

Integrated Pest Management for Organic Growing

Diane Alston

Entomologist, Utah State University

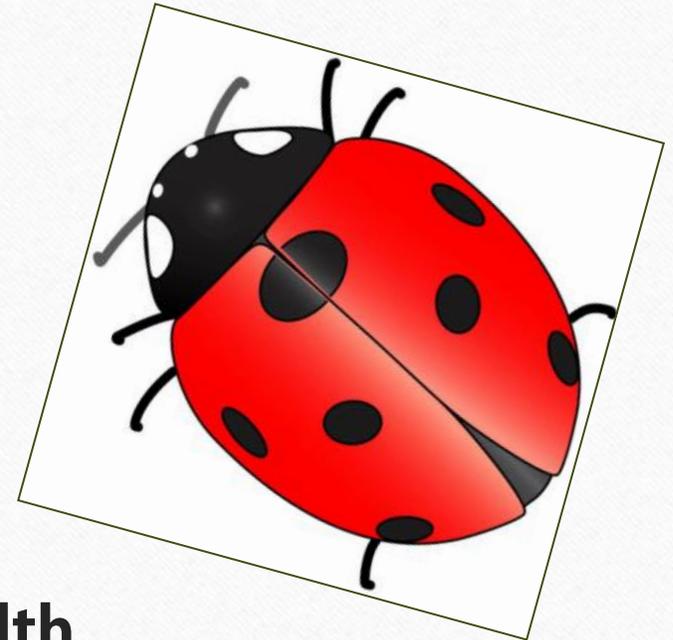
Organic Growing Workshop, Wheeler Farm Historic Barn, SLC

March 14th, 2015

IPM: Integrated Pest Management

- Prevents pests & plant health problems
- Uses a combination of methods
 - Cultural
 - Mechanical
 - Biological
 - Chemical
- Increases tolerance of plants to pests
- Avoids harm to human & environmental health
- Improves sustainability (environment, economics, and social)

**Preferred
Order**



Develop an IPM Program for your Organic Garden

Organic tools

Practical

Sustainable

1. Know Your Resources

Local & Online

Utah State University Extension

USU Extension Pest Management Team



Dr. Ricardo Ramirez
Entomologist



Dr. Claudia Nischwitz
Plant Pathologist



Marion Murray
Plant Pathologist
IPM Project Leader



Dr. Diane Alston
Entomologist
IPM Coordinator



Ryan Davis
Arthropod Diagnostician
Utah Plant Pest Diagnostic Lab



Dr. Lori Spears
Entomologist
Invasive Pest Survey

Utah Pests Online Resources

www.utahpests.usu.edu

One-stop shopping
for pest management
information

The screenshot shows the homepage of the Utah Pests website. At the top, there is a navigation bar with the text "EXTENSION UtahStateUniversity" and "UTAH PESTS". Below this, there are several menu items: "UTAH PESTS Home", "Utah Plant Pest Diagnostic Lab", "Integrated Pest Management", "School IPM", and "Cooperative Agricultural Pest Survey". A search bar is located on the left side. The main content area features a large image of a pest on a plant, followed by four featured articles: "Utah Plant Pest Diagnostic Lab", "Integrated Pest Management", "School Integrated Pest Management", and "Cooperative Agriculture Pest Survey". On the right side, there is a "In the News" section with three news items: "Predators, Parasites, Pests, and the Paradox of Biological Control", "Insect Communication", and "A Taxonomic Toolkit Ends a Century of Neglect For a Genus of Parasitic Wasps". At the bottom, there is a footer with the text "Utah State University is an affirmative action/equal opportunity institution. © 2015 Utah State University Utah Pests".

USU Links >> USU Home A-Z Index calendars MyUSU directory contact

EXTENSION UtahStateUniversity

UTAH PESTS

UTAH PESTS Home Utah Plant Pest Diagnostic Lab Integrated Pest Management School IPM Cooperative Agricultural Pest Survey

Google™ Search

Home
Fact Sheets
Video Fact Sheets
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Utah Pests News
Quarterly Newsletter
Bees and Other
Pollinators
In the News
Contact Us

Utah Plant Pest Diagnostic Lab
Just \$7 gets your pest problem diagnosed or insect identified.

Integrated Pest Management
Your source for fruit, vegetable, and landscape pest problems.

School Integrated Pest Management
Teaching responsible pest management for a healthy learning environment.

