Organic Integrated Pest Management

How to Avoid Problems

Healthy soils contain many organisms that feed & protect plants.

Good Pest Management is Based on Healthy Soils

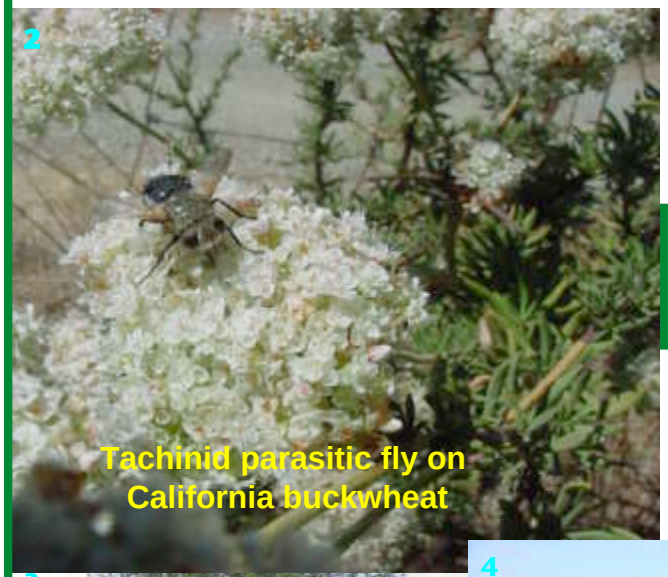
- Healthy soils contain many different organisms that compete with pest organisms, keeping them in check
- Having a variety of flowering plants on the farm provides food — pollen & nectar — and refuge for numerous beneficial insects.

Maintain the Diversity and Fertility of the Soil

- By using compost
- By planting cover crops and green manures
- By rotating crops in the field

Healthy soil protects and feeds plant roots. The plant on the left grew in better soil.

It's Important to Care for the Beneficial Organisms Both Above *and* Below the Soil Surface.



Keep a diversity of plants in the field to feed and shelter the beneficial organisms that help fight pests.

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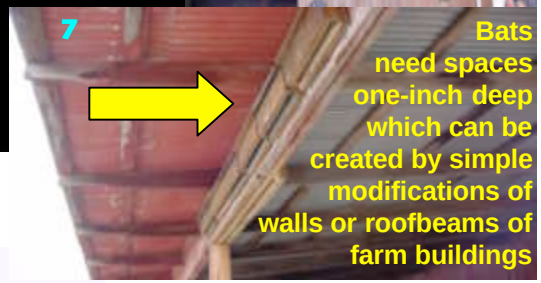
Providing Habitat for Beneficial Organisms

Keeping a diversity of plants on the farm helps with pest control

Hedgerows and Plant Habitat Provide:

- Habitat for beneficial organisms and wildlife
- Windbreaks to slow erosion
- Dust barriers
- Pesticide barriers between conventional and organic fields
- Protection from soil loss by water erosion
- Food, fruit, nuts, & aromatic herbs
- Beautiful landscape

Bats Eat Insect Pests



- Bats are nocturnal, like the moths (armyworm and cutworm adults) that plague many crops.
- One colony of bats can consume as many as 100,000 insects — such as cucumber beetles and moths— in a single season.

Flowering annual plants attract beneficial insects

Nest boxes can be made for owls. These night hunters eat many insects and rodents.

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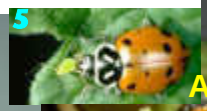
Protect these Beneficial Insects that Eat Insect Pests!

Life Cycle of Lady Bugs



What do they eat?

Larvae & adults eat:
Aphids
Mealy bugs
Mites
Soft scale
Eggs of insect pests.

Where do they live?

In plants of the carrot family — fennel, dill, Queen Anne's lace. Also yarrow and sunflowers. Deergrass and other clumping grasses are excellent habitats for overwintering ladybugs.

Life Cycle of Lacewings

What do they eat?

The larvae eat soft-bodied insects including aphids, thrips, mealy bugs, soft scale, worms, and mites.

The adults eat pollen & nectar.

Where do they live?

In plants of the carrot family — fennel, dill, Queen Anne's lace. Also yarrow, sunflowers, buckwheat, California buckwheat, corn, amaranth, holly leaf cherry, alyssum, coyote brush.

Life Cycle of Syrphid Flies

What do they eat?

The larvae eat aphids.

The adults eat pollen & nectar.

Where do they live?

In plants of the carrot family— fennel, dill, Queen Anne's lace. Also yarrow, sunflower, buckwheat, alyssum, coyote brush, and other flowering plants.

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Protect these Beneficial Insects that Eat Insect Pests!

Life Cycle of Damsel Bugs

Adult devouring a Lygus Bug

What do they eat?

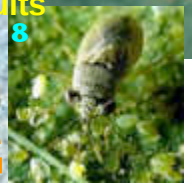
Nymphs & adults eat:
Aphids
Mites
Thrips
Worms
Lygus bugs
Leafhoppers

Where do they live?

Yarrow
Alfalfa
Goldenrod

Plants of the sunflower family.

Life Cycle of Big-Eyed Bugs



What do they eat?

Nymphs & adults eat many insects including:
Aphids
Mites
Thrips
Worms
Flea beetles
Insect eggs

Where do they live?

Cool season cover crops (berseem clover & subterranean clover) and common knotweed

Tachinid Flies

Trichopode pennipes (Big Foot Fly), a parasite of squash bugs.

