Insects, Mites that Feed With Sucking Mouthparts
Injuries Produced By Sucking Mouthparts

- Aphids, leafhoppers, scales, whiteflies, mealybugs
- True bugs
- Thrips
- Mites
Some insects chew leaves

Some insects suck fluids from leaves
MOUTH TYPE

labrum

mandible

maxillae

labium
The Basic Chewing Mouthparts of an Insect
Labrum
Mandibles
Maxillae
Piercing-sucking mouthparts
Aphids
Hemiptera: Aphididae
Aphids associated with *Populus* spp.
Aphids associated with *Prunus* spp.
Rose Aphids
Largest Aphid in RM Region – Giant Willow Aphid
Giant conifer aphids, *Cinara* species
Leafcurl Ash Aphid
Cabbage aphids – Covered with a waxy bloom
Woolly apple aphid
“Woolly” aphids on conifers
Aphid life cycles – All aphids go through three feeding stages, each punctuated with a molting event.
Diagnostic: Cast Skins Remain after Aphids Molt
Asexual reproduction

Normal reproduction by aphids is live birth of a genetically identical daughter.
Aphid populations can increase rapidly
Live birth and asexual reproduction are the norm with aphids.
Adults may be winged or wingless
Adults may be winged or wingless.
Example of aphid dispersal ability – Honeysuckle witches’ broom aphid
How Do Aphids Survive Winter in Places - Such as Colorado?

- **Outdoors**
  - Eggs
  - Nymphs, adults in continuous reproduction

- **Indoors**
  - Nymphs, adults in continuous reproduction
Overwintering stage of aphids on woody plants is as an egg.
Aphid eggs on pine

Aphid eggs on rose

Photograph courtesy of Jim Kalisch, University of Nebraska
Stem mother, the stage that hatches from the overwintering egg
Host Alternation - A life cycle pattern among about $\frac{1}{2}$ of the aphids

Life cycle involves a winter host plant and a different summer host plant(s)
Green Peach Aphid
*Myzus persicae*

An example of an aphid that undergoes a life cycle with host alternation (outdoors)
Late-summer female produces winged migrant forms of both sexes

Male mates with special egg-producing form (oviparae) on winter host

Eggs on winter host through winter

Stem mother hatches from egg in spring

Winged and wingless females on winter host, winged forms disperse to summer hosts

Continual summer generations develop on summer hosts

Winged or wingless female forms are present
Overwintering egg laid near the bud
Stem mother, the stage that hatches from the overwintering egg.
On the winter host plant the first generations may cause leaf curing injuries to the new growth.
Sometime, usually in June, the green peach aphids on the winter host switch to becoming all winged forms – that then disperse to the “summer hosts”

Winged and wingless females on winter host, winged forms disperse to summer hosts
Summer hosts include various vegetables and weeds
Continual summer generations develop on summer hosts

Winged or wingless female forms are present
Late-summer female produces winged migrant forms of both sexes

Male mates with special egg-producing form (oviparae) on winter host

Eggs on winter host through winter
Winged male aphid mating with egg-producing female stage

Mated females and overwintering eggs
Late-summer female produces winged migrant forms of both sexes

Male mates with special egg-producing form (oviparae) on winter host

Eggs on winter host through winter

Stem mother hatches from egg in spring

Winged and wingless females on winter host, winged forms disperse to summer hosts

Continual summer generations develop on summer hosts

Winged or wingless female forms are present
Sugarbeet root aphid on roots of garden beet

Sugarbeet Root Aphid

*Pemphigus populivenae*

Galls produced on overwintering host plant – certain *Populus* spp.
Rose Aphid

*Macrosiphum rosae*

An example of an aphid that does not alternate between host plants.
Cabbage Aphid
*Brevicoryne brassicae*

One of the very few aphids that may survive winter outdoors in actively developing stages (nymphs, adults)
How Do Aphids Survive Winter in Places - Such as Colorado?