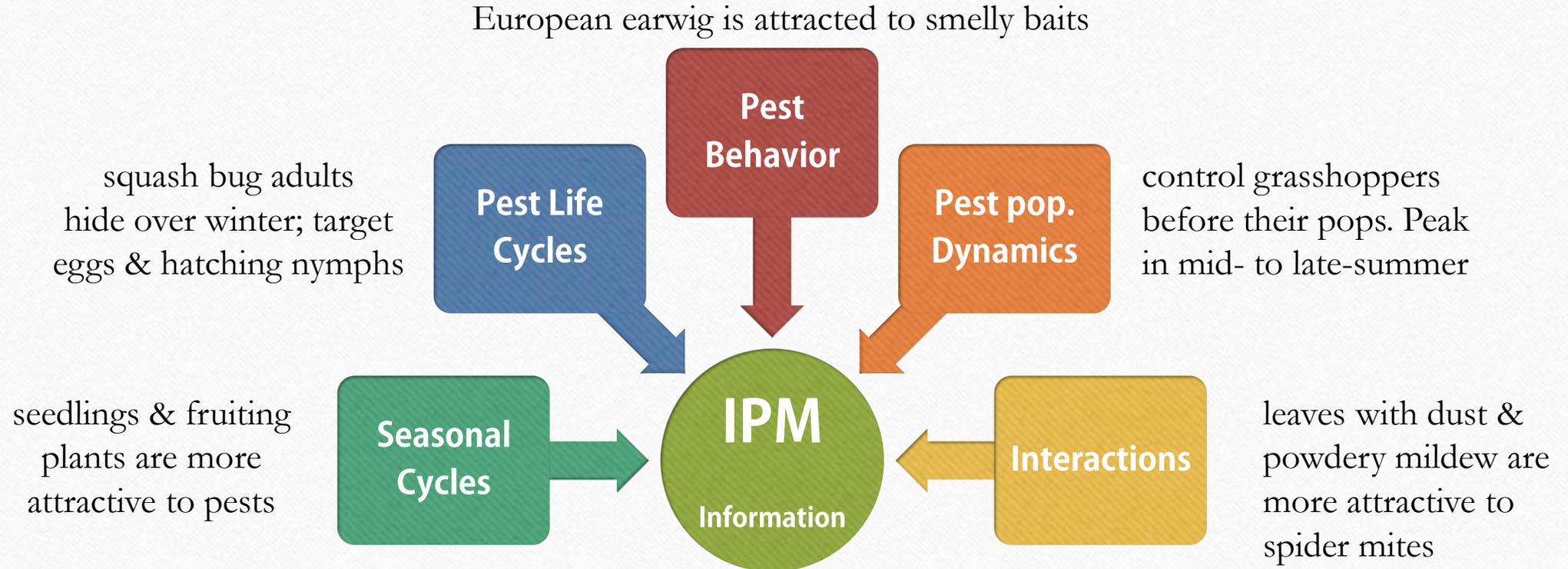
Cooperative Agriculture Pest Survey
CAPS protects Utah agriculture through statewide monitoring of invasive pests.

In the News
Predators, Parasites, Pests, and the Paradox of Biological Control
Jan 20, 2015
Insect Communication
Jan 13, 2015
A Taxonomic Toolkit Ends a Century of Neglect For a Genus of Parasitic Wasps
Dec 15, 2014

UTAH PESTS' is a group of Extension entomologists and plant pathologists that helps to solve the thousands of plant pest issues that concern Utah citizens every day. The UPPDL identifies, the IPM Program educates, and the CAPS Program investigates. Open one of the websites to get answers!

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2. Know Your Plant & Pest Biology



3. Pest Monitoring

- **Look for big picture patterns of plant injury first**
- **Where to look?**
 - new growth, undersides of leaves, on/in stems, inside fruits, on roots in soil, under bark, etc.
 - look at night with a light! - many insects are nocturnal
- **Use a hand lens - most insects are small**
- **Dislodge insects onto a light-colored surface**
- **Use appropriate traps**
 - sticky traps with attractant colors & baits
- **Check for crown & root problems**



Squash bug eggs & nymphs



Beating tray

4. Treatment Thresholds

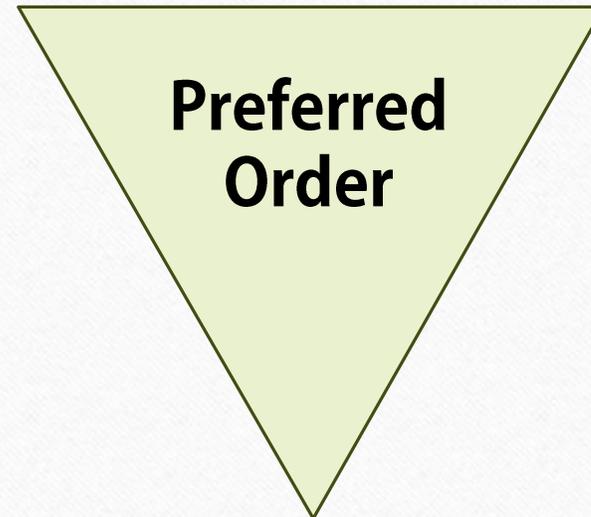
- **Develop personal guidelines**
 - vary with gardener & situation
 - value of plants, costs to manage
- **Invasive & quarantine pests may have lower thresholds**
- **Timing controls with degree-days**
 - what are DDs? - heat units
 - where to get DDs? - USU Ext. IPM Advisories



Traps for codling moth (above) & cherry fruit fly

5. IPM Tactics

- Cultural
- Mechanical
- Biological
- Chemical



Cultural Control:

“Best Practices for Healthy Plants

- **Select plant species and cultivars adapted to the site**
- **Use good plant production practices**
 - fertility, water, sunlight, etc.
- **For annual plants, rotate location across years**
 - avoid build-up of soil pests
- **Stressed plants are more attractive and susceptible to pests**



Cultural Control: Enhance Landscape Biodiversity

- “Hides” host plants from pests
- Avoid large monocultures to reduce pest attraction
- Spreads the risk of plant injury (do not put all your eggs in one basket)
- Attracts beneficial insects - diverse food resources



Cultural Control: Sanitation

- Pick up / chop up dropped fruit
- Remove structures / sites where insects may overwinter (wood piles, garden debris, etc.)
- Prune out diseased limbs (cankers)



Mechanical Control:

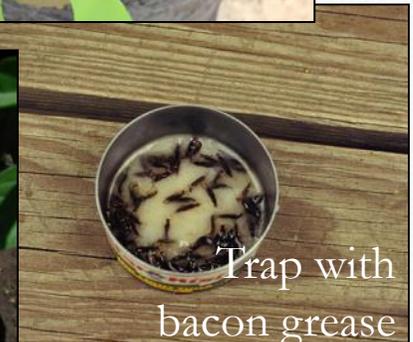
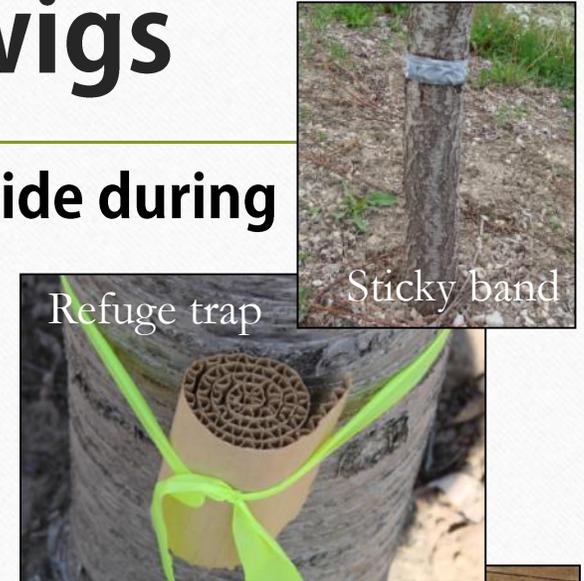
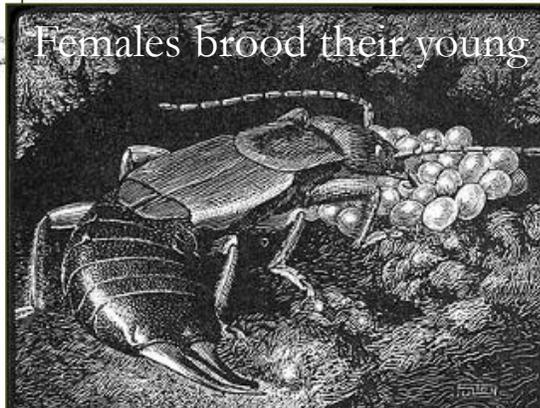
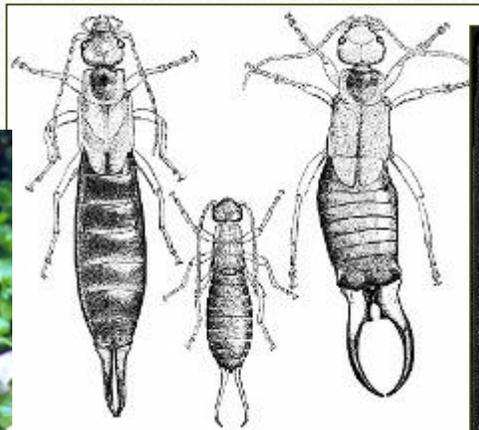
Traps and Barriers

- **Traps**
 - yellow jacket wasps, slugs, spiders
- **Sticky bands**
 - trees and shrubs
- **Row covers**
- **Diatomaceous earth**



Mechanical Control: Traps & Exclusion for Earwigs

- Avoid overuse of mulch and damp debris (earwigs hide during the day)
- Traps: fat-based baits, protected refugia
- Exclusion: Tanglefoot on base of trunks, stems



Mechanical Control: Exclusion of Cabbage Worms

- Caterpillars chew large holes in leaves; produce abundant frass (excrement)
- Exclusion: Row cover fabric - cover plants to prevent egg-laying