What do they eat?

The larvae parasitize many worms, Japanese beetles, and some bugs.

Adults eat pollen & nectar.

Where do they live?

In plants of the carrot family — fennel, dill, Queen Anne's lace. Also yarrow, sunflowers, buckwheat, alyssum, coyote brush.

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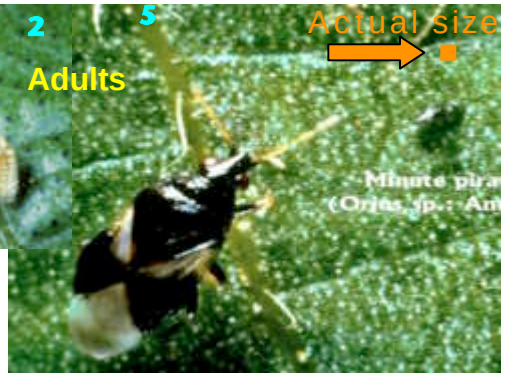
Protect these Beneficial Insects that Eat Insect Pests!

Life Cycle of Pirate Bugs



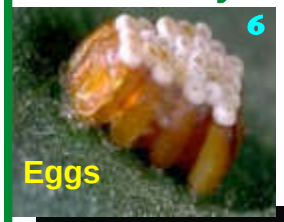
What do they eat?

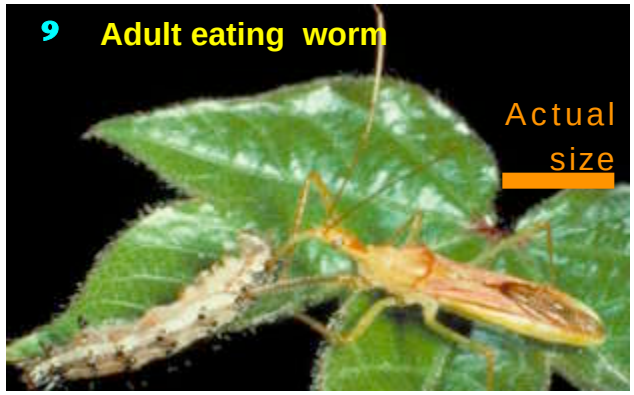
Nymphs & adults eat:
Thrips
Mites
Leafhoppers
Small worms
Insect eggs

Where do they live?

In plants of the carrot family — fennel, dill, Queen Anne's lace. Also yarrow, sunflowers, buckwheat, alyssum, coyote brush, alfalfa, corn, clover, & vetch.

Life Cycle of Assassin Bugs





What do they eat?

Nymphs & adults eat:
Many insects including large insects and worms

Where do they live?

In permanent plantings such as hedgerows, which provide shelter and food.

Spiders

Actual size

Actual size

Wolf Spider

Ground Spider

What do they eat?

Spiders eat a great variety of pests, including aphids, flea beetles, cucumber beetles, leafhoppers, & many others.

Where do they live?

One of the best ways to increase the number of spiders is to use straw mulch and maintain undisturbed habitat strips, such as hedgerows.

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Important Insect Pests

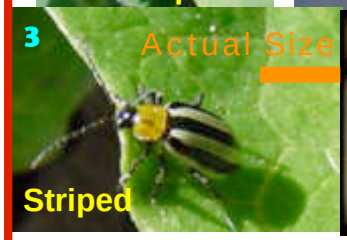
Why Is It Important to Understand the Life Cycles of Pests?

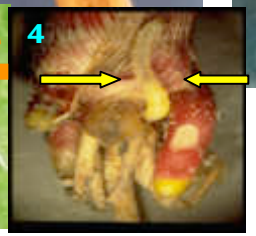
1. To understand what these insects are like in all phases of their life cycles. Many juveniles do not look at all like the adults and can live in completely different kinds of places.

2. To understand the various stages and forms that these insects take, and to manage the places they live — whether on the undersides of leaves, in the soil, or other locations—to decrease their populations.

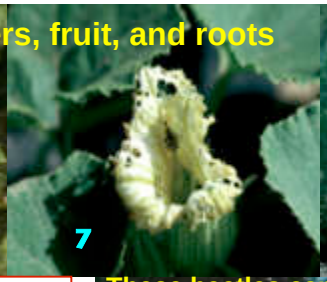
3. To manage the insects by varying planting dates, and using trap crops, and sticky traps.

Cucumber Beetles (*Diabrotica sp.*)





Damage Caused by Cucumber Beetles



Preferred Hosts of Cucumber Beetles

Most Susceptible to Damage

Number one is highly susceptible and number seven is least susceptible.

1. Cucumber
2. Cantaloupe
3. Honeydew Melon
4. Casaba Melon
5. Winter Squash
6. Summer Squash
7. Watermelon

Also:

• Corn • Potatoes
• Tomato • Fruit • Beans
• Cabbage • Lettuce

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How to Manage Cucumber Beetles

• Set aside or create habitat for beneficial insects and bats.
• Delay planting to avoid the time when the beetles lay their eggs. (Beware: this could cause you to miss an early marketing window.)
• Use row covers or paper cones to protect the young plants. (Beware: this may interfere with weeding.)
• Thick mulch prevents pest insects from laying their eggs in the soil at the base of the stems.
• Trellis the plants to get them up off the ground.
• Cultivate and eliminate crop residues.
• Monitor the pest populations twice a week when the plants have less than five leaves: Check five plants in five different parts of the field. If you find more than five beetles per plant, some treatment is called for.
• Use trap crops, bait, and sticky traps.
• Consider using protective substances and organically approved insecticides.
• Be aware that the following varieties are extremely susceptible to damage:
Zucchini: all varieties.
Other squash: Cocozelle, Caserta.
Butternut Squash: Early Butternut, Waltham.
Buttercup: Honey Delight, Buttercup Burgess, Ambercup.
Pumpkins: Happy Jack, Big Max, Baby Boo.