• **Outdoors**
  - Eggs
  - Nymphs, adults in continuous reproduction

• **Indoors**
  - Nymphs, adults in continuous reproduction
Primary aphid species found in greenhouses

Indoors there is continuous, asexual reproduction. There are no eggs produced, nor sexual forms (males, sexual form females)
Plant Injuries Aphids May Produce

- Contamination of produce
- Reduced vigor from heavy, sustained feeding
  - Leaf yellowing, premature senescence
- Nuisance problems with honeydew
- Leafcurl distortions of new growth
- Vectors of some viral diseases
Aphids as Contaminants of Produce

Red lettuce aphid on lettuce

Cabbage aphids on Brussels sprouts
Plant Injuries Aphids May Produce

- Contamination of produce
- Reduced vigor from heavy, sustained feeding
  - Leaf yellowing, premature senescence
- Nuisance problems with honeydew
- Leafcurl distortions of new growth
- Vectors of some viral diseases
Sustained feeding by high populations of aphids can produce wilting, leaf yellowing, retarded growth.
However, numerous natural enemies usually curtail aphids before serious damage occurs.
Important Note: Presence of aphids does not equate to occurrence of plant injury!
Probocis (primarily the labium) of an aphid

Stylet bundle (mandibles and maxillae) meandering through plant en route to phloem
Important Note:
Presence of aphids does not equate to occurrence of plant injury!
Plant Injuries Aphids May Produce

- Contamination of produce
- Reduced vigor from heavy, sustained feeding
  - Leaf yellowing, premature senescence

- Nuisance problems with honeydew
  - Leafcurl distortions of new growth
  - Vectors of some viral diseases
Honeydew production
Honeydew Producing Insects*

- Aphids
- Soft scales
- Whiteflies
- Mealybugs
- Psyllids (some)
- Leafhoppers (phloem feeding species)

*All suck sap from the phloem
Mealybugs
Soft Scales
Whiteflies
Psyllids (some)
Sooty Molds

Fungi that grow on honeydew-contaminated surfaces
Sooty mold growing on linden aphid honeydew
Ants are commonly associated with honeydew producing insects
Ants and Aphids – A Mutualistic Relationship

- Aphids provide food – **honeydew**
- Ants provide protection
Ants and Aphids
A Mutualistic Relationship

- Aphids provide food – *honeydew*
- Ants provide protection
Ants on the peonies?
Western yellowjacket visiting aphid honeydew
Plant Injuries Aphids May Produce

- Contamination of produce
- Reduced vigor from heavy, sustained feeding
  - Leaf yellowing, premature senescence
- Nuisance problems with honeydew
- **Leafcurl distortions of new growth**
- Vectors of some viral diseases
Leafcurl Plum Aphid

Brachycaudus helichrysi

Summer hosts are various Aster family plants
Snowball Aphid Injury
Black Cherry Aphid

*Myzus cerasi*
Currant Aphid

*Cryptomyzus ribis*
Dill
Carrot-Willow Aphid

Caveriella aegopodii
“Double or Nothing Pests”

Organisms that Require **Two** Host Species
Host alternation between a winter host and a summer host is a common life cycle with many species of aphids.
Annual problem – leafcurling aphids on dill, parsley
Carrot-Willow Aphid

Caveriella aegopodii
Woolly elm aphid, *Eriosoma americanum*
Amelanchier, alternate host of the woolly elm aphid
Cooley Spruce Gall Adelgid

Overwintered form produces galls of spring growth on spruced

Alternate host is Douglas-fir
Plant Design Consideration

Avoid plantings that allow pest life cycle completion
Plant Injuries Aphids May Produce

- Contamination of produce
- Reduced vigor from heavy, sustained feeding
  - Leaf yellowing, premature senescence
- Nuisance problems with honeydew
- Leafcurl distortions of new growth
- Vectors of some viral diseases
Some viruses aphids can transmit to vegetable crops

Potato virus Y

Cucumber mosaic virus
Most aphid-transmitted viruses are known as non-persistent viruses.

They are acquired by probing an infected plant.

They are transmitted when probing the next plant.
Ode to an Aphid

by Alan Petersen

Oh thou tiny little pest,
Alighting on my plant to rest.
How can my mind be at ease
When I think you carry some disease?

Alas, you hold your stylets steady,
And now begin to probe already!
I’d like to swat you little one,
But you dirty work’s already done!
Aphid Control - Scenario One

Aphids are Exposed on the Plant
Different Levels of Control Response to Aphids

• Do nothing. Natural controls will ultimately take care of things.
  – Indoor production will require introduction of natural enemies

• Treat the plants with a strong jet of water to kill aphids

• Use a soap/detergent spray to kill aphids

• Use some other effective ‘aphicide’
Check for aphid natural enemies!
Diagnostic: Cast Skins Remain after Aphids Molt
Aphid Parasitoids

Aphid mummies
Lady beetle larvae
Aphid biological controls for greenhouses may include:

