

Direct any questions about this test or the interpretation of the results to your county UF/IFAS Extension agent.

Fill in all requested information, using one line per sample. Use additional forms for more than 11 samples.

Lab Use Only	Sample ID	County	Estimated Acreage*	Crop Code(s) (see page 2)	Test Code (see page 2)	Cost (see page 2)

* This information is used to compute the total acreage served by the UF/IFAS Soil Testing Program.

Check ○ Money Order ○ Cash ○ Total________

Please enclose payment and this sheet in the same package as sample(s).

Please make checks and money orders payable to **UNIVERSITY OF FLORIDA.**

Samples will not be processed without payment. Do not send cash through the mail.

Important Information for Soil Sample Collection and Submission

Before Sampling

1. Develop a soil sampling plan of your field. Samples should represent the area being tested, so collect samples from areas of the same soil type, appearance, or cropping history. Sample problem areas separately, if needed. From this plan, count the number of samples you will collect.
2. Soil sample bags, addressed shipping boxes, and test forms are available for free from your county UF/IFAS Extension office. Obtain the materials you need before completing your sampling plan.

Collecting Samples

1. Collect soil from 20 or more spots in each area, mixing these samples in a clean plastic bucket.
2. Sample from soil surface to depth of tillage, usually 0–6 inches. For pastures, sample from 0 to 4 inches depth.
3. Spread the composited material on clean paper or other suitable material to air-dry. Do not send wet samples.
4. Mix the dry soil, and place about 1 pint of soil in a labeled sample bag.

Sending Samples to the Extension Soil Testing Laboratory

1. Enter each sample's ID on its sample bag and in the Sample ID column. List each sample separately.
2. Lime and fertilizer recommendations are provided only if the Crop Code(s) is listed.
3. Include the Test Code for each desired test.
4. Enter costs from the Test Cost list found on page 2 of this form.
5. Add the costs of all samples and tests. Make check or money order payable to **University of Florida**. Checks written to other names will NOT be honored and will be returned, causing a delay in processing the samples.
6. Include the completed Producer Soil Test Form and the check or money order in the shipping box with the sample(s).

Test Results

A soil test report will be emailed/mailed to you in 3–6 days after your sample arrives at the Extension Soil Testing Laboratory. Contact your county UF/IFAS Extension office if you have questions about the soil test report.

Crop and Test Codes for Producer Soil Test Form

Standard fertilizer and lime recommendations based on the soil test results will be supplied with the test results if you indicate a Crop Code. Please write the appropriate Crop Codes on page 1 of this form. If your cropping situation is not in the list of codes below, routine soil tests may not be appropriate. In such instances, consult your local county UF/IFAS Extension agent before sending soil samples for testing.

AGRONOMIC CROPS

Please use the Landscape and Vegetable Garden Test Form (SL136) for home gardens. Codes for particular vegetables will result in fertilizer recommendations for commercial vegetable production that are not appropriate for home vegetable gardens.

Crop Code	Field Crops
2	Corn, non-irrigated
5	Corn, irrigated
9	Cotton
7	Grain sorghum
8	Oats for grain
10	Peanuts
8	Rye for grain
11	Soybeans
13	Sugarcane for syrup
12	Tobacco (flue cured)
27	Wheat for grain

Crop Code	Pasture and Forage Crops
23	Alfalfa
26	Cool-season annual grasses (small grains and ryegrass)
22	Cool-season legumes or legume-grass mixtures (lupines, sweetclover, vetches, and all true clovers, white, red, arrowleaf, crimson, subterranean)
32	Hay or silage (perennial grass)
25	Improved perennial grasses other than bahiagrass (bermuda, digit, star)
33	Limpograss (Hemarthria)
28	Perennial peanuts
14	Summer forages (e.g., millet or sorghum)
21	Warm-season legumes or legume-grass mixtures (aeschynomene, alyceclover, desmodium, hairy indigo, and other tropical legumes)

FRUIT CROPS

Except for pH and lime requirement, and in some cases P, soil tests are not used as a basis for fertilization of perennial fruit and nut crops in Florida. Program fertilization is practiced, and plant tissue testing is helpful in certain crops. Tissue testing is available from commercial labs. Consult with your county UF/IFAS Extension agent about interpretation before taking samples.

Crop Code	Crop Description
67	Blueberry (bearing)

Use special forms for requesting other tests, including the Landscape and Vegetable Garden Soil Test (SL136), the Container Media Test (SL134), or the Pine Nursery Soil Test (SL132).

VEGETABLE CROPS

Please use the Landscape and Vegetable Garden Test Form (SL136) for home gardens. Codes for particular vegetables will result in fertilizer recommendations for commercial vegetable production that are not appropriate for home vegetable gardens.

Crop Code	Crop Description	Crop Code	Crop Description
217	Bean, lima, pole, or snap	227	Okra
228	Beet	223	Onion, bulb
212	Broccoli	229	Onion, bunching
212	Brussels sprouts	204	Parsley
207	Cabbage, head or Chinese	216	Pea, English, snow or southern
226	Carrot	201	Pepper, bell or specialty
212	Cauliflower	215	Potato, Irish
214	Celery	218	Potato, sweet
207	Collard	230	Pumpkin squash
220	Corn, sweet	219	Radish
211	Cucumber	210	Spinach
203	Eggplant	230	Squash, summer or winter
225	Kale	224	Strawberry
229	Leek	200	Tomato, cherry or slicing
209	Lettuce, crisphead endive, escarole, or romaine	225	Turnip
205	Muskmelon	221	Watermelon
225	Mustard		

ORNAMENTAL HORTICULTURE

Do not use this form for potting media used in containers. Use the Container Media Test Form (SL134). For fertilization of plants in the landscape, use the Landscape and Vegetable Garden Test Form (SL136).