Floating
row cover



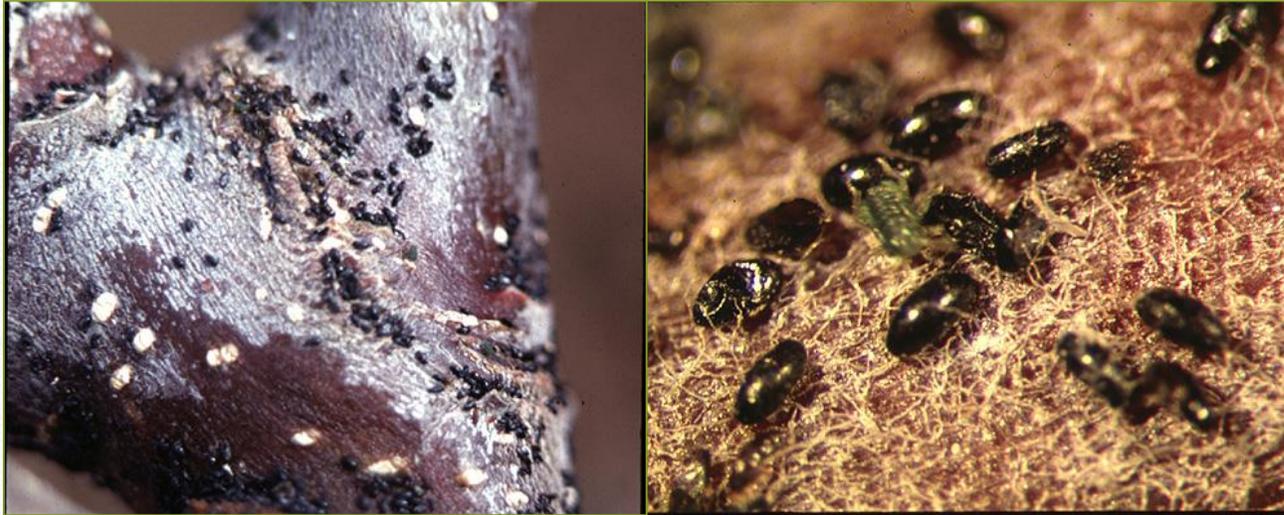
Imported
cabbage
butterfly



Cabbage
looper



Mechanical Control: Oil Sprays (Dormant and In-Season)



Aphids overwinter as eggs on their woody host plants (trees & shrubs)
Dormant oil applied at bud break targets hatching aphid young



San Jose scale
overwinters on
tree limbs



Biological Control Insect Groups

Robber
Fly



Aphid
Wasp



Varroa
Mite



- Predator

- consumes (kills) two or more individuals to complete its development

- Parasitoid

- consumes (kills) exactly one individual to complete its development

- Parasite

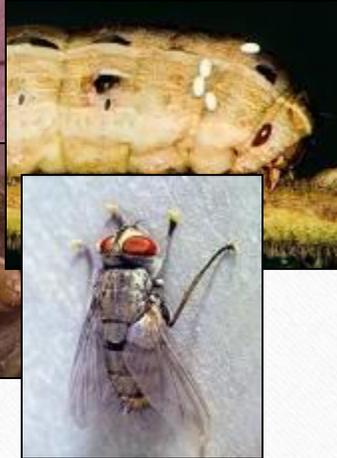
- consumes, but generally does not cause the death of one or more individuals; reduces growth rate & health of host

Beneficial Insects & Mites

Cast of Common Characters in the Garden



Parasitic wasps & flies



Predaceous true bugs & beetles



Predaceous mites

Common aphid predators

Lady Beetle

Misconceptions About Biological Control

- Releasing insects is the best method - No
 - Lady beetle & Praying mantid
- Predatory insects will stay in your garden after release - No
- Other practices/activities don't matter - No



Biological Control: Conserve Natural Enemies

- Enhance biodiversity
- Spatial diversity across the landscape
- Temporal diversity, throughout the season and from year to year
- Needs to be the right kind of diversity!!



Beneficial Insects & Pollinators Need a Diverse Diet & Shelter

- **Protein and carbohydrate (sugar) food sources**
 - Protein
 - Insect prey, pollen, bird droppings
 - Carbohydrate
 - Nectar, plant nectaries, aphid honeydew
- **Shelter & varied habitat**



Flowering perennials & annuals
Trees & shrubs
Herbs
Wildflowers



Alyssum Attracts Hover Flies

Hover Fly Larvae Prey on Aphids

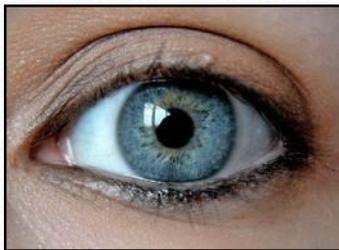


Alyssum intercropped in lettuce fields



Alyssum planted in orchard alleys

The Attractive Garden



Color
Texture
Design
Variety
Function



Plant Diversity
Continuous Bloom
Nectar & Pollen
Shelter
Variety of Insect Prey
Water & Mud



Native Pollinators



Cavity-
(mud, leaf)
& ground-
nesting bees

Nest gregariously
Solitary
Low propensity
to sting



Gardening for Pollinators & Beneficial Insects

www.utahpests.usu.edu – Fact sheets: Insects-Beneficial



UTAH PESTS fact sheet

Utah State University
COOPERATIVE EXTENSION



Published by Utah State University Extension and Utah Plant Pest Diagnostic Laboratory ENT-133-09 September 2009

Gardening for Native Bees in Utah and Beyond

James H. Cane Research Entomologist, USDA ARS
Linda Kervin Logan, UT Pollinating Insect-Biology, Management, Systematics Research

Do You Know?