Grow Crops These Beetles Don't Eat

Try to grow the varieties that are LEAST attractive to cucumber beetles:

Summer Squash

Yellow Squash: Sunbar, Slender Gold
Straightneck: Seneca Prolific, Goldbar.
Crookneck: Yellow Crookneck
Scallop: Peter Pan

Winter Squash

Acorn: Table Ace, Carnival, Table King
Pumpkins: Baby Pam, Munchkin

Important Insect Pests

Lygus Bugs

Crops Affected by Lygus

- Strawberries
- Green Beans
- Cotton
- Lettuce
- Dry Beans
- Alfalfa
- Fruit

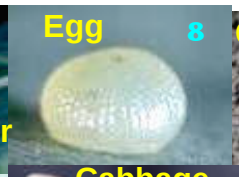
Methods of Controlling Lygus

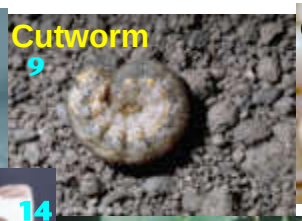
- Create habitat for beneficial insects
- Eliminate weeds
- Monitor plantings for beneficial insects
- Plant trap crops (alfalfa & radish)
- Botanical pesticides as a last resort

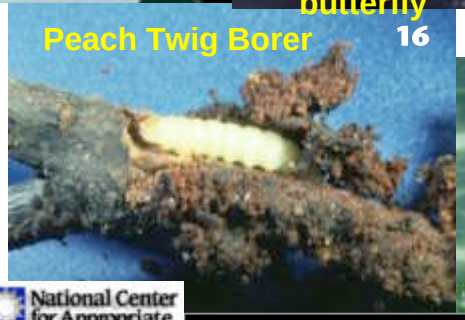
Beneficial Organisms that Attack Lygus

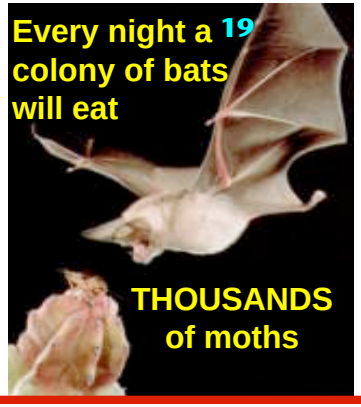
- Fungus: *Beauveris bassiana* (Mycotrol™)
- The parasitic wasps *Anaphes ioles* & *Peristenus sp.*
- Damsel Bugs, Big-Eyed Bugs, Assassin Bugs, Lacewings, Spiders

Caterpillars of Moths & Butterflies









Wasp parasitizing an egg

Methods of Controlling Caterpillars

- Create habitat for beneficial predators and parasites
- Bacillus thuringiensis (Bt)
- Botanical pesticides
- Repellents: dilute garlic, onion or chilis with water
- Pheromones

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Important Insect Pests

Aphids

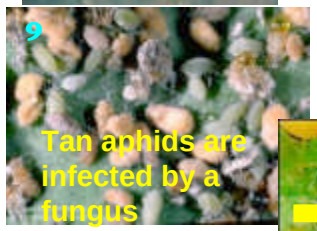
Methods of Control

- Create habitat for beneficial insects
- Control ants
- Repellents: Dilute garlic, onion or chilies with water
- Insecticidal soaps
- Diatomaceous earth
- Vegetable oils
- Botanical Insecticides (Neem)
- Physical (water sprays)

Ants tend aphids, harvesting the juice they exude.

Natural Enemies

- Predators such as Lacewings, Syrphid Flies & Ladybugs
- Parasites
- Diseases



Aphid mummies, showing exit holes of parasitic wasps

Leaf Miners

Some Affected Crops

Methods of Control

- Parasitic wasp (*Diglyphus isaea)*
- Row covers
- Use sticky traps
- Don't plant next to infected crops
- Use botanical pesticides (on adults)
- Use "Neem" (for larvae)
- Sanitation
- Mulches

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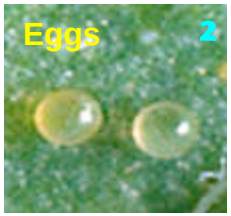
Important Insect Pests

Mites

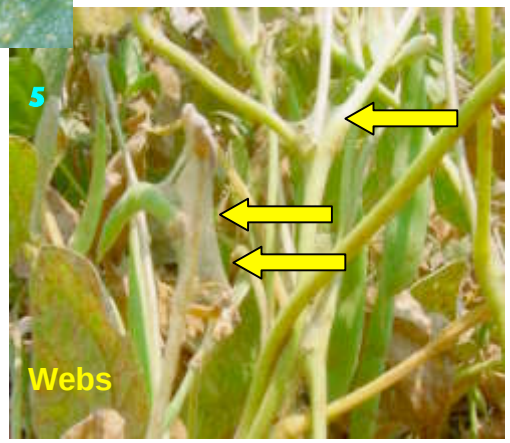


Affected Plants

- More than 300 host plants
- 100s are cultivated crop plants
- Strawberries, cotton, peppers, chiles, tomatoes, tree fruit, & various ornamental plants

