


NC COOPERATIVE EXTENSION

Diagnosing Plant Problems & IPM


Extension Gardener
Class 6



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Today's Class

- Signs and symptoms of plant problems
- **Causes of plant problems**
- Resources for diagnosing plant problems
- **Managing plant problems**
- Integrated Pest Management (IPM)



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Bad Things Happen To Good Gardeners!

- Even when you do everything right, problems happen in the garden and landscape
- Before doing anything, observe the symptoms to determine the cause of the problem




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Plant Problems: Symptoms and Signs

Symptoms

- Changes in growth
- Changes in appearance
- Dead plant parts



Signs


- Evidence of a pest
- **Actual Insect**
- Observed mechanical damage
- Secretions from the plant
- Damage pattern
- Recent weather records (severe freeze, late frost, hail storm, etc)

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Symptoms: Holes in tissue

Flea Beetles – small beetles, small holes

- May be large or small, ragged or precise
- **Most Common Cause:**
 - **Caterpillars or beetles**
 - Also grasshoppers
 - Look for **frass** (insect poop)
 - **Caterpillars may produce webbing**



Orange striped oakworm

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With holes, also look for frass:
Larger insect, larger frass



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Holes may also include webbing


- Some caterpillars produce webbing
- May tie leaves together with webbing
 - Frass often collects in webbing



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Incomplete Holes

- **Skeletonizers**
- Only eat top surface of leaf (epidermis)
- May eat tissue between veins and leave fine network of veins – skeleton



Rose Sawfly

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"Shot hole"

- Center drops out of leaf spot leaving round holes



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Symptoms: Spots

- May be brown, black, tan, purple, red, yellow . . .
- When caused by disease usually have a halo



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Spots

- May be caused by insects feeding on back of leaf
- Always check back!



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Symptom: Leafmining

- Caused by **Leafminers (insects)**
- Feed in between top and bottom surface of leaves
- Usually do not cause serious damage



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Symptom: Blight

- Rapid death (necrosis) of leaf tissue
- Large areas of tissue die



Late Blight, Tomato

Fireblight, Pear


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Symptom: Distortion

Misshapen – may appear:

- Puckered or blistered
- Crinkled or pinched
- Strapped or twisted

Oak Leaf Blister, fungal disease



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Distortion

- Insect feeding
- Many inject toxins in plants to keep phloem flowing – causes distortion

Aphid feeding often causes distortion



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Distortion: Strapping

Usually herbicide related
Some viruses cause distortion



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Distortion: Galls

- Entire leaf may become thickened and rubbery
 - Fungal disease
 - Azaleas, camellias in spring
- Galls may form in the leaf tissue
 - Usually insects
 - Gall wasps




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Symptom: Discoloration

- Leaves may appear:
 - Darker than normal
 - Lighter than normal
 - Tan, white, gray
 - Yellow = chlorotic
 - Red or purple
 - Bright orange
 - Brown or rust (dead) = necrotic

Bright orange discoloration is almost always a sign of rust (fungal disease)



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Symptom: Discoloration

- Pay attention to where discoloration occurs:
 - On the plant:
 - New growth versus old growth
 - Within the leaf:
 - Between veins
 - All over

Yellowing of older leaves only typically a sign of nitrogen deficiency



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Discoloration: Interveinal Chlorosis

- Yellow tissue between the veins
- New growth only= **Iron deficiency**, causes:
 - pH too high
 - Root rot or physical root damage
 - Cold soils

Paper Rice Plant, *Tetrapanax*



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Discoloration: Red or Purple

- Sign of stress
- May develop in cold weather due to Phosphorous deficiency
- When accompanied by dieback/stunting usually root problem




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Discoloration

- **Stippling**
 - Bronzing or yellowing of leaf, made up of hundreds of tiny spots
- **Piercing-sucking insects**
 - Remove chlorophyll from leaf

Stippling caused by azalea lace bug on older leaves – have not spread to new leaves, yet!



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Discoloration: Darkening

- Piercing sucking insects which feed on sap in phloem of plants secrete sweet, sticky substance known as honeydew
 - Attracts ants and wasps
- **Black Sooty Mold**
 - Grows on sticky, sweet honeydew
 - Can block sunlight
 - **Horticultural Oil** helps to break down



Look for insects on back of leaf and on stems/branches

Black Sooty Mold can persist long after the insects are gone



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Discoloration: Lighter


- White or gray coating on leaf
- Powdery Mildew
- Fungal disease
- Common on certain perennials, vegetables and trees/shrubs



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Symptoms that usually indicate "Problem Lower Down"

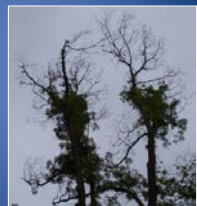
- Wilting
- Dieback
- Flagging
- Stunting, often accompanied by chlorosis
 - Lichen may grow on stems
- No leaves/leaves falling off
 - Plant dead or dying



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Symptoms: Dieback

- Branches die starting at tips and progressing back toward trunk
- Often due to root damage (construction)
- Severe drought can also cause
- Symptoms may develop years after event!



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Symptoms: Flagging

- Leaves/needles on individual stems wilt and/or turn brown and hang on
 - Canker disease
 - Borers in stem

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Symptom: Cankers

On Stems

Discolored areas may be sunken or ooze sap (gummosis)

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Symptoms: Wilting

- All leaves
 - Root or stem problem
 - Drought
- Leaves on one branch or stem
 - Disease, stem damage, insect borers

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Symptoms: Root Rot

White firm roots = Healthy
Brown soft roots = Unhealthy

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Causes of Plant Problems

- Non-living causes** - Known as abiotic problems, these include:
 - Weather
 - Herbicide injury
 - Soil compaction, pH issues
- Living causes** - Known as biotic problems:
 - Pathogens
 - Insects
 - Other critters

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Nonliving Causes of Plant Problems

- Most (~75%) plant problems have nonliving causes!
- Especially true for plants that decline or die within first year of being planted
- The wrong plant for the site or climate!

