Vegetable Pest Management

Gerald Brust
IPM Vegetable Specialist

UNIVERSITY OF MARYLAND EXTENSION
Solutions in your community
Insects
Metamorphosis: Complete

Metamorphosis: Incomplete
Exoskeleton
Mouthparts

- Labrum
- Mandible
- Maxilla
- Palp
- Proboscis
- Labium
- Labial Groove
- Stylets

Caterpillars (left)
Butterfly (center)
Bug (right)

Rasping/sucking (Thrips and mites)
Stippling of foliage from thrips feeding, also can look like mite feeding
Natural Enemies of insect pests
Carabids like mulched areas
Lady bug larva
Lady bug eggs
Lacewing eggs
Lacewing adult
Lacewing larva
Orius insidiosus - insidious flower bug
Syrphid fly adult
Syrphid fly adult

Syrphids look like bees and wasps
Syrphid fly maggot
Predatory Mites
Tachinid eggs are always laid on the outside of host. Look for something that looks like rice stuck to sides of caterpillar.
Another type of Tachinid fly

Tachinid larva inside stink bug adult
Parasitoids come in many shapes and sizes
These brown bloated aphids have been parasitized by a wasp.
Wasp lays egg inside aphid host
The egg hatches and the little wasp eats the aphid from the inside out.
When ready it pupates inside the aphid’s old skin and emerges from the pupa and cuts a hole in the aphid skin with its jaws.
It pushes the cut flap back and emerges and starts to lay eggs on other aphids. Can lay 50-150 eggs
Size of parasitized aphid
What are blue lines pointing to?
What are red lines pointing to?
What is yellow line pointed to?
A mix of flower types are good to have to bring these natural enemies into your garden or field.
Mulch will attract soil dwelling predators
<table>
<thead>
<tr>
<th>Product Name</th>
<th>Active Ingredient</th>
<th>Controls</th>
<th>Poor control of</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Baythroid, or Decis</strong></td>
<td>Cyfluthrin or Deltamethrin</td>
<td>Caterpillars, Japanese beetle, most beetles, flies, fleas, ants, wasps, stinkbugs, flea beetles, leaf beetles (i.e. asparagus, cucumber beetles, etc.)</td>
<td>Aphids, scales, leaf miner, seed corn maggot</td>
</tr>
<tr>
<td>1</td>
<td>Carbaryl</td>
<td>As in no. 1</td>
<td>Same as no. 1</td>
</tr>
<tr>
<td><strong>Warrior</strong></td>
<td>Lambda cyhalothrin (pyrethroid)</td>
<td>As in no. 1 + thrips</td>
<td>Same as no. 1</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>As in no. 1</td>
<td>As in no 1</td>
</tr>
<tr>
<td><strong>Ambush, Mustang, Pounce</strong></td>
<td>Pyrethroid</td>
<td>As in no. 1</td>
<td>As in no 1</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>As in no. 1</td>
<td>As in no. 1</td>
</tr>
<tr>
<td><strong>Capture</strong></td>
<td>Bifenthrin (pyrethroid)</td>
<td>As in no. 1</td>
<td>As in no. 1</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Admire, Provado, Cruiser, Poncho, Assail,</strong></td>
<td>Imidacloprid other neonicotinoids Thiamethoxam Clothianidin Acetamiprid</td>
<td>Aphids, scales, beetles-Japanese beetles and their grubs</td>
<td>Thrips, stinkbugs</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Product Name</td>
<td>Active Ingredient</td>
<td>Controls</td>
</tr>
<tr>
<td>---</td>
<td>-------------</td>
<td>------------------------------------</td>
<td>---------------------------------------</td>
</tr>
<tr>
<td>1</td>
<td>Neemix</td>
<td>Azadirachtin, Neem oil</td>
<td>Beetles, caterpillars</td>
</tr>
<tr>
<td>2</td>
<td>Entrust</td>
<td>Spinosad</td>
<td>Thrips, some beetles-CPB, most caterpillars</td>