Biological Control of Mites

- Beneficial Mites
- Predators:
  - Pirate Bugs &
  - Big-Eyed Bugs
  - Lacewings
  - Thrips
  - Ladybugs

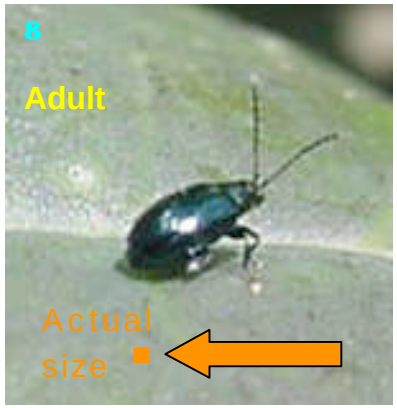


Other Controls for Mites

- Sulfur
- Soaps
- Vegetable Oil
- Citric Acid or Lemon Juice
- Some Botanical Insecticides

Predatory mite attacking spider mite

Flea Beetles



They jump like fleas and chew numerous holes in plant leaves. They can transmit diseases.

Controls

- Row covers
- Beneficial nematodes
- Sticky traps located every 15 to 30 feet along the rows
- Repellents: Dilutions of garlic, onion, or chilies with water
- Botanical Insecticides

Cultural Controls for Mites

The most important practice: Eliminate dust by…

- Creating hedges and windbreaks between roads and fields
- Using cover crops or mulches and leaving crop residues after harvest
- Wetting down roads
- Giving crops sufficient moisture
- Using sprinkler irrigation
- Planting cover crops

Remember to apply only materials accepted by your certifier!

Plant Diseases


Fungal Damage: Botrytis


Fungal Damage: Powdery Mildew


Viral Damage: Cucumber Mosaic

What causes diseases in plants?

Many times they are caused by microscopic organisms such as:

Fungi


Fungal Damage

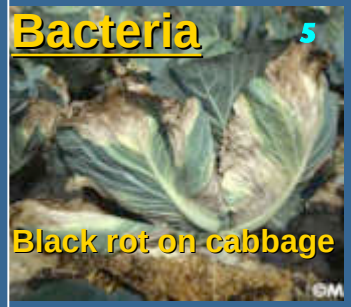
Fungi cause soil-borne diseases such as:

- Damping off
- Root rots

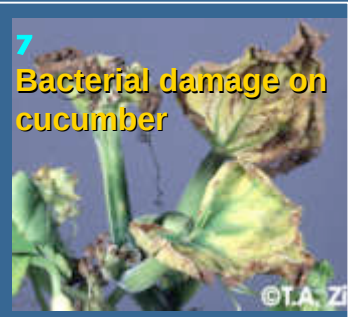
They cause diseases above ground on the plant such as:

- Powdery Mildew—squash and cucumbers
- Downy Mildew—lettuce and spinach
- Botrytis—strawberries and grapes

Bacteria


Black rot on cabbage


Bacterial wilt transmitted by the cucumber beetle


Bacterial damage on cucumber

Prevention of bacterial diseases

- Resistant varieties
- Crop rotation
- Nutrient management
- Sanitation; removal of prunings
- Some copper fungicides
- Irrigation management
- Spacing, air circulation.

Virus


Viral symptoms on lettuce

Virus examples

- Tobacco mosaic virus
- Cucumber mosaic virus
- Lettuce Big Vein virus


Viral damage on beans

Nematodes


Root nodules caused by nematodes

Worm-like microscopic animals that live in soil and water. Some are parasites to animals and plants but most are beneficial.

Nematodes are only visible by microscope.

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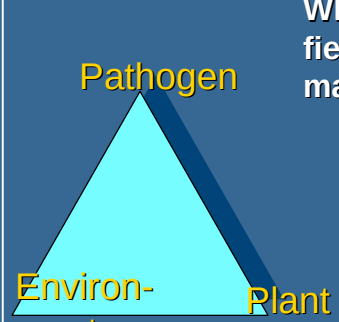
An ounce of prevention is better than a pound of cure. How to prevent plant diseases.

CULTURAL PRACTICES THAT STRENGHEN YOUR CROPS

Drip irrigation provides desired amounts of water and nutrients, keeping the foliage dry and preventing diseases.

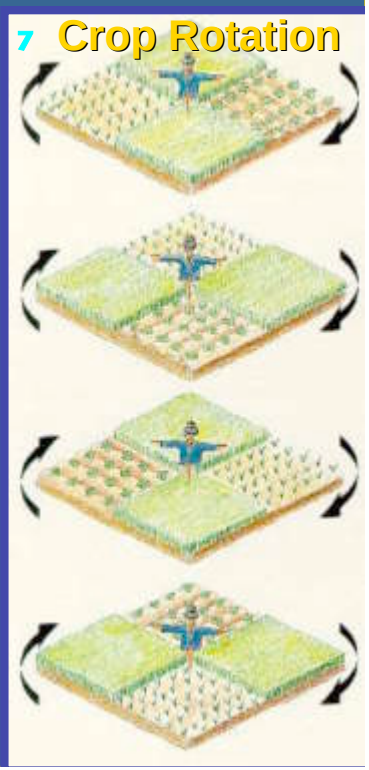
- Sanitary practices that exclude or remove pests (or residues that may contain pests) from the field or orchard.
- Selection of well-adapted varieties that are resistant to pests.