Sunburn on hosta

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Characteristics of Abiotic Problems

- Symptoms appear all at once
- Symptoms do not spread after initial damage
- Many different types of plants may be affected
- May impact a large area
- May have a noticeable pattern
- Defined line from healthy to unhealthy tissue

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Common Abiotic Problems

- Water management** - too much or too little
- Most critical immediately after planting
- Often related to soil conditions

Symptoms: wilting, plant death

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Common Abiotic Problems

- Soil compaction**
 - Plants grow poorly - stunting
 - Lichen on trees and shrubs
- pH imbalance**
 - Symptom - discoloration; Soil test to determine


Lichen

Interveinal Chlorosis


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Common Abiotic Problems

- **Mechanical Injury**
- Problems in the crown, look near the ground!
- Symptoms: wilting, dieback, plant death



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Common Abiotic Problems

- **Weather**
 - Drought
 - Cold/Frost
 - Wind
 - Hail
 - Lightening

Cold injury on Indian hawthorn



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Common Abiotic Problems

- **Herbicide Injury – distortion, discoloration**



Glyphosate (RoundUp) injury on tomato




2,4-D Injury on Tomato

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Living Causes of Plant Problems


- Plant pathogens
- Insect pests
- Critters are living, but do not reside on the plant
 - Deer
 - Rabbits
 - Squirrels
 - Birds



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Characteristics of Biotic Problems

- Occurrence is isolated or patchy
- Distribution is random
- Symptoms spread over time
- Nearby plants of the same species or plant family may become infected in time
- Gradual change from healthy to unhealthy tissue




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Living Problems

Plant Pathogens Include:

- Fungi – vast majority, 80% of plant pathogens
- Bacteria
- Virus
- Nematodes

- Fungi and bacteria cause similar problems
- Problems caused by virus typically unique



Discoloration caused by virus

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Blights



Leaf Spots

Mildews


Wilts

Cankers

Root and Crown Rots

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- Most are caused by fungi, some by bacteria
- **Least damaging** especially if treated early
- **Host specific**
- Often weather dependent – **worse in wet weather**



Entomosporium Leaf Spot on Indian Hawthorn

Septoria Leaf Spot on Hydrangea

Cercospora Leaf Spot on Hydrangea

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Fungal Leaf Spots

Dots within spots



Zonal Leaf Spot:
Concentric Circles



Colorful:
Red, yellow halos



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Bacterial Leaf Spots



Often angular because they are initially limited by the leaf veins





Usually uniform in color (brown-black), may appear water soaked or greasy

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Powdery Mildew

- Fungal – white spores on top of leaf cause discoloration and sometimes distortion
- Favored by dry weather
- Most common early summer
- Species specific – different strains infect specific plants
- For most, resistant varieties are available – best defense
- Can be treated with fungicides IF started early

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Downy Mildew

- Fungal – gray spores on back of leaf, yellow discoloration on top of leaf
- Host specific
- Common in wet weather
- Not easily treated

Rust

- Fungal – orange spores
- Host specific
- Common early summer – treatable with fungicides
- Look for resistant varieties



Basil Downy Mildew




Rust on Blackberry

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Blights

- Cause rapid death of large areas of leaf tissue
- Most are fungal
- Treatable IF detected early
- Fireblight is bacterial – infects apple and pear




Oak Anthracnose

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Canker Diseases

- Cause flagging and dieback
- Most are fungal
- Usually serious – deadly
- Most cannot be treated
- May be able to prune out
- Host specific
- Often stress related




If you notice flagging or dead stems, look for cankers on the trunk

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Wilts

- Most are fungal
- Clog up vascular tissue (circulatory system) – cause wilting, sometimes cause discoloration (yellowing)
- Soil borne
- Most common in vegetables – esp. tomato
- Fatal



Southern Bacterial Wilt in Tomato

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Root and Crown Rots

- Often associated with poor drainage!
- Can effect seedlings and mature plants
- Roots turn brown, soft and mushy
- Plants may die quickly or slowly
- Persist in the soil
- Not treatable!

Symptoms:
Wilting
Discoloration
Dieback






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Nematodes

- Microscopic worms, considered plant disease
- Feed inside plant roots
- Cause stunting, yellowing, slow decline
- No treatment for infected plants
- Host specific – choose resistant species
- Often occur in “hotspots”




Gardenia infected with nematodes

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Nematode Types

- **Root knot**
 - Hollies, hibiscus, gardenia, boxwoods, roses, okra, peaches and figs
- **Lesion**
 - Boxwood
- **Stubby root**
 - Azalea
- **Dagger**
 - Rose
- **Sting**
 - Turf





Only root knot nematodes produce visible symptoms

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Virus

- Submicroscopic infectious agent – host specific
- Not usually deadly, often cause **strange patterns or color breaks** on leaves and flowers
- **Need living host**
- Can spread by seed, insects, and nematodes
- NOT treatable


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Living Problems: Insects

Common ways insects damage plants:

- **Feed on plant tissue**
 - Eat leaves, buds, flowers, roots
- **Bore into woody stems and trunks**
- Feed on chlorophyll and plant sap
- **Transmit diseases**




Eating leaves is only one way insects damage plants

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Insect Development

- **Metamorphosis**
 - Unique to insects
- **Simple metamorphosis**
 - 3 stages, change gradual over time
- **Complete metamorphosis**
 - 4 distinct stages, each unique
- All insects begin as eggs



Stink Bug Eggs

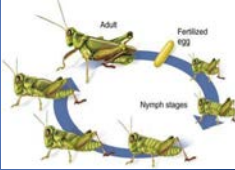
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Simple Metamorphosis – 3 stages

- Egg
- Nymphs
- Adult

- How do you know when you have an adult?
 - **Wings!**
- Adults and nymphs usually feed on same food
 - Cause damage through whole life cycle