</tr>
<tr>
<td>3</td>
<td>Various names</td>
<td>garlic tea or garlic/pepper tea, lemon juice</td>
<td>Some beetles, caterpillars</td>
</tr>
<tr>
<td>4</td>
<td>Dipel, or Xentari</td>
<td><em>Bacillus thuringiensis kurstaki or aizawa</em></td>
<td>Caterpillars--very good control of many species</td>
</tr>
<tr>
<td>5</td>
<td>Safer Soap</td>
<td>K fatty acids</td>
<td>aphids, mites small caterpillars</td>
</tr>
<tr>
<td>6</td>
<td>Pyrenone Crop Spray</td>
<td>Rotenone and/or pyrethrum</td>
<td>Japanese beetles, some caterpillars, aphids</td>
</tr>
<tr>
<td>7</td>
<td>Surround</td>
<td>Kaolin clay</td>
<td>Aphids, mites, worms, thrips</td>
</tr>
<tr>
<td>8</td>
<td>Horticultural Oils</td>
<td>Dormant (trees, shrubs) horticultural or summer oil (use during season)</td>
<td>Scales, aphids Aphids, mites Mealy bugs</td>
</tr>
<tr>
<td>9</td>
<td>Botanigard</td>
<td>Beauveria bassiana</td>
<td>Aphids, mites, small worms</td>
</tr>
</tbody>
</table>
Kaolin clay sprayed on one cucumber, but not the other. Clay acts as a physical barrier. If mixed with pyrethrum it works even better to keep pests from feeding on plants.
<table>
<thead>
<tr>
<th>Product Name</th>
<th>Chemical Name</th>
<th>How it works</th>
<th>What it controls</th>
</tr>
</thead>
<tbody>
<tr>
<td>Confirm, Intrepid</td>
<td>tebufenozide, methoxyfenozide</td>
<td>IGR – ecdysone agonist causes a premature lethal molt. Mostly through ingestion, some contact, feeding ceases in 24 hrs, death in 2-3 days</td>
<td>Small Lepidoptera larvae (worms or caterpillars) such as armyworms, beet AW, tomato fruit worm, loopers, hornworm,</td>
</tr>
<tr>
<td>Spintor</td>
<td>Spinosad</td>
<td>Microbial metabolite– fermentation product (interferes with nicotine-like receptors in nerve endings) of soil bacteria-Actinomycetes</td>
<td>Lepidoptera larvae, leaf miners, certain thrips species, Colorado potato beetle</td>
</tr>
<tr>
<td>Fullfill</td>
<td>Avermectins-emamectin benzoate Pymetrozine</td>
<td>Microbial metabolite, Mostly through ingestion. Disruption of nerve impulses causes paralysis in hours, death in days Stops aphids from feeding quickly after initial contact. Aphids may remain alive for days, but don’t feed. Translaminar and systemic</td>
<td>Lepidoptera larvae Aphids, some activity on whiteflies</td>
</tr>
<tr>
<td>Avaunt</td>
<td>Indoxacarb</td>
<td>Inhibits Na⁺ entry into nerve cells, paralysis and death 6-48 hours. Contact and ingestion</td>
<td>Lepidoptera larvae, beet AW, diamond back moth, fruit worms</td>
</tr>
<tr>
<td>Courier, Applaud</td>
<td>Buprofezin</td>
<td>IGR – Chitin synthesis inhibitor, contact and ingestion</td>
<td>White flies, leaf hoppers</td>
</tr>
<tr>
<td>Agri-Mek</td>
<td>Avermectins</td>
<td>Fermentation product of soil bacterium <em>Steptomyces avermitilis</em>, via ingestion. Inhibits signal transmission at neuromuscular junctions</td>
<td>Colorado potato beetle, mites, thrips, some Lepidoptera larvae</td>
</tr>
<tr>
<td>Knack</td>
<td>Pyriproxyfen – slow acting</td>
<td>IGR- Jh mimic sterilizes whitefly adults and eggs</td>
<td>Lepidoptera larvae, good on large beet armyworms</td>
</tr>
<tr>
<td>Rimon</td>
<td>Novaluron</td>
<td>IGR – chitin inhibitor, enters via ingestion</td>
<td>Immature: Whitefly, thrips, some Lept larvae</td>
</tr>
<tr>
<td>Oberon</td>
<td>Spiromesifen</td>
<td>Tetronic acid derivatives interfere with lipid biosynthesis</td>
<td>Mites, whiteflies</td>
</tr>