When pathogens are present in the field, damage can be reduced by manipulating one of these three points:

1. Strengthen the plant: use resistant cultivars, manage for healthy soil
2. Make environment friendlier to plant or less friendly to pathogen
3. Reduce pathogen load (crop rotation & sanitation)

SOIL MANAGEMENT: CROP ROTATION AND GOOD NUTRIENT MANAGEMENT



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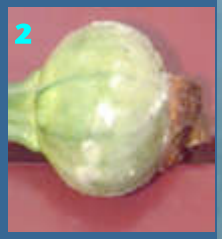
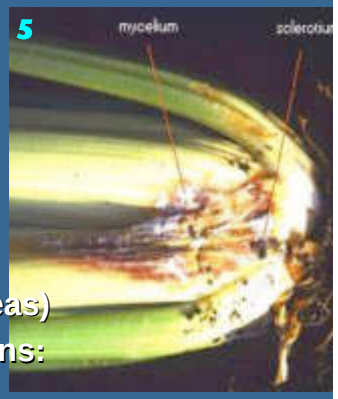
12 Sclerotinia or White Mold

This disease is caused by a soil fungus and its symptoms are a moist rot covered by white cottony mycelium.



Controls for Sclerotinia

- Resistant varieties
- Drip irrigation
- Rotate with grains and other grasses
- Control weeds and increase air circulation
- Solarization with clear plastic (warm inland areas)
- Biological control options:
  - Serenade®
  - Intercept ®



Powdery Mildew

- Caused by one or two fungi: *Erysiphe* sp. and/or *Sphaerotheca* sp.
- These fungi primarily infect leaves & stems of cucumber, squash, melon & watermelon plants .
- Damage consists of weakening & killing the plants.

Control Options for Powdery Mildew

- Resistant varieties
- Plant in full sun with good drainage
- Don't crowd plants (this reduces air circulation)
- Don't over fertilize
- Cull infected plants or prune infected plant parts
- Irrigate in the morning
- Sulfur (garlic)
- Vegetable oil
- Bicarbonate of soda recipe:
  - 4 Tbls/ gallon of water
  - 8 drops of liquid soap per gallon
  - 4 Tbls hydrogen peroxide per gallon
- Compost teas
- Yeast & sugar solutions
- Milk (10% milk/water mix or more by volume)
- Biological Controls:
  - *Ampelomyces quisqualis*
  - Serenade®

Diseases: Mosaic Virus

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Prevention

- Control insects that vector the virus (aphids)
- Harvest by hand (without a knife that transmits the virus from plant to plant)
- Wash hands
- Do not smoke

There are no controls

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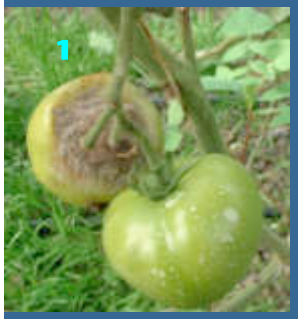
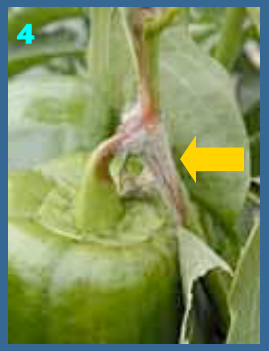
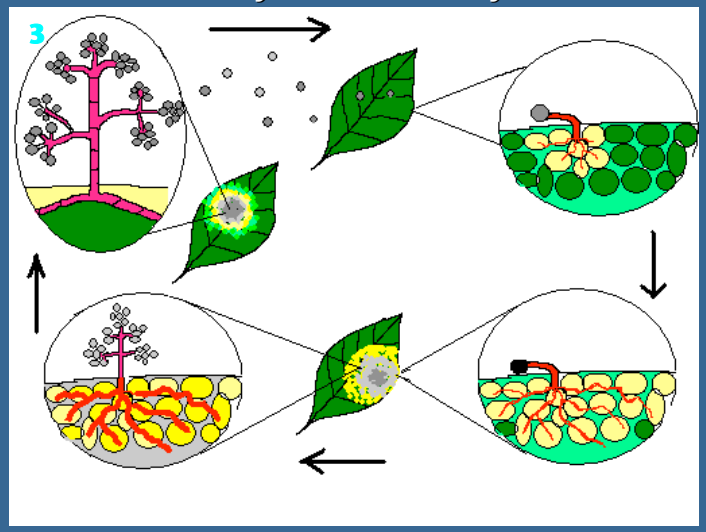
Botrytis or Gray Mold





Botrytis is a fungus that rots stems, buds, leaves, flowers and fruit.

Botrytis Life Cycle



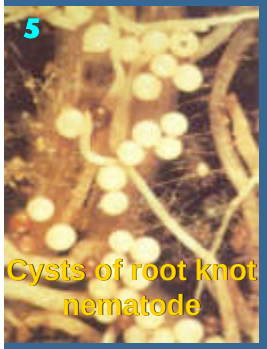
Botrytis attacks numerous crops: flowers, strawberries, raspberries, grapes, apples, cherries, kiwis, pears, lettuce, asparagus, onions and many others.