Grasshoppers, termites, thrips, true bugs, aphids, scale

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Complete Metamorphosis

- 4 distinct stages
 - Egg
 - Larva
 - Pupa
 - Adult
- Larva and adult usually feed on different foods
- Most are very host specific




Butterflies & moths, beetles & weevils, true flies, wasps, ants, and bees

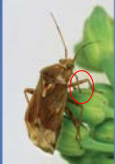
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2 Basic Types of Mouthparts



chewing
Caterpillars, beetles, weevils, grasshoppers, termites



piercing/sucking
True bugs, aphids, scale, mealybugs

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Signs and Symptoms of Insects


<p>Chewing Insects</p> <ul style="list-style-type: none"> • Holes in leaves • Skeletonized leaves • Webbing (caterpillars) • Frass 	<p>Piercing Sucking Insects</p> <ul style="list-style-type: none"> • Discoloration • Distortion • Dieback • Honeydew and Black Sooty Mold 
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Beetles

- Relatively large, hard bodies
- **Complete metamorphosis**
- Larvae often referred to as **grubs** – some feed on plant roots
- **Over 600,000 species, 40% of all insects!**
 - Most do not damage plants!
 - Most plant damaging species feed on vegetables
- Most beetle populations peak in June-July



Spotted Cucumber Beetle




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Beetles

Generally grubs underground, adults fly around, but not always

Colorado Potato Beetles








Japanese Beetles

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Butterflies and Moths

- Complete metamorphosis
- Larvae often referred to as **caterpillars**
- Larvae have **chewing mouthparts**, adults have coiled sucking mouthparts (proboscis) if any at all!
- Moths generally active night, butterflies day

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Many types of caterpillars!

Are they pests or butterflies?




Parsley Worm aka Black Swallowtail

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Caterpillars

- Some produce **webbing**
- Prolific **frass** producers!
- **Bird food!!!**








Fall Webworm

Braconid Wasp cocoons – Parasitize caterpillars

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Borers

- Bore into stems and trunks
- Some are beetles, others are moth larvae
- Typically fatal, cannot be treated once plant is infested
- Attracted to stressed plants

Asian Ambrosia Beetle

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Non Insect Leaf Feeders

- **Slugs and snails**
 - Active at night
 - Typically ragged holes
 - Often see slime trail
- **Deer, rabbits**
 - Large volumes of foliage eaten during short time



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Insects with Piercing Sucking Mouthparts

Honeydew Producers:

- Aphids
- Scale
- Whitefly
- Mealybug

Others:

- True Bugs




Black Sooty Mold grows on honeydew secreted by some insects

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Aphids



- Tiny, fragile insects suck plant juices from tender growth
- Feeding can cause distortion of tips and leaves
- Can spread virus diseases
- Produce honeydew
- Many species, many colors
- Many natural enemies
- Easily controlled



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Scale Insects

- Bumps on stems and leaves
- Actual insect is hiding under the "scale"
- Most but not all produce honeydew
- Many species, host specific
- Can be difficult to control if plants are stressed
- Horticultural oil works for most – spray in May and June when crawlers present



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Mealybug

- Closely related to scale and aphids
- More common on houseplants – move outside for summer

Whitefly

- Tiny white insects
- Typically found on back of plant leaves
- Fly off when plant disturbed





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True Bugs

- Gradual metamorphosis
- Adults and nymphs have **piercing sucking** mouthparts to suck plant juices or other insects!
- **Many have glands that release odor when threatened:** Stink bugs vs. Scentless plant bugs

Azalea Lace Bug



Kudzu Bug



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True Bugs

- Stinkbugs and Leaf-footed Bugs
- Difficult to control!





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Azalea Lace Bug

- **The most common pest problem in SE USA!**
- Prolific on azaleas in full sun
- Cause stippling, bronzing of leaf
- Generally do not seriously injure plants, damage mainly cosmetic
- Several generations per growing season




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Other Lacebugs

- Other lacebugs:
 - Lantana
 - Cause plants to stop flowering, leaves discolored, edges turn brown
 - Pyracantha
 - Sycamore
- All difficult to control – cut plants back and spray insecticidal soap



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Spider Mites

- Not insects, related to spiders – 8 legs, not 6
- Plant damaging mites have piercing sucking mouthparts **but do NOT** produce honeydew
- Causes bronzing of leaf, stippling
- Can produce fine webbing close to leaf surface
- Tiny, found on back of leaf

2-Spotted Spider Mite





Passionflower – stippling caused by spider mite feeding

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Determining What is Wrong

- Gather information
 - What is the plant
 - What are the symptoms
 - Distribution and progression
 - do you think problem is likely biotic or abiotic?
 - Recent weather, activity near the plant (spraying, digging, etc)
- Research common problems



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Online Resources:
eXtension search engine
<https://search.extension.org>



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Search for problems of specific plant:

- Tomato problems
- Tomato diseases
- Tomato insect pests

One Search
Hundreds of Cooperative Extension Sites

Ready to Use! Search for problems of specific plants.

Search for problems of specific plants.

Search for problems of specific plants.

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Check results from SE states first

- NC = ces.ncsu.edu
- VA = ext.vt.edu/
- SC = clemson.edu
- GA = caes.uga.edu
- FL = edis.ifas.ufl.edu
- MS = msucares.com
- AL = aces.edu
- LA = lsuagcenter.com
- TX = horticulture.tamu.edu
- VA = pubs.ext.vt.edu

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Integrated Pest Management

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Focus for Today:

- What is Integrated Pest Management?
- IPM Practices
- Using pesticides to manage:
 - Diseases
 - Insects
 - Weeds
- IPM for ticks and deer

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What is Integrated Pest Management (IPM)?

- A **comprehensive program** that includes both preventative and control strategies
- **Seeks balance, not eradication**
- **Goal = minimize adverse effects on environment AND protect plant health**

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Focuses on...