<tr>
<td>Admire, Provado Actara, Platinum, Assail</td>
<td>Imidacloprid</td>
<td>Interferes with nerve endings, keeps nerve receptor channels open</td>
<td>Sucking insects, Colorado potato beetle, beetles, other chewing insects</td>
</tr>
<tr>
<td>Agree, Cutlass, Deliver, DiPel, Javelin, XenTari</td>
<td><em>Bacillus thuringiensis kurstaki, aizawa</em></td>
<td>Protein toxin attaches to gut of insect causing rupture and death in 24-48 hours</td>
<td>Many Lepidopteran larvae such as hornworm, cabbage looper, fruitworm, armyworms</td>
</tr>
<tr>
<td>Crop</td>
<td>Pest</td>
<td>Organic Control</td>
<td>Reduced Risk</td>
</tr>
<tr>
<td>----------------------</td>
<td>-----------------------------------------------------</td>
<td>---------------------</td>
<td>-----------------------</td>
</tr>
<tr>
<td>Tomato</td>
<td>Worm/Army worm complex - Beet, cut, pm, tree, hornworm B,RR,Ch</td>
<td>Bt or Entrust</td>
<td>Spintor/Bt</td>
</tr>
<tr>
<td>Pepper</td>
<td>Colorado Potato Beetle C, RR,Ch</td>
<td>Entrust</td>
<td>Spintor/Neonicotinoids</td>
</tr>
<tr>
<td>Eggplant</td>
<td>Stinkbug Ch</td>
<td>Poor controls, soap, pyrethrum</td>
<td>Poor controls</td>
</tr>
<tr>
<td>Potato</td>
<td>Thrips B,RR, Ch</td>
<td>Entrust, Soaps, hort oil</td>
<td>Spintor</td>
</tr>
<tr>
<td></td>
<td>Flea beetles Ch</td>
<td>Soaps, hort oil, poor control</td>
<td>Neonicotinoids</td>
</tr>
<tr>
<td></td>
<td>Aphids B, RR, Ch</td>
<td>Soaps, hort oil, biocontrol</td>
<td>Neonicotinoids</td>
</tr>
<tr>
<td></td>
<td>Leafminer B, RR, Ch</td>
<td>Biocontrols, soaps</td>
<td>Spintor</td>
</tr>
<tr>
<td></td>
<td>Mites C, B, RR, Ch</td>
<td>Soaps/hort oils</td>
<td>Oberon</td>
</tr>
<tr>
<td>Squash</td>
<td>Worm/Army worm complex - pickle, melon, vineborer, looper, cut</td>
<td>Bt or Entrust</td>
<td>Spintor/Bt</td>
</tr>
<tr>
<td>Cantaloupe</td>
<td>Cucumber beetle RR, Ch</td>
<td>Difficult to control – trap crop, screen mesh out crop</td>
<td>Neonicotinoid drench</td>
</tr>
<tr>
<td>Watermelon</td>
<td>Seed corn maggot Ch</td>
<td>Screen mesh over crop, plant later into season</td>
<td>Plant when ground is warmer</td>
</tr>
<tr>
<td>Cucumber</td>
<td>Aphids – green peach/ melon B, RR, Ch</td>
<td>Soaps/hort oils</td>
<td>Neonicotinoids/ Pymetrozine</td>
</tr>
<tr>
<td></td>
<td>Squash bug ~C, Ch</td>
<td>Difficult control – biocontrol</td>
<td>Neonicotinoid drench</td>
</tr>
<tr>
<td></td>
<td>Thrips B, RR, Ch</td>
<td>Soaps, hort oils</td>
<td>Spintor</td>
</tr>
<tr>
<td></td>
<td>Mites C, B, RR, Ch</td>
<td>Soaps, hort oils</td>
<td>Oberon</td>
</tr>
<tr>
<td>Cauliflower</td>
<td>Worm complex – cabbage looper, diamondback moth, cabbage worm</td>
<td>Bt or Entrust</td>
<td>Spintor/Bt</td>
</tr>
<tr>
<td></td>
<td>Flea beetles</td>
<td>Soaps/hort oils – poor control</td>
<td>Foliar neonicotinoids</td>
</tr>
<tr>
<td></td>
<td>Aphids</td>
<td>Soaps/hort oils – biocontrol</td>
<td>Neonicotinoids/ pymetrozine</td>
</tr>
<tr>
<td>Lettuce</td>
<td>Worm Complex</td>
<td>Bt/Entrust</td>
<td>Spintor/Bt</td>
</tr>
<tr>
<td>Endive</td>
<td>Leafhopper</td>
<td>Difficult, screen over crop</td>
<td>Neonicotinoid drench</td>
</tr>
<tr>
<td>Escarole</td>
<td>Aphids</td>
<td>Soaps, hort oil – biocontrol</td>
<td>Pymetrozine, Neonicotinoids</td>
</tr>
<tr>
<td></td>
<td>Tarnished plant bug C, Ch</td>
<td>Difficult to control</td>
<td>Difficult to control</td>
</tr>
</tbody>
</table>
Top 10 Insect Pests for Vegetables