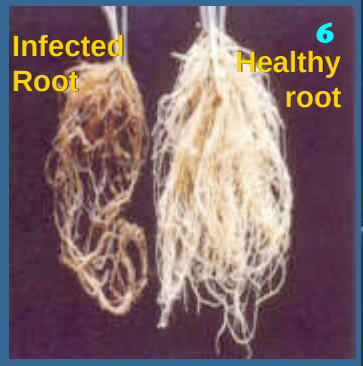
Botrytis infects through wounds, preferring new tender succulent growth of stems and leaves.

Botrytis Management Options:

- Avoid wounding plants
- Good water, drainage & fertilization management
- Good ventilation (plant spacing & leaf thinning in vineyards)
- Crop rotation
- Cull infected plants & prune plant parts
- Bicarbonate of soda
- Compost tea
- Nettle tea
- Vegetable oil
- Biological controls

Root Nematodes





Root nematodes are miniscule eel-like animals less than 1 mm long in the adult stage, only visible with a microscope. They possess a stylet that penetrates cell walls in order to absorb their content. The plant's roots form tiny nodules or cysts that are visible to the naked eye.

Nematode Controls

- Resistant Varieties
- Cover Crops:
  - Castor bean
  - Chrysanthemum
  - Sesame and marigolds
- Red plastic mulch
- Solarization

- **Botanical Controls:**
  - Caraway oil & seed
  - fennel
  - mint or oregano

- **Biological Controls:**
  - Ditera®
  - Prospernema ®
  - Deny ®
  - Beneficial Nematode: *Steinernema* sp.

For more information call the ATTRA project toll free at 1-800-346-9140

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Organic Integrated Weed Management

One Year Seeding is Seven Years Weeding

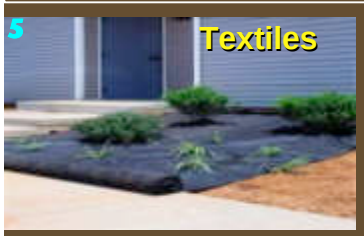
- Remove the weed before it produces seed. It is easier to weed one plant today than 1,000 weeds next year.
- The soil is a reservoir of seeds, a seed bank.

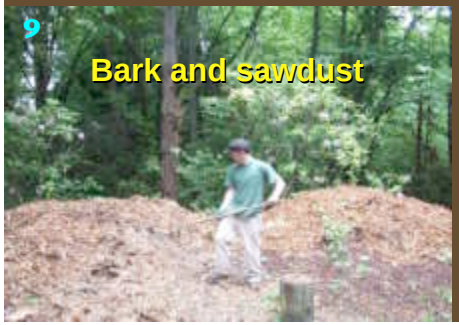
Early weed competition reduces quality and yields

How to Prevent Weed Damage

- Plant clean or certified seed
- Avoid importing manure or compost that has not been well composted or decomposed
- Crop rotation decreases the seeds of weeds that grow well with certain crops

Ground Covers





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Organic Integrated Weed Management

Flamers

This works better in warm regions. Cover moist soil with 1 or 2 layers of clear plastic for 6 to 8 weeks during the summer. It will sterilize 4 to 6 inches deep, destroying weeds seeds and other pests.

Flamers on Tractors

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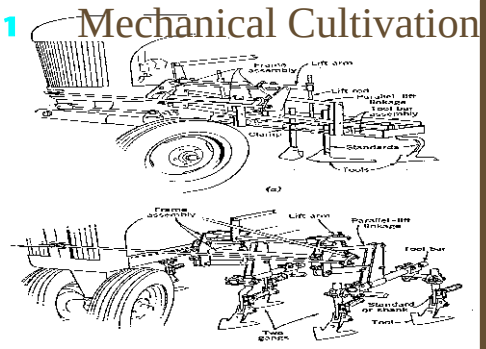
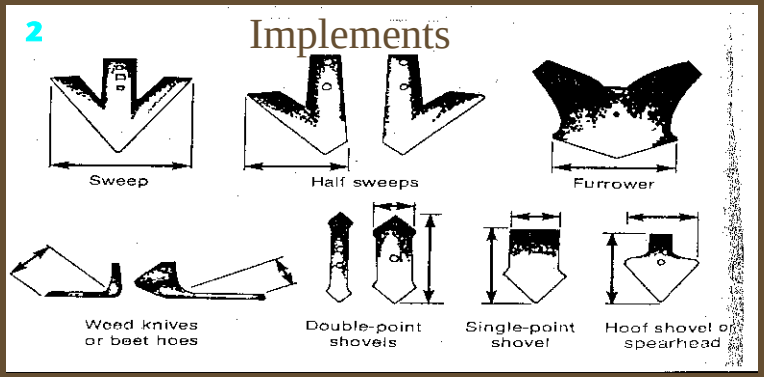
Organic Integrated Weed Management

1 Mechanical Cultivation



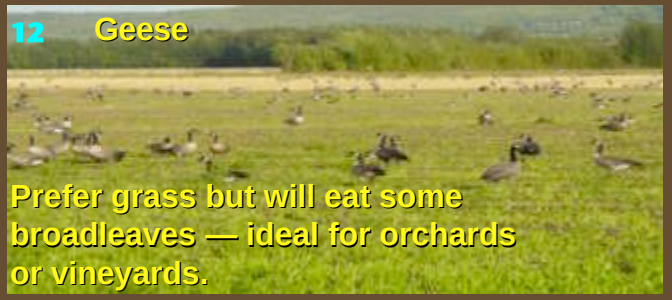
2 Implements



Weed with Animals

Chickens

Chickens graze pastures or clean up after harvest if they are confined to mobile cages known as chicken tractors.