- **Plant Health Mgmt**
 - Build healthy soils!
 - Sanitation
 - Plant selection
 - Reduce stress
- **Encouraging Beneficials**
- **Treatment**
 - Use less toxic/natural pesticides first

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Step 1: Correct Diagnosis of the Problem!

- Remember: 75% of plant problems are abiotic (non living!)
- Most are in the **root system** – soil problems or water management issues
- **Plants that die within a few months** of planting usually over or under watered
- **Living/Biotic Problems** include insects and diseases

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Common Insect Pests

Two Main Groups

Chewing Insects

Beetles, Caterpillars, Grasshoppers (slugs/snails)
Holes in leaves, webbing and frass may be present

Piercing Sucking Insects

Aphids, Mealybug, Scale, Whitefly, Thrips, True Bugs
Distortion, Discoloration including Black Sooty Mold, Dieback – check back [or leaf!](#)

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Plant Diseases

- Can affect:
 - **Leaves** – mildew, leaf spot, blight
 - **Flowers and Fruits** – fruit rots
 - **Stems and Limbs** – canker
 - **Vascular Tissue** - wilt
 - **Roots and Crown** – root rot, nematodes
- **Only leaf diseases are realistically treatable**

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Non Treatable Problems

- Canker
- Root Rot
- Wilt
- Virus
- Nematodes
- Borers



Wilt diseases clog the vascular tissue of plants and cannot be treated

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Step 2: Deciding If You Need To Do Anything

- Problem must be **correctly identified** before deciding what to do!
- Pest problems much easier to control if caught early - **Monitor Regularly!**
- **Be on the lookout for symptoms of problems**




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Do You Need To Do Anything?

Is the insect/disease still active?

Is the problem serious?

- Is it likely to **persist** over a large portion of the growing season?
- Does it **threaten long term health** of the plant?
- NOTE: Young, recently planted plants are more sensitive to pest damage




Lecanium Scale can be a serious pest of trees. **Stressed trees** are more severely affected.

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Do You Need To Do Anything?

- **Is the problem likely to reoccur?**
 - Would it better to replace the plant?
- **Is the plant valuable?**
- **Can anything be done?** When is the right time?




Azalea leaf gall is completely harmless - also by the time the galls form it is too late to treat.


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Tolerance Levels

- Will depend on **type of plant** - edible versus ornamental
 - Typically less tolerant of damage on edible plants
- **Value of plant** - \$1 annual versus \$100 tree
- **Location of plant** - front yard versus backyard



Which would you treat?



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Step 3: Determine a Course of Action

Short term:


May be able to treat with pesticide (synthetic or organic)

- **If infection active/ongoing**

Long term:

Prevention and IPM

Success of both depends on **correct identification** of the problem!



Caterpillars on broccoli - treat with an insecticide now, cover plants with row cover to prevent further infestation.

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Long Term: Prevent Stress

Stress

- Reduces photosynthesis
- Reduces growth and defense
- Attracts pests

Stressors:

- Too dry or too wet,
- High or low soil pH,
- Nutrients too low or too high,
- Planted too deep
- Planted wrong season
- Compact soil




Drought stressed plants 'glow' and 'scream' to insects

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Prevent Stress!

- **Improve Soil:** Alleviate compaction, add organic matter, correct pH and nutrient issues based on soil test results (class 2)
- **Choose right plant for the climate and site conditions**
 - Class 6 - ornamentals
 - Class 5 - fruits and berries
 - Class 4 - vegetables
 - Class 3 - lawns




Till compost, lime and nutrients into the soil before planting

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Prevent Stress!

- Plant at the right time
- Plant disease resistant varieties
 - Classes 4, 5, 6
- Mulch
 - Class 7



Mulch conserves moisture, slowly enriches the soil and keeps mowers away from tree trunks



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Prevent Stress:

Watering

- **Water during drought**
 - Apply water slowly so it is able to soak deep into the soil
- **To reduce leaf diseases, avoid wetting leaves**
 - Most fungal leaf diseases require 4 hrs + of continual leaf wetness to infect
- **Don't overwater** – this encourages root rot!

Drip irrigation delivers water directly to the soil

Water fan sprinklers spray water in the air wetting foliage

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Prevent Stress:

Proper Spacing

- **Plan for mature size**
- Allows air flow between plants to **promote drying** & prevent disease
- **Allow adequate space to minimize:**
 - **Competition for Water, Nutrients, & Light**
 - **Habitat for pests**

Proper spacing depends on mature size of plant – most plants do best when leaves just touch at full size



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IPM: Exclusion



Floating row covers can keep **flying adult insects** from laying eggs on vegetables – e.g. Cabbage whites

Will also keep out pollinators – okay for leafy greens, not for fruiting crops

Cover when insects are active – stake down edges

Lay directly onto crop or install PVC supports

Cabbage White

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IPM: Sanitation

- Pull out infested plants
- Remove infested leaves
- Clean up 'mummy' fruit!
- Take away from the garden!

If only a few leaves are infested, remove them from the plant




Mummy berry survives in shriveled fruit that fall to the ground

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IPM: Sanitation

- **Physically remove insects and eggs**
 - Squish or drop in sudsy water
- **Remove plant debris** (fallen fruit, twigs, and leaves)
 - Prevents insects and diseases from overwintering


Squash Bug Eggs



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IPM: Diversity

- **Plant many different species!**
- Avoid placing all plants of one kind together in large groups
- Alternate groups of different plants within rows or patches in vegetable garden – include flowers and herbs!
- **Flowers help attract beneficials**



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Encourage Beneficials – Plant Flowers!