1. Description, damage, life cycle, etc. of pest

2. Cultural Management

3. Organic Management

4. Synthetic Management
1. Colorado potato beetle
Cultural
• Rotate away from solanaceous crops
• Use straw mulch around plants

Organic
• Entrust
• Kaolin clay
• Btt-\textit{Bacillus thuringiensis tenebrionis}

Synthetic
• Pyrethroids
• SpinTor
• Abamectin
• Neonicotinoids
2. Caterpillars
Cultural
• Use straw mulch around plants
• Sweet corn-plant early as possible
• Use corn earworm pheromone trap >10/night

Organic
• Entrust
• Bt- *Bacillus thuringiensis*
  \( Bt\ aizawai \)
  \( Bt\ kurstaki\ strain\ HD-1 \)
• Kaolin clay applied to ‘tomato’ plant not fruit

Synthetic
• Pyrethroids
• SpinTor
• Lannate
• Coragen
3. Thrips and Spider mites
Orius insidiosus - insidious flower bug
Thrips Predator Mite
Cultural
- Make sure plants not heat stressed
- Use straw mulch around plants
- Heavy water-spray application - wash off

Organic
- Entrust-thrips ONLY
- Hort oils, soaps-both
- K-clay

Synthetic
- Pyrethroids-both**
- SpinTor-thrips only
- Abamectin-mites only
- Neonicotinoids-thrips only
- Spiromesifen-mites only
4. Aphids
Cultural
• Non stressed plants
• Use straw mulch around plants
• Reflective mulch

Organic
• Hort oils, soaps
• K-clay

Synthetic
• Neonicotinoids
• Pyrethroids
• Pymetrozine
5. Flea beetles
**Cultural**
- Floating row covers
- Trap cropping-radish and mustard greens
- Crop Rotation
- Yellow sticky traps

**Organic**
- Hort oils, soaps
- Pyrethrums + K-clay

**Synthetic**
- Neonicotinoids
- Pyrethroids
Row Covers
Trap crops
Sticky traps
6. Stink bugs and Harlequin bug
Stinkbug damage
Harlequin bug damage
BMSB damage to fruit and vegetables
Cultural
• Floating row covers

Organic
• Pyrethrums and
• K-clay + Pyrethrums

Synthetic
• Neonicotinoids+Pyrethroids
• Pyrethroids
7. Striped cucumber beetle
Cultural
• Floating row covers
• Trap cropping

Organic
• Pyrethrums
• Py + K-clay

Synthetic
• Neonicotinoids
• Pyrethroids
8. Squash bug
Organic
• Pyrethrins or Py + K-clay directed at base of plant-early season

Cultural
• Floating row covers
• Trap cropping

Synthetic
• Pyrethroids
• Carbaryl
• Neonicotinoids
9. Squash vine borer
Cultural
• Floating row covers
• Pheromone trap monitoring
• Cover 1st 12 inches of vine

Organic
• Pyrethrums or Py + K-clay directed to base of plant

Synthetic
• Pyrethroids directed at base of plant
9. Mexican bean beetle and bean leaf beetle
Pediobius foveolatus
Cultural

- Floating row covers
- Hand-pick
- Clean-up debris
- Several varieties of bean show some level of tolerance. They are: Wade, Logan, and Black Valentine.