Crop Code	Crop Description
601	Commercial nursery growing azaleas, camellias, gardenias, hibiscus, or ixora in the ground
600	Commercial woody ornamental nursery growing plants other than azaleas, camellias, gardenias, hibiscus, or ixora in the ground
71	Athletic field, golf green, tee, or fairway

Test Code	Test Name	Determinations Made	Test Cost
1	Standard Soil Fertility Test	pH, lime requirement, P, K, Ca, and Mg	$7
2*	Soil pH and Lime Requirement	pH and lime requirement	$3
3	Soil Micronutrients	Cu, Mn, Zn, and pH	$5
4	Organic Matter	percent organic matter	$10
5	Electrical Conductivity (soluble salts)	conductivity in 1:2 soil:water	$2
	Other	Additional Tests	Inquire

* Included in standard soil fertility test. Do not request both codes 1 and 2 for the same soil sample.

Mailing Address (please print)

Name ________________________________ Date ________

Address ____

__________________ FL, Zip ______ Phone ____________

Email* ____
*Please provide an email address to receive your results faster.

Signature ______________________________________
(signature only required for UF personnel for approval of chartfield charges)

UF/IFAS Analytical Services Laboratories
Extension Soil Testing Laboratory
2390 Mowry Road/PO Box 110740/Wallace Building 631
Gainesville, FL 32611-0740
Email: soilslab@ifas.ufl.edu Website: http://soilslab.ifas.ufl.edu

PLANT TISSUE TEST

Note: This lab only tests samples from Florida.

Direct any questions about this test or the interpretation of the results to your county UF/IFAS Extension agent.

The fee for tissue analysis is $10 per sample. Samples will not be processed without payment

Fill in all requested information, using one line per sample. Use additional sheets for more than 8 samples.

Lab Use Only	Sample ID	County	Crop	Estimated Acreage	Cost

Check ○ **Money Order** ○ **Cash** ○ **Total** ________

Please enclose payment and this sheet in the same package as sample(s).
Please make checks and money orders payable to **UNIVERSITY OF FLORIDA.**
Samples will not be processed without payment. Do not send cash through the mail.

Important Information

- Plant tissue analysis includes: N, P, K, Ca, and Mg (in percent) and B, Cu, Fe, Mn, and Zn (in ppm).
- Sample results are forwarded to a UF/IFAS Extension blueberry or pecan specialist. The Extension Soil Testing Lab can help locate specialists for other types of plant tissue.

How To Take, Prepare, and Submit Plant Tissue Samples for Analysis

1. Ensure that each sample contains at least a generous handful of plant material.
2. Do not sample leaves contaminated with soil or sprays. If all tissue is dusty or spray contaminated, wash leaves gently with flowing distilled water.
3. Place tissue samples directly into a clean paper or cloth bag or envelope. Do not use plastic containers. If the plant tissue is wet or succulent, allow plant material to air-dry for at least one day before mailing.
4. When sampling suspected nutrient-deficient plants, two samples are recommended. Take one sample from normal plants and another sample from abnormal plants.
5. Do not sample disease-, insect-, or mechanically damaged plant tissue.
6. When sampling, the plant part and plant maturity are important factors. Be sure to collect the proper plant part at the recommended time. A general rule of thumb is to sample the youngest, fully mature leaves during the growth cycle or just prior to fruit set.
7. Make checks payable to **University of Florida**. Checks written to other names will NOT be honored and will be returned, causing a delay in processing the samples.
8. Mail this form, your sample(s), and payment (if applicable) to: **UF/IFAS Analytical Services Laboratories, Extension Soil Testing Laboratory**, 2390 Mowry Road, PO Box 110740, Wallace Building 631, Gainesville, FL 32611-0740.

Commercial Plant Diagnostic Clinic Form

Identification #______

PLEASE FILL OUT FORM CLEARLY, LABEL YOUR SAMPLE(S) WITH ID AND LEAVE ON TABLE. TAKE YELLOW COPY FOR YOUR RECORDS. AGENT(S) WILL CONTACT YOU WITHIN A WEEK.

DATE___________________________________

CONTACT PERSON______________________

BUSINESS_______________________________

ADDRESS_______________________________

____

PHONE_________________________________

FAX____________________________________

MOBILE ________________________________

E-MAIL_________________________________

Production Horticulture Agent:

Liz Felter - Production Horticulture
UF/IFAS Extension Orange County
6021 S. Conway Road, Orlando, FL 32812
(407) 254-9203 FAX (407) 850-5125
E-Mail: Lfelter@ufl.edu

Specimen Name/Problems:____

____

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____

Chemicals Recently Applied:____

____

OFFICE USE ONLY, DO NOT WRITE BELOW THIS LINE

Diagnosis/Recommendations:____

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Please check: ☐ WHITE ☐ BLACK ☐ HI/LA ☐ A ☐ NH/PI ☐ AI/AN ☐ MALE ☐ FEMALE

HI/LA = Hispanic/Latino A = Asian NH/PI = Native Hawaiian/Other Pacific Islander AI/AN = American Indian/Alaskan Native