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Gophers

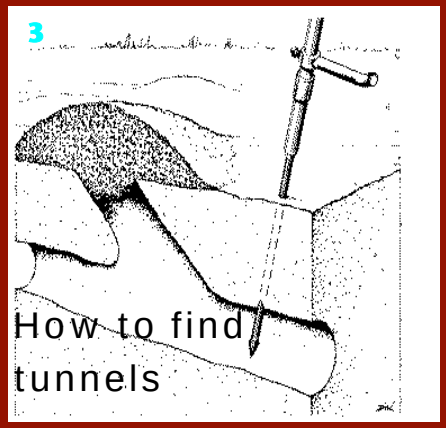
Gopher Controls

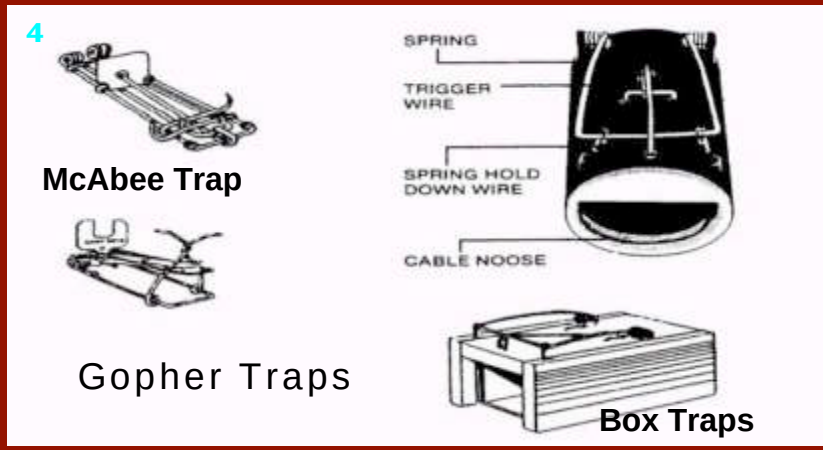
- Exclusion
- Keep areas weed- free
- Traps
- Flooding (if practical)

- Repellents (non-synthetic)
  - Blood meal
  - Hair
  - Rotten eggs in tunnels
  - Predator scents (urine)
- Vitamin D3 (Cholecalciferol)

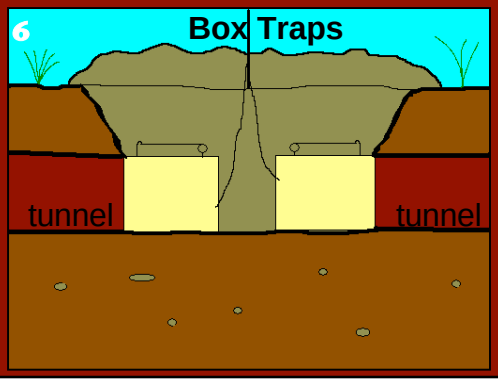
PREDATION

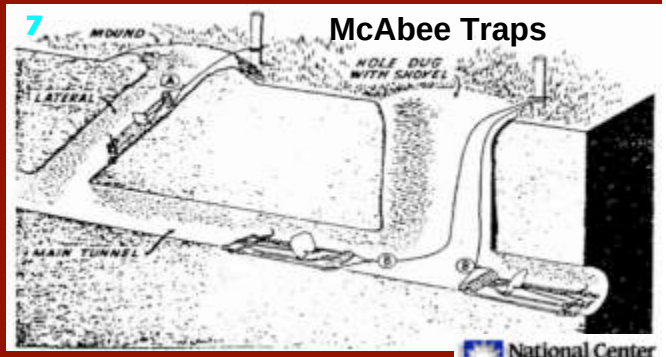
- Birds of prey
  - Owls
  - Eagles
  - Hawks
- Coyotes & Foxes
- Snakes
- Dogs & Cats





How to Place Traps





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Organic Integrated Vertebrate Management

Owls hunt many vertebrate pests

PROTECT these nocturnal hunters

- **An owl can consume 155 gophers per year, and it also eats rats and mice.**
- **A pair of owls can have a clutch of 5 to 6 chicks.**
- **One nest for every 10 acres is needed if the problem is severe, one nest every 20 acres if the pest pressure is average.**

PVC nest for owls

Box nests for owls

Owls hunt rodents:

- **Gophers**
- **Rabbits & Jackrabbits**
- **Ground Squirrels and Tree Squirrels**
- **Rats**
- **Mice**

For more information call the ATTRA project toll free at 1-800-346-9140.

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Squirrels

Squirrel Controls

- Traps
- Repellents
- Remove obstacles like trash, rocks and tree trunks
- Pellet or squirrel gun (use with caution)
- Predators: hawks, owls, eagles, snakes, coyotes, foxes & dogs
- Vitamin D-3 Cholecalciferol

Squirrel Traps

Deer

Deer Controls

- Fencing — electric
- Row covers
- Scare devices
  - Sound
  - Lights
- High powered rifle (use with caution)
- Dogs
- Repellents
  - Rotting meat
  - Soap
  - Hair
- Repellent plants

Feral Pigs

Feral Pig Controls

- Fencing
- Hunting
- Traps
- Dogs

For more information call the ATTRA project toll free at 1-800-346-9140.