- *Beauveria bassiana*
- Parasitic wasps of aphids
- Aphid predator midge
Different Levels of Control Response

- Do nothing. Natural controls will ultimately take care of things.
- Treat the plants with a strong jet of water to kill aphids
- Use a soap/detergent spray to kill aphids
- Use an effective ‘aphicide’
Hosing for aphid control
Rose Aphids - Before
Rose Aphids - After
Some aphid control products – Exposed Aphids

- Insecticidal Soaps
- Pyrethroids
  - Bifenthrin, cyhalothrin, cyfluthrin, etc.
- Neonicotinoids
  - Imidacloprid
  - Acetamiprid
Soaps as Insecticides

Insecticidal Soap

MULTI-PURPOSE INSECT KILLER

- For Use on Flowers, Trees, Shrubs, Ornamentals, Fruits, Nuts and Vegetables
- Kills Aphids, Mites, Mealybugs, Thrips, Whiteflies, and Other Listed Pests

ACTIVE INGREDIENTS
Potassium Salts of Fatty Acids 49.52%
OTHER INGREDIENTS 50.48%
TOTAL 100.00%

KEEP OUT OF REACH OF CHILDREN
WARNING See back panel for Precautionary Statements and First Aid

Concentrate! Makes up to 12 Gallons

NET CONTENTS 32 FL. OZ.
Soaps are Salts of the Fatty Acids Found in Plant Oils and Animal Fats.
### Fatty Acid Components of Some Common Fats and Oils

<table>
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<tr>
<th>Component Acids (percent)*</th>
<th>Myristic $C_{14}$</th>
<th>Palmitic $C_{16}$</th>
<th>Stearic $C_{18}$</th>
<th>Oleic $C_{18-1}$</th>
<th>Linoleic $C_{18-2}$</th>
<th>Linolenic $C_{18-3}$</th>
<th>Eleostearic</th>
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<tr>
<td>Butter</td>
<td>7-10</td>
<td>24-26</td>
<td>10-13</td>
<td>28-31</td>
<td>1.0-2.5</td>
<td>0.2-0.5</td>
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<tr>
<td>Lard</td>
<td>1-2</td>
<td>28-30</td>
<td>12-18</td>
<td>40-50</td>
<td>7-13</td>
<td>0.2-0.5</td>
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<td>24-32</td>
<td>20-25</td>
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<td>8-12</td>
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<td>34-62</td>
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<td>1-2</td>
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* Totals less than 100% indicate the presence of lower or higher acids in small amounts.
Pesticidal Fatty Acid $\leftrightarrow$ Pesticidal Soap

$\text{RCOOH} + \text{KOH} \leftrightarrow \text{RCOO}^- \text{K}^+ + \text{HOH}$
Relative Toxicity to Insects of Soaps of the Most Naturally Occurring Fatty Acids on Insects

Mortality

Carbon Number of K Salts

Cont. C₆ C₁₀ C₁₄ C₁₆ C₂₀ C₁₈₋₁ C₁₈₋₂
Soaps as Insecticides

Insecticidal Soap

Multi-Purpose Insect Killer

- For use on flowers, trees, shrubs, ornamentals, fruits, nuts and vegetables
- Kills aphids, mites, mealybugs, thrips, whiteflies, and other listed pests

Active ingredients: by wt.
- Potassium salts of fatty acids: 49.52%
- Other ingredients: 50.48%
- Total: 100.00%

NET CONTENTS: 32 fl. oz.

Concentrate! Makes up to 12 gallons

Keep out of reach of children
WARNING
See back panel for precautionary statements and first aid
Environmental Limitations to Effective Use of Insecticidal Soaps

- Soaps are strictly contact insecticides
  - No residual activity
- Efficacy degrades in ‘hard water’
  - Minerals combine to make insoluble soaps
- Rapid drying may decrease uptake and efficacy
What about household products for insect control?
Some soaps will damage plants (herbicidal soaps)
Aphid Control - Scenario Two

Aphids Produce Spring Leaf Curls

… and they overwinter as eggs on the plant
Horticultural Oils
LIFE CYCLE OF THE GREEN PEACH APHID

- Eggs overwinter on branch tips of Prunus (peach, plum, certain cherries)
- Spring Migrant
- Spring Migrant ♀
- Summer Migrants
- Wingless Adults
- Broadleaf Weeds and Vegetables
- Fall Migrant
- Fall Migrant ♀
- Sexual
- Fall
- Prunus
- Eggs
- Stem Mother
- Winter
Stem mother from overwintered egg
LIFE CYCLE OF THE GREEN PEACH APHID

