Integrated Pest Management for Vegetable Gardens
Integrated Pest Management (IPM)

• Utilizing a variety of pest management measures including cultural, physical/mechanical, biological, and chemical to keep pests at acceptable levels.
Cultural Methods of Control

- Plant resistant varieties
- Inspect plants
- Crop rotation
- Sanitation
- Good cultural practices (fertilizer, watering, etc.)
## Crop Rotation

### Garden Map 2006

<table>
<thead>
<tr>
<th>Crop</th>
<th>Family</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carrots</td>
<td>Apiaceae</td>
</tr>
<tr>
<td>Onions</td>
<td>Subfamily - Allioideae</td>
</tr>
<tr>
<td>Peas</td>
<td>Leguminosae</td>
</tr>
<tr>
<td>Squash</td>
<td>Curcurbitaceae</td>
</tr>
<tr>
<td>Tomatoes</td>
<td>Solanaceae</td>
</tr>
</tbody>
</table>

### Garden Map 2007

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Mechanical Control

- Collars
- Screens or rowcovers
- Mulches
- Your fingers or your toes
Biological Control

- Beneficial Insects
  - Lady beetles, lacewings, wasps, etc.

Excellent

Not so great
Plants To Attract Beneficial Insects

- Dill / fennel
- Coriander
- Buckwheat
- Sweet Alyssum
- Sunflowers
- Cosmos
- California Poppy
- Cornflower
- Basil

- Borage
- Yarrow
- Catmint
- Coneflower
- Goldenrod
- Golden Marguerite
Chemical Control

- Pesticides
  - Conventional or Synthetic
  - Botanical
  - Biological
  - Horticultural Oils
  - Insecticidal Soaps
  - Check post-harvest interval
  - Label is the law!
Insecticidal Soap

• **Ingredients:** Insecticidal soap is sodium or potassium salts combined with fatty acids

• **Application:** Insecticidal soap must come in direct contact with the insect. It is no longer effective once it has dried.

• **How It Works:** The fatty acids in the soap penetrate the insect’s outer covering and cause the cells to collapse.

• **Pros:**
  - One of the safest pesticides.
  - Non-toxic to animals.
  - No residue.
  - You can use on vegetables up to harvest.

• **Cons:** Can burn or stress plants. Don’t use in full sun or high temperatures.
Bt (Bacillus thuringiensis)

- **Ingredients:** bacteria. There are more than 80 types of Bt used as pesticides.

- **Application:** Generally available in powdered form that is sprinkled or dusted on a plant. It must be eaten by the targeted insect.

- **How It Works:** Bt is a stomach poison. It releases toxins in the stomachs of susceptible insects which cause them to stop eating and starve.

- **Pros:** Bt strains are very host specific and will not harm people, pets, birds or bees.

- **Cons:** Slow acting. It may take days for the insect to completely stop eating and die. Breaks down quickly. Can kill ‘good insects’ like butterfly larva. Breaks down rapidly in sunlight. Can be a skin irritant.
Pyrethrins

- **Ingredients:** Derived from *Chrysanthemum cinerariifolium*

- **Application:** Generally found in powder form and dusted on leaves.

- **How It Works:** Poisons the insect, causing a quick death

- **Pros:** Quick acting. Low toxicity to animals. Degrades within a day.

- **Cons:** Broad spectrum insecticide. Kills any insect. Very toxic to honeybees

- **Precautions:** Use cautiously, only when you have a major problem with hard-to-kill insects.
Rotenone

- **Ingredients**: Derived from the roots of tropical legumes
- **Application**: Dust onto plant
- **How It Works**: Inhibits a cellular process, depriving insects of oxygen in their tissue cells.
- **Pros**: Low residual effect. Breaks down quickly in sunlight.
- **Cons**: Broad spectrum pesticide
- **Precautions**: Apply in the evening, when bees are less active.
Potassium Bicarbonate

- **Ingredients:** Potassium bicarbonate usually combined with horticultural oil and / or a substance to improve spreading and coverage of the leaves. There are commercially available products such as GreenCure® and Kaligreen, or you can prepare your own. Note: Baking soda or sodium bicarbonate is often recommend for similar fungus problems, however research has shown potassium bicarbonate works better and is safer on plants.

- **Application:** Spray at the first sign of disease or use as a preventative before infection.

- **How It Works:** It’s still unclear, but it appears that bicarbonates can damage the cell wall and possible create a pH that is not conducive to further fungal growth. The effect is immediate. **Pros:**
  - Lasts 2 - 3 weeks as a preventative.
  - You can use on vegetables up to harvest.