- 900 species of native bees reside in Utah.
- Some wild bees are superb pollinators of Utah's tree fruits; raspberries, squashes, melons and cucumbers.
- Few of our native bees have much venom or any inclination to sting.
- Our native bees use hundreds of varieties of garden flowers, many of them water-wise.
- A garden plant need not be native to attract and feed native bees.



Fig. 1. Carder bee (*Anthidium*) foraging at lavender (*Lavendula*: Lamiaceae).¹

Utah is home to more than 20 percent of the 4,000+ named species of wild bees that are native to North America. Except for bumblebees and some sweat bees, our native bees are solitary, not social, many with just one annual generation that coincides with bloom by their favorite floral hosts. In contrast, the familiar honey-bee is highly social, has perennial colonies, and was brought to North America by settlers from Europe. Regardless of these differences, however, all of our bees need pollen and nectar from flowers. The sugars in sweet nectar power their flight; mother bees also imbibe some nectar to mix with pollen that they gather. Pollen is fortified with proteins, oils and minerals that are essential for the diets of their grub-like larvae back at the nest.

Our flower gardens can become valuable cafeterias for local populations of diverse native bees. In our cities and towns, native plant communities have been displaced by pavement, buildings and lawns. In the countryside, grain and hay crops likewise



Fig. 2. A pollinator garden can also be water-wise. Purple Penstemon *stictus*, front, treecreeper penstemon (*P. eatoni*), center, and blue fox (*Linum perenne*), background, combine to make a pleasing design.²

Garden Plant Recommendations for Wild Bees of North America

This table contains nearly 200 garden plant genera with species whose flowers are sought by wild bees of North America.

The **Code** column is useful for Utah gardeners. Some additional species not coded as G or U are suitable for Utah but only in the hot, southernmost climates (e.g. *Larrea* or creosote bush).

- G - grows in Utah
- U - Utah native
- W - water-wise
- F - food product

Form tells whether the usable species in the genus are

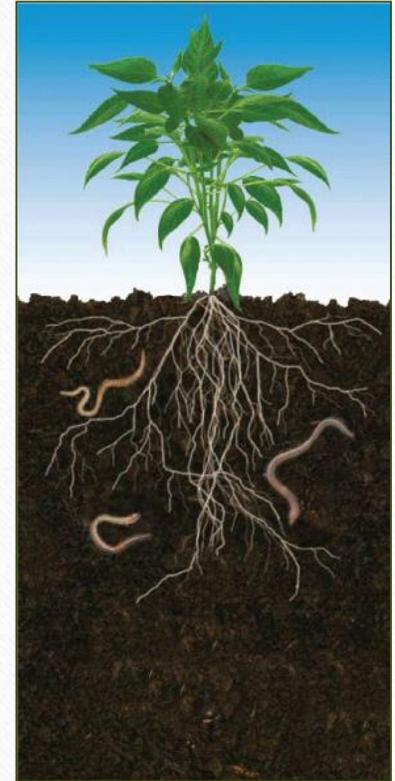
- A - annual
- P - perennial
- S - shrub
- T - tree

Plants in **bold italic>** are great choices for Utah gardeners.

| Genus | Family | Common Name | Code | Forms | Notes |
|-----------------------|----------------|--------------------|------|-------|-----------------------------|
| <i>Abelia</i> | CAPRIFOLIACEAE | abelia | | S | |
| <i>Acacia</i> | FABACEAE | acacia | W | ST | |
| <i>Acer</i> | ACERACEAE | maple | GU | T | |
| <i>Achillea</i> | ASTERACEAE | yarrow | GUW | P | <i>A. millefolium</i> weedy |
| <i>Aconitum</i> | RANUNCULACEAE | monkshood | GU | P | |
| <i>Agastache</i> | LAMIACEAE | hyssop | G | P | see Fig. 10 |
| <i>Ajuga</i> | LAMIACEAE | carpet bugle | G | P | |
| <i>Allium</i> | LILIACEAE | ornamental onions | GUW | P | |
| <i>Althea</i> | MALVACEAE | hollyhock | G | P | not double-flowered |
| <i>Amelanchier</i> | ROSACEAE | serviceberry | GU | S | |
| <i>Amorpha</i> | FABACEAE | false indigo | G | S | |
| <i>Anchusa</i> | BORAGINACEAE | wild forget-me-not | | AP | |
| <i>Anethum</i> | APIACEAE | dill | G | A | |
| <i>Aquilegia</i> | RANUNCULACEAE | columbine | GU | P | not double-flowered |
| <i>Arctostaphylos</i> | ERICACEAE | manzanita | GUW | S | |

Protect, Conserve & Promote Native Insects

- Diverse, healthy garden with flowering plants
 - Continuity in food & shelter in space & time
- Quality pollen & nectar
 - Wildflowers, herbs, fruit trees
- No toxic pesticides
 - Use cultural & mechanical pest management practices
 - Use selective, “soft” pesticides
- Tolerate some plant-feeding insects
 - Natural enemies must have food to survive