SUMMER
- SUMMER MIGRANTS
- WINGLESS ADULTS

WINTER
- EGGS
- EGGS overwinter on branch tips of Prunus (peach, plum, certain cherries)

SPRING
- SPRING MIGRANT ♀

FALL
- FALL MIGRANT ♀
- FALL MIGRANT SEXUAL

BROADLEAF WEEDS AND VEGETABLES

PRUNUS

STEM MOTHER

EGGS
Horticultural Oils

- Highly refined petroleum (mineral) oils
- Cottonseed oils
- Soybean oils
- Neem oils
Sanitation. Remove plant debris with eggs prior to egg hatch in spring.
Herbaceous perennial plants with aphid problems include lupines, asparagus, columbine, and asters.
Sanitation. Remove plant debris with eggs prior to egg hatch in spring.
Aphid Control - Scenario Four

Aphids Have Already Produced A Leaf Curl
Systemic insecticides
– Insecticides that move within the plant after application
Some older organophosphate insecticides with systemic activity
Systemic Insecticides Used to Control Leafcurling Aphids

- **Imidacloprid**
  - Common soil applied systemic insecticide. Neonicotinoid class

- **Acetamiprid**
  - New foliar applied systemic insecticide. Neonicotinoid class

- **Acephate**
  - Older foliar applied systemic insecticide. Organophosphate class
Acetamiprid is replacing Orthene and other organophosphates as a systemic insecticide to be sprayed.
Over-the-Counter Imidacloprid Formulations
Methods of Applying Systemic Insecticides

- Foliar sprays
- Soil applications
- Trunk injections
Important advantage of the neonicotinoids – systemic activity in plants allows soil applications
Pollinators and Systemic Treatments
Soil Applied Systemic Insecticides and Honey Bees – Targets for Concern

• Plant is heavily used by honey bees as pollen and/or nectar source
  – Risk related to the amount the plant contributes to the overall intake of a specific hive
Soil Applied Systemic Insecticides and Honey Bees – Targets for Concern

• Plant is heavily used by honey bees as pollen and/or nectar source

• The type of application has high potential to cause exposure and harm to the pollinator
  – Risk related to time of application
  – Risk related to inherent hazard of the insecticide to pollinators
  – Risk related to rate applied
Soil Applied Systemic Insecticides and Honey Bees – Highest Risk Scenario

• Plant is heavily used by honey bees as pollen and/or nectar source
  – Treated plants constitute important part of food being brought to hive

• The type of application has high potential to cause exposure and harm to the pollinator
  – Treatments are likely to result in hazardous levels of residues in pollen and/or nectar
Top honey bee-visited plants include: most Sedums, most thistles, catmint, *Gaillardia*, most *Agastache*, Blue mist spirea, Russian sage, fruit trees, linden, golden raintree ……..
My greatest concern about neonicotinoids and woody plants - Lindens
2013 Oregon Bumble Bee Kills
Neonicotinoids and Pollinators: Bottom Line

Avoid applications to plants that bees visit that are in bloom – or soon will be in bloom
Contributors in Declines of Honey Bees in North America

What Honey Bee Health Researchers are Saying

- Varroa mite
  - Sublethal effects from in-hive varroa mite treatments
- Extremely narrow genetic base of NA honey bees
- New viruses (many vectored by Varroa mite)
- *Nosema ceranae*, other new pests
- Changes in symbionts/microbes from use of antibiotics by beekeepers
- Effects of fungicides on symbionts that contribute to food utilization/immune response
- Periodic movement and concentration of honey bees for crop pollination which allows transfer of pathogens
- Possibly some insecticides being used in agriculture, including neonicotinoids
Varroa mites transferred from an Asian giant bee (*Apis cerana*) to honey bee. Probably sometime in 1960s in the Philippines.
Varroa mite
Recent Developments Affecting Neonicotinoids and Pollinators

- Description of several new sublethal effects of neonicotinoids on honey bees
  - Deleterious behaviors
  - Effects on susceptibility to other stressors
- Studies showing presence of neonicotinoids in plants is more widespread than previously known
  - Agricultural uses as seed treatment primarily
  - Chlothianidin mostly involved
- Better understanding that some insecticide is translocated into pollen and nectar
Contributors in Declines of Honey Bees in North America

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