- **Small flowers**
 - Dill, Fennel, Basil
 - Yarrow, Sedum
 - Goldenrod, Joe Pye Weed
- **Daisy flowers**
 - Purple Coneflower, Cosmos
- **Others**
 - Salvias, Mints, Asclepias, Zinnia

Goldenrod



Purple Coneflower



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Hover Fly adults look like bees or wasps

Beneficials

- Learn to recognize all **life stages** of beneficials
- **Diverse landscapes** encourage beneficials
 - Plant many different types of plants, including flowers
- Strive for a **balance** of good and bad insects.

Hover fly larvae look like small slugs or caterpillars – voracious aphid eaters




NC COOPERATIVE EXTENSION

Lacewing

Eggs



Juvenile – 'Aphid Lion'



Adult



NC COOPERATIVE EXTENSION

Parasitic Wasps





NC COOPERATIVE EXTENSION

Assassin Bug







Ladybug
Larvae
Pupae
Adult

NC COOPERATIVE EXTENSION

Control Weeds

- Mulch minimizes annual weeds
- Hand weeding/hoeing
 - Most effective for small annual weeds – pull before they set seed!
 - For perennials, will need to dig out roots
- Herbicides
 - Organic herbicides only effective on young weed seedlings



Weeds can harbor insects and pathogens

NC COOPERATIVE EXTENSION

IPM: Pesticides

- Use if other methods do not provide control
- Choose the right product for the problem:
 - Insecticides = kill insects
 - Fungicides = kill fungi
 - Herbicides = kill plants
- Always choose less toxic options first
 - Soaps and Oils
 - Plant Derived
 - Microbial
 - Mineral based



NC COOPERATIVE EXTENSION

Choosing the Right Product: Must Know the Active Ingredient

Pesticides are much like OTC medications:

- Many brands
- Few different active ingredients
- Some products contain combo of 2 or more a.i.



NC COOPERATIVE EXTENSION

SOME Products Containing Glyphosate

- Ace Concentrate Weed & Grass Killer
- Compare-N-Save Grass & Weed Killer
- Do It Best Grass and Weed Killer
- HDX Weed & Grass Killer
- Hi-Yield Killzall Weed & Grass Killer
- Martin's Eraser Weed & Grass Killer
- Ranger Pro Herbicide
- Scott's Roundup Concentrate Weed & Grass Killer
- Scott's Roundup Pro Herbicide
- Scott's Roundup Super Concentrate Weed & Grass Killer
- Surrender Eraser Systemic Weed & Grass Killer
- Ultra-Kill Grass and Weed Killer
- Quick Kill Grass & Weed Killer
- Pronto Big N' Tuf Weed and Grass Killer



NC COOPERATIVE EXTENSION

Key to understanding and selecting pesticides is understanding active ingredients: Read the label!



Labels for almost every product can be found online but must have complete name of product to search!

NC COOPERATIVE EXTENSION

Information Found On Labels And Labeling

- What is in this product?
- How much do I mix?
- Will this hurt my pet?
- How often do I spray?
- How soon can I harvest?
- How soon can I reseed?
- Can I spray _____?



NC COOPERATIVE EXTENSION

Labels and Labeling

Brand Name

- E.g. Garden Safe Fungicide 3

Active Ingredient

- Net content % + inert ingredients
 - E.g. Neem oil
 - RTU = 0.9 %
 - Concentrate = 70%
 - Mix 1-2 oz per gallon = 0.8-1.6%



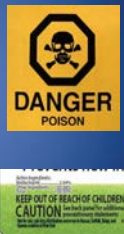
ACTIVE INGREDIENT	Clarified Hydrophobic Extract of Neem Oil	0.9%
OTHER INGREDIENTS		99.1%
TOTAL		100.0%

NC COOPERATIVE EXTENSION

Signal Words

- **Danger** – highly toxic - Poison
 - Adult killed by a taste to a teaspoon
- **Warning** – moderately toxic
 - Adult killed by tsp to 2 tablespoons
- **Caution** – slightly toxic
 - Adult killed by ounce to more than pint
 - Most homeowner products

Does not indicate effect on pest!



NC COOPERATIVE EXTENSION

Labels and Labeling

Precautionary Statements

- Hazard to humans and domestic animals
- Environmental hazards
 - Fish, birds, wildlife, etc.
 - **BEE HAZARD**
- Physical/Chemical hazards
 - Flammable, explosive
- Statement of practical treatment
 - First aid



NC COOPERATIVE EXTENSION

ENVIRONMENTAL HAZARDS

This product is extremely toxic to aquatic and estuarine invertebrates. Do not contaminate water by cleaning equipment or disposal of wastes.

BEE CAUTION: MAY KILL HONEYBEES IN SUBSTANTIAL NUMBERS.


This product is highly toxic to bees exposed to direct treatment or residues on blooming crops or weeds. Do not apply this product or allow it to drift to blooming crops or weeds if bees are visiting the treatment area.

NC COOPERATIVE EXTENSION

Directions for Use

- Pests to be used on
- Crop/animal/site to be used on
 - Must be labeled for site!
- How to apply
- How to mix, rate
- How often to apply
- Waiting periods, pre-harvest interval

The label is the law!!!
Always refer clients to the label for instructions on use



NC COOPERATIVE EXTENSION

Active Ingredients Can Be:

- **Synthetic** = man-made
 - Often based on natural substances
- **Natural** = derived from naturally occurring materials
 - Minerals
 - Plants
 - Microbes
 - Soaps and Oils


Read and follow label directions for ALL products!



NC COOPERATIVE EXTENSION

Residual Activity

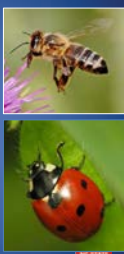
- How long a pesticide remains active after it is applied
- **Synthetics have much longer residual activity** than natural products
 - **Good** = control pests longer
 - **Bad** = stay in environment longer, greater chance of impacting non-target species (people, pests, wildlife, pollinators, beneficial insects)
- Metabolites of synthetic pesticides often have long residual life



NC COOPERATIVE EXTENSION

Pesticides and Beneficials & Pollinators

- **Insecticides most toxic** pesticides to beneficials and pollinators
- Check for beneficials before spraying
- Apply pesticides late in evening once bees have returned to hive
- **Do not spray plants with open flowers**
- Do not spray areas with flowering weeds
- Use natural products when possible – less residual activity



NC COOPERATIVE EXTENSION

How Do You Know if a Product is Natural?