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Rabbits and Hares

Rabbit & Hare Controls

- Fencing 4 feet high and buried 6 inches
- Traps
- Repellents- egg whites
- Hunting at dawn and dusk (use caution)
- Dogs & cats
- Eagles, hawks and owls
- Coyotes & foxes
- Wild cats & pumas
- Vitamin D3 (Cholecalciferol)

Birds

Nets protect against birds in this vineyard.

Bird Controls

- Scare Devices
  - Sound
  - Lights
  - Mylar tape
- Bird netting
- Row covers
- Repellents
- Shotgun (use with caution)
- Other animals

Scarecrow

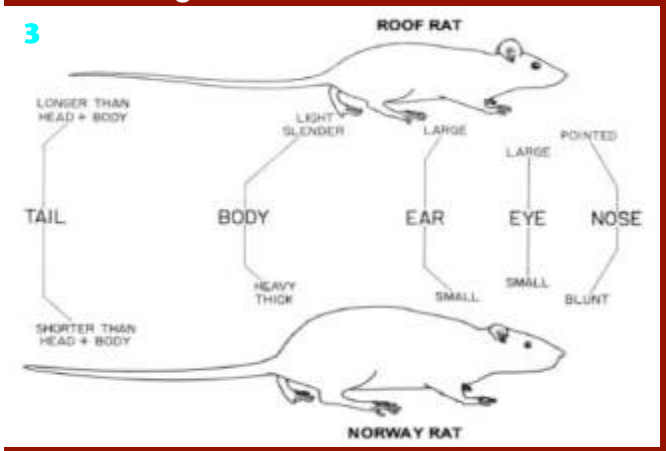
Rats


1 Norwegian rat

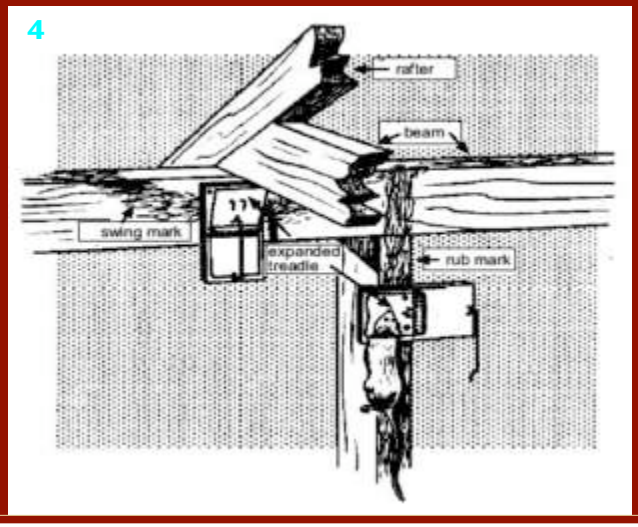
Rat Controls

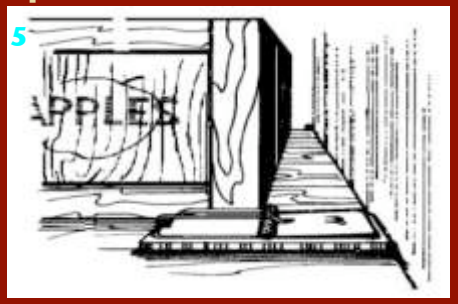
- Cleanliness & sanitation
- Limit access to homes & warehouses
- Owls
- Cats
- Snakes
- Traps – place baits on trigger, using meat, nuts or dried fruits.
- Vitamin D3 (Cholecalciferol)

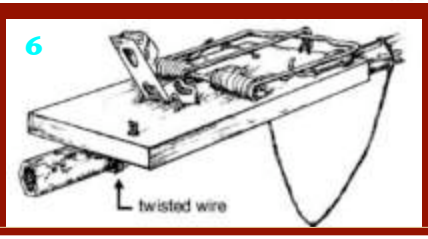
Differences between Norwegian rats and roof rats



How to place rat traps







Mice

Mice Controls

- Cleanliness & sanitation
- Eliminate weeds
- Fencing 1 foot high and buried 6 to 10 inches
- Traps
- Repellents
- Coyotes & foxes
- Cats
- Vitamin D3 (Cholecalciferol)
- Hawks
- Owls
- Gulls

For more information call the ATTRA project toll free at 1-800-346-9140.

National Center for Appropriate Technology

Organic Integrated Pest Management for Some Agricultural Pests

Adapted from a series of workshops sponsored by OFRF (Organic Farming Research Foundation) and NCAT (National Center for Appropriate Technology)

by Ann Baier, Rex Dufour, Martín Guerena, Karen Van Epen

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• **Cornell University Vegetable MD —** www.vegetablemdonline.ppath.cornell.edu
• **OSU Mint —** *Integrated Pest Management on Peppermint- IPMP3.0* [online], by Berry, R.E., and L.B. Cooper (2000), Publication No. IPPC E.01-01-1, <http://mint.ippc.orst.edu>
• **OSU Potato —** *Identification and Management of Major Pest & Beneficial Insects in Potato* [online], by Berry, R.E., G.L. Reed, and L.B. Cooper (2000), Publication No. IPPC E.04-00-1, <http://ippc2.orst.edu/potato>
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