Start from the
bottom up –
healthy soil

Chemical Control: Organic Products

- Derived from plant, animal, or naturally occurring rock or petroleum oil sources
 1. Minerals (rock):
 - Lime
 - Sulfur
 - Copper
 - Diatomaceous earth
 - Boric acid
 2. Natural petroleum sources (oil):
 - Horticultural oils (dormant & in-season)
 3. Natural animal fats (animal)
 - Fatty acids - insecticidal soaps

OMRITM
L i s t e d
Organic Materials
Review Institute

Chemical Controls: Organic Products

4. Botanicals (Plant):

- pyrethrum, ryania, sabadilla, rotenone, nicotine

5. Microbials:

- Bacteria (*Bacillus thuringiensis*, spinosyn)
- Viruses (codling moth granulosis virus)
- Fungi (*Beauveria*, *Metarhizium*)



Organic Insecticides

| Active Ingredient | Brand Name(s) | Class | Mode of Action | Toxicity Class |
|------------------------------------|----------------------------------------------|---------------------|--------------------------|----------------|
| azadirachtin | Aza-Direct, Bioneem, Azatin | Botanical | Growth Regulator | Caution |
| <i>Bacillus thuringiensis</i> (Bt) | Dipel, Javelin, Thuricide | Microbial Bacterium | Larvicide | Caution |
| <i>Beauveria bassiana</i> | Botanigard, Naturalis | Microbial Fungus | Larvicide | Caution |
| beneficial nematodes | <i>Steinernema</i> , <i>Bacteriophora</i> | Biological Nematode | Larvicide, Adulticide | Caution |
| capsaicin | Hot Pepper Wax | Botanical | Repellent | Caution |

Organic Insecticides

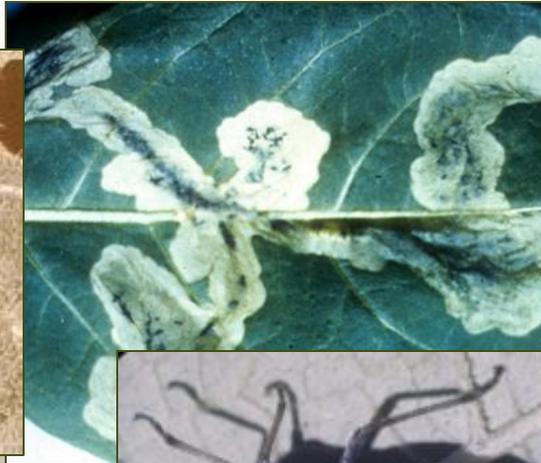
| Active Ingredient | Brand Name(s) | Class | Mode of Action | Toxicity Class |
|----------------------------------------------|------------------------------------|----------------------|-------------------|----------------|
| diatomaceous earth | Natural Guard | Inorganic | Disrupts cuticle | Caution |
| horticultural mineral oil (dormant & summer) | Sunspray, Ultrafine, Orchex, Volck | Petroleum distillate | Suffocate | Caution |
| insecticidal soap | Safer, M-pede | Fatty acids | Disrupts cuticle | Caution |
| iron phosphate* | Sluggo, Ecar-Go | Inorganic | Feeding arrestant | Caution |
| kaolin clay | Surround | Inorganic | Repellent | Caution |

* Molluscicide (Snails & Slugs)

Organic Insecticides

| Active Ingredient | Brand Name(s) | Class | Mode of Action | Toxicity Class |
|-------------------------|-------------------|-----------------|------------------|------------------|
| lime sulfur | | Inorganic | Broad-spectrum | Danger (caustic) |
| pyrethrins, pyrethrum | Pyrellin, Pyganic | Botanical | Paralyze | Caution |
| rotenone | | Botanical | Neurotoxin | Warning |
| spinosyn | Entrust | Microbial | Neurotoxin | Caution |
| sucrose octanoate ester | Sucrocide | Natural product | Disrupts cuticle | Caution |
| sulfur | | Inorganic | Broad-spectrum | Caution |

VEGETABLE AND HERB INSECT PESTS



Leafminers in Leafy Veggies

- Adults – Small flies
- Larvae – White to cream maggots
- Winding trails on leaves, white blotches
- Scout regularly, >1 mine/leaf
- Natural enemies (Paper wasp)
- Row covers
- Spinosad (Entrust) insecticide



Corn Earworm

- Caterpillars feed on new silks & ear tips; reduce pollination & damage ear tips; allow entry of molds, attract other insects (sap beetles, earwigs)
- **Cultural control:** Early & late crops avoid injury (silk before mid July & after late August)
- Protect young silk; difficult to control worms once inside ear tip
- **Organic chemicals:** pyrethrin, neem oil, mineral oils applied to silks (reapply every few days) b/c silks continue to grow



Tomato Hornworm

- LARGE green caterpillars with horn on tail
- Feed on tomato, eggplant, potato
- Consume large amounts of foliage and buds in a short time period
- Remove by hand
- Organic chemicals: Bt (Dipel, Thuricide), spinosad (Entrust)
- Parasitic wasp – white cocoons on caterpillars