- Active ingredients listed on the label
- **OMRI listed** – approved for use by certified organic farmers
- Some products have natural active ingredients but are not OMRI approved

OMRI LISTED
© Organic Materials Review Institute

Active ingredients are listed on the label




NC COOPERATIVE EXTENSION

Characteristics of Natural Pesticides

- **Not persistent**
 - Break down quickly, sometimes in a day
 - Most are less toxic to beneficials
- **No residual activity or systemic uptake**
 - Must reapply often
 - Wait until pest present to treat
- **Not as potent as synthetic pesticides**
 - Must be part of integrated system!
- **Many are very specific** = only work for certain pests
 - Correct pest ID essential!


Pine Sawfly larvae look like caterpillars but are not – B.T. will not control them.



NC COOPERATIVE EXTENSION

Pesticide Formulations


- **Concentrates** – must be mixed with water
- **Ready to Use products** – often in spray bottle
- **Granules and Baits** – mostly fire ant products
- **Dusts** – most harmful to bees and pollinators; less effective than liquid formulations



NC COOPERATIVE EXTENSION

Using Pesticides

- **Most effective when problem just starting!**
 - Monitor regularly, catch problem early
- **Must know the pest to choose a treatment!**
 - Correct identification essential!
 - Need a sample or a picture!
 - First, ID plant
 - Look up common problems for that plant




It is too late to save this tomato plant!

NC COOPERATIVE EXTENSION

Herbicides

- More effective on small weeds!
- Large, flowering annual weeds difficult to kill
- Perennial weeds often require several applications!
- Few natural herbicides = all are contact herbicides, burn foliage



Dollarweed

NC COOPERATIVE EXTENSION

Herbicides


- **Pre-emerge**
- **Post-emerge**
 - Contact
 - Systemic
 - **Selective**
 - **Non-selective**



NC COOPERATIVE EXTENSION

Pre-Emergent Herbicides

- Kill weedlings just after germination
- Timing very important – must be applied before seed germinate
- Must be watered in, usually 1/2" of irrigation
- Form a seal or blanket over soil
- Last 10-12 weeks
- **Must know what weeds targeting**
 - Not effective for all weeds, do nothing to control established weeds or perennial weeds



Apply BEFORE weeds come up!

NC COOPERATIVE EXTENSION

Pre-Emergent Herbicides

Usually granular

For landscape/vegetable beds:

- Trifluralin (Preen), 4 products
- Mainly control annual grasses and small seeded annual broadleaves

For lawns: crabgrass preventers


- Many brands – active ingredients: benefin, bensulfide, dithiopyr, prodiamine, pendimethalin
- Stunt turf growth!



NC COOPERATIVE EXTENSION

Post Emergent Herbicides

- Effective after plants have germinated
- Applied to foliage as spray
- Most effective on young, actively growing plants
- Plant stress (drought, cold) reduces effectiveness
- Not very effective on mature blooming or seeding plants




Henbit, winter annual

NC COOPERATIVE EXTENSION

Post Emergent Herbicides

- Not very effective immediately after mowing
- Generally apply between 60 – 85 degrees
 - See label for specific directions
- Most of the time need 6 hrs before rainfall or irrigation unless 'rainfast' – check label



NC COOPERATIVE EXTENSION

Post Emergents Can Be: Contact

Kills only tissue it touches


- Work fast, but do not kill the root
- mainly effective on small, annual weeds
- **Soaps and Oils – Natural**
 - Not as effective as synthetic herbicides in most trials



NC COOPERATIVE EXTENSION

Post Emergents Can Be: Systemic

- Are translocated by the plant to root system
- Most effective when plants actively growing
 - after rainfall
 - moderate temperatures
- Do not act as quickly as contact
 - can take several days to see effect, versus a few hours with contact herbicides
- Most post emergent herbicides are systemic
 - Eg. Glyphosate – Round Up



Florida Botany

NC COOPERATIVE EXTENSION

Systemics Can Be: Selective

Only kill certain types of plants:
NOT weeds versus ornamentals!

- **Monocots - Grasses**
 - Sethoxydim
 - Fluazifop-p
- **Monocots - Sedges**
 - Imazaquin – Image for nutsedge



NC COOPERATIVE EXTENSION

Systemics Can Be: Selective

- **Dicots – Broadleaf Weeds**
 - 2,4-D alone or in combination (majority of products!)
 - Mecoprop, & Dicamba – “3 Way Spray”
 - Many now “4-way”, + carfentrazone
 - Atrazine – both pre and post emerge activity
 - Triclopyr = brush killer
 - Iron HEDTA = natural but not organic, for broadleaf weeds in lawns




Centipede and St. Augustine lawns are sensitive to 2,4-D: use sparingly!

NC COOPERATIVE EXTENSION

Systemics Can Be: Nonselective

Kill most plants – absorbed by green tissue

- **Glyphosate –**
 - May be combined with other a.i.:
 - **Extended control herbicides:** Imazapyr, Imazapic, Indaziflam – Be careful where you spray!
 - **Contact herbicides:** Diquat, Pelargonic Acid - faster burn down but may reduce effectiveness



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- **Pre-emerge**
 - Crab grass preventers, Preen
- **Post-emerge**
 - **Contact**
 - Natural Herbicides
 - **Systemic**
 - **Selective**
 - » 2,4-D based herbicides - Kill broadleaf weeds only
 - » Sethoxydim; Fluazifop – kill grasses only
 - **Non-selective**
 - » Glyphosate (Round Up)

NC STATE

NC COOPERATIVE EXTENSION

Insecticides

Complete eradication is not the goal!