- **Cons:** Can burn plants, especially if used in full sun. So check label and test on a small area before spraying entire plant.
Horticultural Oil

- **Ingredients:** Highly refined petroleum oil
- **Application:** Mixed with water and sprayed onto foliage
- **How It Works:** Coats and suffocates insects or disrupts their feeding.
- **Pros:** Low toxicity to humans, pets or birds. No toxic residue.
- **Cons:** Most effective against soft bodied insects. Can cause bluish evergreens to temporarily lose their blue tint. Can burn leaves.
- **Precautions:** There are several grades. Be sure to use the one that is right for the season in which you are spraying.
Neem

- **Ingredients:** Contains 2 ingredients, azadirachtin (AZA0 and liminoids, both from the seed kernels of the neem tree fruit.

- **Application:** Sprayed onto plant leaves.

- **How It Works:** Upsets the insects hormonal system and prevents it from developing to its mature stage. Most effective on immature insects and species that undergo complete metamorphosis.

- **Pros:** Non-toxic to humans
- **Cons:** Washes away in rain. Slow acting. Breaks down in sunlight. Indiscriminate pesticide

- **Precautions:** Keep pets from treated leaves until they dry.
Damping-off

- *Pythium and Rhizoctonia*
- Fungus
- Spores survive in soil and on debris
Damping-off Control

- clean potting mix & containers
- good air movement
- seed treatment - fungicides
Cutworm

- Moth lays eggs on low growing plants
- Larva 1-2” gray color feed at night
- Overwinter as larva or pupae
- Likes weedy areas & sod
Cutworm Control

- Collars
- Beneficial nematodes
  - *Steinernema carpocapsae*
- Carbaryl (Sevin)
Aphids

- Small soft bodied various colors
- Suck sap from plants & spread virus diseases
- Winged and wingless
- Overwinter as eggs or adults
- Some species only produce females
Aphid Control

- Forceful water
- Foil mulch
- Insecticidal soap
- Azadirachtin (Neemix)
- Rotenone
- Esfenvalerate
Whitefly

• White insects 1/16” long
• Eggs to nymph to “fly like” adult
• Suck plant sap
• Do not overwinter outdoors in NJ
Whitefly Control

- Floating row covers
- Insecticidal soap
- Pyrethrum
- Pyrethrin
- Esfenvalerate
Tomato Hornworm

- 5” moth lays eggs on tomato plants
- 4” larva long chews on plants
- Overwinter as pupa in soil
Tomato Hornworm Control

- hand-pick
- natural predator
  - *Trichogramma* wasp
- *Bacillus thuringiensis* - Bt
- Carbaryl (Sevin)
Pest?
Tomato Leaf Blight

- Early Blight & Septoria Leaf Spot
- Fungus disease
- Spores overwinter in soil on crop debris
Tomato Leaf Blight Control

- Tolerant varieties ‘Mtn. Supreme’
- Crop rotation
- Good air circulation
- Sanitation
- Fungicides
  - Copper
  - Chlorothalonil
  - Mancozeb
Fusarium & Verticillium wilt

- Fungus disease
- Spores live for years in soil
Fusarium & Verticillium wilt control

- Plant resistant varieties
- Practice good crop rotation
Choosing Varieties

• ‘Celebrity’ - VFFNT, 70 days,
  All American Winner, mid-season, medium red fruit, determinate

V - Verticillium wilt
F, FF - Fusarium wilt race 1, 2
N - Nematodes
T - Tobbaco mosaic virus
Virus Control

- Cull infected plants
- Control aphids, whiteflies, & thrips
Blossom End Rot

- Caused by a lack of calcium
- Common in first fruit & in plants in containers
- Rest of fruit safe to eat
  (if spot is small)
Blossom End Rot Control

- Add calcitic lime
- Keep soil evenly moist, use mulches
Slugs & Snails

• Various colors & sizes
• Shred plants
• Leave clear or silvery trail
• Likes moist shaded areas with organic material
• Most overwinter as eggs
Slug & Snail Control

- Traps – beer, piece of wood
- Diatomaceous earth
- Copper screening
- Iron Phosphate bait (Sluggo)
- Metaldehyde bait
- Carbaryl (Sevin) bait
European Corn Borer/ Corn Earworm

- Moth lays eggs larva hatch and burrow into fruit
- Mature borer larvae overwinter in NJ in corn stubble, or stems of plants, including weeds
- Two generations in NJ
- Earworm overwinters as pupae in southern states
European Corn Borer/ Corn Earworm

- Bacillus thuringiensis – Bt.
- Carbaryl (Sevin)
Spider Mites

- Tiny pests related to spiders
- Suck sap from plants
- Likes hot dry conditions
Spider Mite Control