Cabbage Worms

- Caterpillars chew large holes in leaves; produce abundant frass (excrement)
- Bt (Dipel, Thuricide), spinosad (Success, Entrust)– very effective
- Row cover fabric – cover plants to prevent egg-laying



Row cover



Cabbage butterfly (above)
and cabbage looper (below)



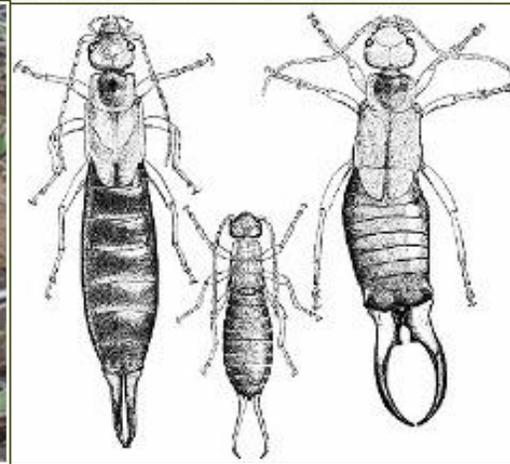
Squash Bug

- Adults & nymphs suck fluids from plant leaves, stems & fruit
- “Sudden wilt” – disruption of xylem vessels
- Congregate in plant debris under plants
- Cultural controls: Remove garden debris in fall, nearby woodpiles or other protected sites (adults over winter)
- Hand pick, use duct tape to remove eggs & nymphs
- Chemicals: spray when first detect nymphs, drench undersides of leaves & stems
- kaolin clay (Surround), neem oil



European Earwig Injury to Seedlings – Basil & Beans

- **Cultural & mechanical controls:** avoid overuse of mulch and damp debris where they hide during the day
 - Traps: attractive odor/fat-based baits; place and remove rolled newspaper or cardboard; protected refugia

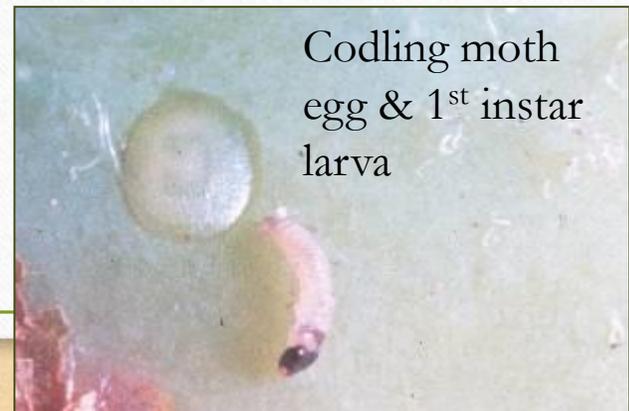


FRUIT INSECT PESTS



Codling Moth

- Caterpillars bore into fruit
- Moths emerge in spring
- Eggs laid on fruit & leaves
- 1st instar larva bores into fruit w/in 24 hr
- Chemical control: target newly hatched larva; timing based on moth trap catch info. & degree-days in your area
 - Tree Fruit IPM Advisory
 - Spinosad/Entrust (7 d)
 - CM virus/CydX (7 d)
 - Horticultural oil (suffocate eggs) (see advisory for egg control timings)
- Sanitation: pick up dropped fruit



Codling moth
egg & 1st instar
larva

Mechanical Control: Codling Moth



Pupate inside silken cocoons on trunk
Corrugated cardboard band -
“mass-trap” to reduce population



Fruit bags to exclude codling moth eggs
Place bags over 3/4” diameter fruit

Peach Twig Borer

- Over winter as young larvae on limbs; brown caterpillars burrow inside twigs from bloom to petal fall; 2nd & 3rd generations enter fruit, usually at the stem end
- Delayed Dormant Spray: Dormant oil + pyrethrin (by first pink) – targets twig boring OR At-Bloom Sprays: 2 Bt (Dipel) sprays (early & full to late bloom)
- Fruit Protection: same insecticides as for CM timed with trap catch and degree-day info. or apply at shuck-fall & repeat if needed
 - Tree Fruit IPM Advisory