- Need some pests to feed beneficials!
- There is no product you can drench the ground with in winter that will get rid of all the bugs!



Ladybug feeding on aphid

NC STATE

NC COOPERATIVE EXTENSION

Insecticides

- **Not all insects can be controlled**
 - Heavy infestations, especially scale
 - Borers, once in the tree
 - Large hard bodied insects are more difficult
 - Beetles, true bugs (stink bugs, kudzu bugs)




Leaf Footed Bug

NC STATE

NC COOPERATIVE EXTENSION

Insecticides

- **More than one application may be needed**
 - Especially for contact products (NOT systemic)
 - Especially for insects that are strong fliers:
 - E.g. Japanese beetles, kudzu bugs
 - Insect may be dead but still on plant – scale
- **For pest prone plants, best option often is replacement!**
 - Junipers and bagworm
 - Euonymus and scale



NC COOPERATIVE EXTENSION

Insecticide Categories

- Systemic or Contact
- Chemistry:
 - Synthetic Pyrethroids
 - Neonicotinoids
 - Older chemistries
 - Naturally derived

Neonicotinoid, Systemic




NC STATE

NC COOPERATIVE EXTENSION

Systemic Versus Contact

- **Systemic** = absorbed by the plant and moved throughout the plant
 - In the plant tissue, not on the surface; persist for months
 - Insects die when feed on leaf or sap; More effective for sap feeders
 - New growth protected if soil applied
- **Contact** = exists on plant surface, not absorbed into tissues
 - Wash off easily; break down in sunlight; Persist for days to weeks
 - Insects die when eat or come into contact with treated surface
 - New growth not protected



NC COOPERATIVE EXTENSION

Chemistry: Synthetic Insecticides

Older products:

- Carbaryl (Sevin)
- Malathion

- Contact, short residual
- Broad spectrum, kill many different pests
- Highly toxic to bees and beneficials
- Will be phased out eventually



NC COOPERATIVE EXTENSION

Chemistry: Synthetic Pyrethroids


- Permethrin, Bifenthrin, Esfenvalerate
 - Older generation
- Cyfluthrin, Lambda-cyhalothrin, Gamma-cyhalothrin, Zeta-cypermethrin
 - Newer generation




NC COOPERATIVE EXTENSION

Chemistry: Synthetic Pyrethroids

- Based on natural Pyrethrins; much longer residual (weeks)
- Broad spectrum: kill most types of insects when applied correctly
- **Very harsh on beneficials**
 - Often get flare up of secondary pests: mites, aphids, whitefly, etc.
- **Highly toxic to bees** within a day of application



Spider mite feeding causes stippling – populations often explode with repeated use of pyrethroids



NC COOPERATIVE EXTENSION

Chemistry: Neonicotinoids

Merit

- Imidacloprid (Merit), most widely used insecticide in the world!
- Single most widely used insecticide in the world
- Other Neonics:
 - Acetamiprid (3 products)
 - Thiamethoxam
 - Thiacloprid
 - Clothianidin
 - Dinotefuran



NC COOPERATIVE EXTENSION

Neonicotinoids

- Control most piercing sucking insects : aphids, whitefly, scale, lace bug
- Control leaf feeding beetles
- **Does NOT control caterpillars**
- Does NOT control ambrosia beetle borers, e.g. black twig borer




NC COOPERATIVE EXTENSION

Neonicotinoids

Systemic


- Can be applied as granules (watered in), drench, or spray to foliage
 - Ground applications accumulate and persist in soil!!!
 - Levels build up with repeated applications: research indicates no need to treat every year!
- Bayer Advanced products often combine a Neonic and a Synthetic Pyrethroid



NC COOPERATIVE EXTENSION


Neonicotinoids

- Systemic: Transported to all parts of plant, including pollen and nectar
- **HARMFUL TO POLLINATORS**
 - Most effects sub-lethal
 - Causes disorientation, reduced foraging efficiency, increased disease susceptibility
 - Do not soil apply to flowering plants



ARE NEONICOTINOIDS KILLING BEES?
A group of researchers has linked chronic colony collapse disorder to bees with neonicotinoid use.

Xerces Society report – available online



NC COOPERATIVE EXTENSION

Neonicotinoids

- Acetamiprid is less toxic to bees than imidacloprid
- Neonics are less harmful to beneficial insects than pyrethroids
- May cause flare up of secondary pests, particularly spider mites



NC COOPERATIVE EXTENSION

Naturally Derived/ Less Toxic Insecticides

- Insecticidal Soap
- Horticultural Oil
- Microbial
- Plant derived

Hazardous if misused!
Read and follow all label directions



NC COOPERATIVE EXTENSION

Insecticidal Soap

- Potassium Salts of Fatty Acids
 - kills soft body pests: aphids, whitefly, mites
 - Kills only what it contacts – not eggs
 - Repeated applications often necessary
- No residual activity



NC COOPERATIVE EXTENSION

Horticultural Oils

Mineral oils

- kill by smothering,
- kill all life stages (eggs must be exposed)
- great for scale, spider mites, aphids, whitefly
- Can damage plants at high temperatures
- Older “dormant” oils = winter only

No residual activity

Plant oils (sesame, clove, canola, etc) work similarly



NC COOPERATIVE EXTENSION

Neem Oil and Azadirachtin

- Derived from Neem tree seed
- Over 70 cmpds, **Azadirachtin** believed most active
- Controls aphids, mites, thrips, whitefly
- May help control powdery mildew
- Primarily acts as **growth regulator** – works best on immature insects
- Not quick knockdown – slow acting
- Breaks down in sunlight



NC COOPERATIVE EXTENSION

Pyrethrum and Pyrethrins

Tanacetum cinerariifolium,
Dalmatian Chrysanthemum

- **Pyrethrum** = Made from the dried flower heads of *Tanacetum cinerariifolium*
- **Pyrethrins** = active compounds
- Quick, knock down for wide range of insects
- Breaks down rapidly in sunlight
- Harsh on beneficials
- Secondary pests may flare up