- Forceful water
- Insecticidal soap
- Horticultural oil
Colorado Potato Beetle

- 3/8” Adults overwinter in soil lay eggs on plants
- Larva feed on leaves
- 2 generations in NJ
- Resistant to many pesticides
Colorado Potato Beetle Control

- Hand-pick
- Heavy mulch
- Floating row cover with crop rotation
- Bt *tenebrionis* on small larva
- Rotenone
- Pyrethrum
- Carbaryl (Sevin)
Flea Beetles

- 1/16” adults overwinter in protected places
- Lay eggs in soil near plant roots
- Larva feed on plant roots
- Jump when disturbed
- 2 generations in NJ
Flea Beetle Control

- Floating row covers with crop rotation
- Hot pepper wax
- Carbaryl (Sevin)
- Esfenvalerate
Verticillium Wilt of Eggplant

• Fungus disease – attacks many types of plants including those in the Solanaceous family
• Spores, microsclerotia, live in soil for years - Up to 8 years
Verticillium Wilt of Eggplant Control

- Crop rotation – may have limited affect
- Plant in clean potting mix in containers
- Remove crop debris
- Fumigate soil
Imported Cabbageworm

- Adult white butterfly native to Europe
- Eggs laid on plants
- 1” Larva chew on leaves
- Overwinter as pupa attached to plants
- 3-4 generations
Imported Cabbageworm Control

- Hand-pick
- *Bacillus thuringiensis* - Bt (Dipel)
- Carbaryl (Sevin)
- Esfenvalerate
Cabbage Maggot

- Adults similar to houseflies
- Overwinter as pupae
- Flies lay eggs in April to May on soil near base of plants
- Eggs hatch into maggots which bore into roots
Cabbage Maggot Control

- Floating row covers with crop rotation
- Protective collar
- Plant after June 1
Squash Vine Borer

- Adult clear wing moth
- Eggs laid on stalks in early summer
- Eggs hatch into borers which tunnel into stem
- Overwinter as cocoon
Squash Vine Borer Control

- Floating row covers – remove at flowering
- Make several plantings (after July 1)
- Hand destroy
- *Bacillus thuringiensis* Bt - injection
- Rotenone
- Carbaryl (Sevin)
- Esfenvalerate
Cucumber Beetle

- Adult beetles 1/5” long
- Overwinter as adults in plants debris
- Eggs laid on plants near soil
- Larva feed on roots
Cucumber Beetle Control

• Floating row covers – remove at flowering
• Less attractive varieties (less cucurbitacin)
• Rotenone
• Pyrethrum
• Carbaryl (Sevin)
• Esfenvalerate
Powdery Mildew

- Fungal disease
- Can infect in dry weather
Powdery Mildew Control

- Resistant & tolerant varieties
- Potassium bicarbonate
- Chlorothalonil
Mexican Bean Beetle

- Adult beetles 1/4 “ long
- Overwinter in grass or weeds
Mexican Bean Beetle Control

- Natural predator – wasp
  *Pediobius foveolatus*
- Rotenone
- Pyrethrum
- Pyrethrin
- Carbaryl (Sevin)
- Esfenvalerate
Bean Rust

- Fungal disease
- Reddish dusty spots on lower surface of leaves
- Overwinters on residue from diseased plants
- Spores can spread by wind or by people, tools and implements
Bean Rust Control

- Resistant varieties
- Do not handle wet plants
- Chlorothalonil
Corn Worm

- Corn earworm, European corn borer, Fall armyworm
- Lay eggs on corn ears larva tunnel into ear
- Populations build over summer
Corn Worm Control

- Plant early – mid-April
- Vegetable oil plus Bt on silk
  - 6 days after silk appears
- Carbaryl (Sevin)
- Esfenvalerate
Corn Smut

• Fungal disease
• Overwinters in soil
• Favored by dry conditions and temperatures 79-94 F
• Injury from environmental, cultural or insect problems helped to promote smut development
• Delicacy in South America
Corn Smut Control

- Plant resistant varieties
Poor Pollination of Corn

- Plant in blocks
- Hand pollinate
Root Knot Nematode

- Microscopic worm
- Infects roots causing knots and stunted growth
Root Knot Nematode Control

- Rotate with marigolds
Leafminer

- Adult fly (1/10”) lays eggs on underside of leaves in early spring
- Eggs hatch into maggots which tunnel in leaf
- Overwinter as pupa in soil
- Larger plants more tolerant of damage
- 2-3 generations/year
Leafminer Control

- Floating row covers
- Permethrin