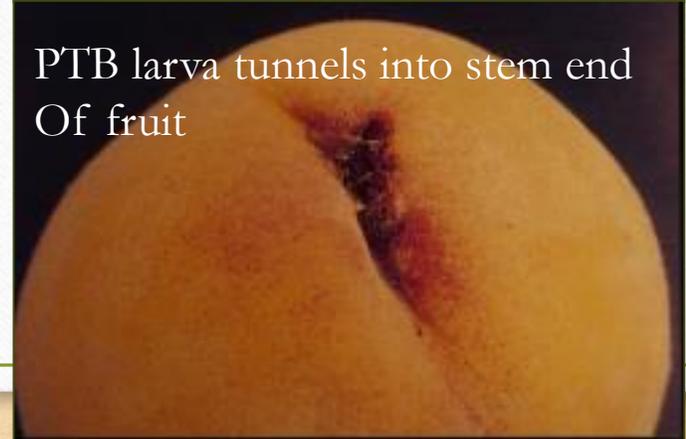
PTB larva feeding on peach shoot



Shoot strike



PTB larva tunnels into stem end of fruit



Western Cherry Fruit Fly

- Larvae feed in sweet & tart cherries; female flies lay eggs in ripening fruit; fruit doesn't become soft enough for egg-laying until it turns salmon colored
- Cultural controls: Landscape fabric or barrier under tree canopy
- Chemical control: spinosad (7 d), GF-120 (spinosad + bait; 7 d), pyrethrin (3 to 5 d)
 - Homemade bait spray: spinosad + 2% sugar



Fruit-Eating Wasps: Paper wasps



European paper wasp (fruit-eater):
Thin waist, more black than yellow,
Upside down umbrella-shaped nests



Yellow jacket:
“Chunky” body, more yellow
than black
Paper nests in ground &
under dense vegetation
Aggressively defend nest
(painful sting!)

Wasp traps

- Place around perimeter of garden and yard and in spots slightly away from high human activity
- Yellow jacket – predator/scavenger
 - Commercial traps with heptyl butyrate bait
 - Homemade trap with raw meat
 - Locate ground nests in area - treat with insecticides & remove
- European paper wasp – fruit-eater/predator
 - Homemade trap - liter plastic bottle with diluted fruit juice (1 part juice: 10 parts water) – ferment juice (1/4 tsp yeast) + 1/4 tsp liquid dish detergent (add piece of ripe fruit to speed up fermentation)
 - Treat & remove nests



Aphids

- Suck fluids from leaves & stems; curl leaves; produce sticky honeydew; black sooty mold growth
- Protect young trees, older trees can tolerate more aphid feeding
- **Controls:** Dormant oil at green tip stage
- Insecticidal soap, horticultural oil, azadirachtin
- **Biological control:** lady beetles, lacewings, syrphid flies, parasitic wasps



Aphid & Mite Mechanical Control

Stiff spray of water every 2-3 days until aphid or mite numbers decline

Best if initiated before leaves are tightly curled (aphids) or extensive webbing & leaf injury occurs (mites)



Spider Mites

- Feed on leaves; produce webbing; injury appears as white speckles; severe feeding leads to bronzing
- Mites build up on broadleaf weeds (bindweed, knotweed, mallow, prickly lettuce); reproduce rapidly in hot weather
- **Cultural controls:** Avoid mowing, herbicides, drying of vegetation - prompts mites to move into trees
- Avoid multiple applications of pyrethroid insecticides (permethrin, gamma-cyhalothrin)
- **Biological control:** naturally occurring predatory mites & small lady beetle
- **Chemicals:** horticultural oil, insecticidal soap



Look for this slideshow and others at utahpests.usu.edu

The screenshot shows the homepage of the Utah Pests website. At the top, there is a navigation bar with the Utah State University logo and the text "EXTENSION UtahStateUniversity" on the left, and "UTAH PESTS" with a logo on the right. Below this is a secondary navigation bar with links: "UTAH PESTS Home", "Utah Plant Pest Diagnostic Lab", "Integrated Pest Management", "School IPM", and "Cooperative Agricultural Pest Survey".

On the left side, there is a "Google™ Search" box and a vertical menu with links: "Home", "Fact Sheets", "Video Fact Sheets", "Image Galleries", "Slideshows", "Utah Pests News", "Quarterly Newsletter", "Bees and Other Pollinators", "In the News", and "Contact Us".

The main content area features a large image of insects on a red fruit. Below this are four featured sections:

- Utah Plant Pest Diagnostic Lab**: "Just \$7 gets your pest problem diagnosed or insect identified." (Icon: microscope)
- Integrated Pest Management**: "Your source for fruit, vegetable, and landscape pest problems." (Icon: leaf with insect)
- School Integrated Pest Management**: "Teaching responsible pest management for a healthy learning environment." (Icon: apple on a book)
- Cooperative Agriculture Pest Survey**: "CAPS protects Utah agriculture through statewide monitoring of invasive pests." (Icon: envelope)

On the right side, there is an "In the News" section with three news items:

- 2014 Farm Bill, No limit on Forestry Pesticides?** (Mar 03, 2014)
- Stink bug saliva proteins could lead to new control methods** (Mar 03, 2014)
- Example of Invasive Bumblebee** (Jan 27, 2014)

At the bottom right, there is a paragraph of text: "UTAH PESTS' is a group of Extension entomologists and plant pathologists that helps to solve the thousands of plant pest issues that concern Utah citizens every day. The UPPDL **identifies**, the IPM Program **educates**, and the CAPS Program **investigates**. Open one of the websites to get answers!"

At the very bottom, a small footer reads: "Utah State University is an affirmative action/equal opportunity institution. © 2014 Utah State University Utah Pests"

Over 140
slideshows posted

This one posted under
“Insects - Vegetable”