NC COOPERATIVE EXTENSION

B.t.– *Bacillus thuringiensis*

Naturally occurring bacteria effective for **caterpillar control**

- Most effective when pest are young/small
- Stop feeding within a few hours, slow death
- Spray in evening, breaks down in sunlight
- Separate strain for **Colorado potato beetle control**



NC COOPERATIVE EXTENSION

Spinosad


- Developed from soil dwelling bacterium
- Causes death within a few days
- A little more persistent than B.t. and neem (3-5 days)
- **Effective for**
 - Caterpillars,
 - Colorado potato beetle,
 - Fire ants (baits)




NC COOPERATIVE EXTENSION

Fungicides

- Only control certain **fungal diseases** – not viral or bacterial
 - Primarily foliage diseases; e.g. leaf spots, mildews
 - Weather has huge impact on disease development
 - **Wet weather = more disease pressure**; exception is powdery mildew, more severe in dry weather



Leaf Spot




Powdery Mildew

NC COOPERATIVE EXTENSION

Fungicides

- Symptoms do not disappear after treating; Instead new growth is clean
- Disease prone varieties = REPLACE!
- **No products can treat root rot, canker, wilt diseases**
- Most plant problems have abiotic/non-living causes!

Some varieties of Saucer Magnolia are extremely susceptible to powdery mildew; By the time symptoms are noticeable, too late



NC COOPERATIVE EXTENSION

Fungicide Categories

<p>Protectants</p> <ul style="list-style-type: none"> • Only persist on surface of leaf; • Wash off easily, must be reapplied often • Older synthetics and all naturals 	<p>Penetrants</p> <ul style="list-style-type: none"> • Absorbed into leaf tissue but not moved systemically • More effective and longer lasting • Synthetic only
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NC COOPERATIVE EXTENSION

Synthetic Fungicides: Penetrants

- Myclobutinal
- Propiconazole
- Tebuconazole
- Triforine

- For leaf spot, mildews, leaf blight and other foliage diseases
- Make labeled to use where you wish to spray (vegetables, fruits, lawn, ornamentals/landscape)



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NC COOPERATIVE EXTENSION

Synthetic Fungicides: Protectants

- Chlorothalonil - Daconil
- Thiophanate-methyl
- Mancozeb
- Captan – found in fruit tree sprays

For leaf spot, mildews, leaf blight and other foliage diseases



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NC COOPERATIVE EXTENSION

Natural Disease Control Products

- **Protect plants** from disease as part of integrated system
- **Do not cure problems** – only suppress them – must reapply as long as disease is active
- **Neem and oils** may have some effect on diseases, particularly powdery mildew



Early Blight on Tomato

NC STATE

NC COOPERATIVE EXTENSION

Minerals

- **Sulfur** – fungal disease control
- **Copper** – fungal and bacterial diseases – Copper Octanoate
- Contact protectant
- **Apply carefully** - Leaf damage can occur



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NC COOPERATIVE EXTENSION

Natural Fungicides

- **Bacillus subtilis** – For leaf diseases, sold as 'Serenade'
- **Potassium bicarbonate** – Especially effective for powdery mildew – Sold as 'Remedy' and other brands – [May have to order online](#)




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NC COOPERATIVE EXTENSION

IPM for Ticks

- Personal protection - when entering tick infested areas:
 - Repellants containing DEET
 - Tuck pant legs into socks
 - Wear long sleeves
 - Clothing treatment with permethrin
 - Avoid brushing against vegetation



Ticks climb up grass and shrubs to wait for prey – they must periodically climb down to avoid dehydration

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NC COOPERATIVE EXTENSION

IPM for Ticks: Landscape Modification

Reduce habitat for ticks:

- Ticks love leaf litter, groundcovers, tall grass and low shrubs
- Woodland edge is favored habitat
- **Mow grass frequently**
- Create 3'+ wide zone of bark mulch along woodland edge – not irrigated!



Traversing wide dry areas of exposed soil, stone or mulch is challenging for ticks

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NC COOPERATIVE EXTENSION

IPM for Ticks: Minimize Hosts

- Deer are single most important host for ticks
 - Deer thrive in urbanizing areas
- Mice and small mammals are also prime hosts
 - Tall grass and brush piles harbor mice




More deer = more ticks

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NC COOPERATIVE EXTENSION

IPM for Deer

- Landscape with deer resistant plants (class 6)
- Repellents can help:**
 - Few registered for vegetables/fruits
 - Apply based on label directions
 - Deer Away, Bobbex, Repellex and Tree Guard most effective in Maryland study
 - Bars of soap suspended from trees/shrubs?




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NC COOPERATIVE EXTENSION

IPM for Deer

- Herd management at community level
- Fencing – to keep deer out
 - Electric most effective – deer prefer to climb under rather than jump over
 - Single strand for temporary fence
 - Double strand for permanent fence




Polytape is easier to work with than 17 gauge wire for electric fencing

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NC COOPERATIVE EXTENSION

IPM for Deer: Fencing

- Offset/double fence
 - 2 wires, 15" and 43" from ground
 - Third single wire 52" away on inside, 30" from ground
- At least 8' if vertical, not electric
- Slanted fence – 7 wires, 12" apart, fence 48" tall, 56" wide



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For fence plans, see:

<http://ncwildlife.org/>

Slanted, 7-wire fence



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Learn More About Active Ingredients:

- National Pesticide Information Center: <http://npic.orst.edu/ingred/specchem.html>
- UC Davis – Pesticide Active Ingredient Database: <http://ipm.ucanr.edu/GENERAL/pesticides.html>

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Extension Recommendations:

eXtension search engine

<https://search.extension.org>



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Questions?

Thank you for participating in the Extension Gardener Course!

Please take time to complete the course evaluation.

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