Beans very susceptible are the State, Bountiful, and Dwarf varieties.
Organic
• Pyrethrums

Synthetic
• Pyrethroids
10. Seed corn maggot and Pickleworm/Melonworm
Cultural
- Floating row covers - Both; off during day on at night - worms
  Cover early season for SCM; later season for worms
- Plant after soil warms (70° F) - SCM
- Manure and decomposing cover crop attract flies - till in 3-4 weeks before planting - SCM

Organic
- *Pyrethrums or diatomaceous earth directed to base of plant before damage is observed* - SCM
- Pyrethrums at flowering - worms

Synthetic
- *Pyrethroids directed at base of plant - SCM*
- Pyrethroids at flowering - worms
Plant Diseases
The Disease Triangle

Successful disease management strategies are aimed at managing these three components.
Plant Diseases

Pathogens – living agents

- Fungi
- Bacteria
- Viruses
- Nematodes

Non-living agents: cold, heat
Know your crop
- Optimum growing conditions
- Common diseases

Know biology of pathogens
- How pathogen spreads
- Environmental requirements
General Management Strategies

Resistance
Sanitation and Eradication
Environmental Modification
Cultural Modification
Pesticide Application
Plant Parasitic Nematodes
Predatory Nematode
Viruses and Phytoplasmas
1. Alternaria, Septoria leaf spots
Organic
• Oxidate applied to foliage
• There are biopesticides available

Cultural
• Rotation
• Keep foliage dry as possible
• Destroy plant residue
• Tolerant varieties- Mt: Fresh, Belle, Supreme, Pride, Gold

Synthetic
• Chlorothalonil rotated with Quadris or Endura
2. Phytophthora blight, wilt
<table>
<thead>
<tr>
<th>Host</th>
<th>Plant part affected</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pepper, especially bell and cherry types; also many pungent types</td>
<td>Blight (foliar phase); damping off, crown rot, root rot, fruit rot Damping off</td>
</tr>
<tr>
<td>Tomato, all types; some varieties differ in susceptibility</td>
<td>Buckeye fruit rot Phytophthora root rot</td>
</tr>
<tr>
<td>Eggplant</td>
<td>Phytophthora fruit rot; also collar rot and stem canker</td>
</tr>
<tr>
<td>Cucurbits:</td>
<td>Phytophthora root rot stem and leaf collapse</td>
</tr>
<tr>
<td>Summer squash</td>
<td>Phytophthora fruit rot</td>
</tr>
<tr>
<td>Winter squash (Butternut, Hubbard, etc.) and pumpkins (small and large types); cucumber and watermelon</td>
<td>Phytophthora blight</td>
</tr>
</tbody>
</table>
Cultural
• Crop rotation-2-4 years with grain or crucifers
• Avoid wet areas, create a crown in bed
• Break up hard pans-increase drainage
• Prevent soil splash
• Select resistant varieties-pepper Paladin, Aristotle and Revolution

Organic
• See above

Synthetic
• Mefenoxam* (Ridomil Gold, Ultra Flourish), mixes of mefenoxam and copper hydroxide (Ridomil Gold/copper), famoxadone plus cymoxanil (Tanos), zoxamide plus mancozeb (Gavel), or copper plus maneb
3. Late blight
Cultural

- Rotation
- Destroy plant residue-sanitation
- Destroy volunteer plants

Organic

- Oxidate applied to foliage-poor

Synthetic

- Chlorothalonil or mancozeb rotated with Curzate or Forum or Ranman or Revus
4. Bacterial spot and speck
Cultural
• Rotation-2-3 years to non solanaceous crops
• Destroy plant residue-sanitation

Organic
• Copper applications
• Oxidate applied to foliage-poor

Synthetic
• Actigard or fixed copper and mancozeb or ManKocide or Cuprofix MZ
• Streptomycin on transplants only
5. Powdery and Downey Mildews

Different races of both
Cultural
- Reduce overhead watering-PM, DM
- No late season N additions-PM
- Do not compost infected leaf material-PM
- Resistant or tolerant cultivars-PM, DM

Organic
- Oxidate applied to foliage-poor

Synthetic
- PM – chlorothalonil + Rally or Folicur or Procure
- DM – chlorothalonil + Presidio or Ranman or Tanos
6. Fruit Rots
Cultural
- Good field drainage
- Clean seed
- Keep fruit from contacting soil
- Do not over apply nitrogen
- Destroy crop residue

Organic
- Oxidate applied to foliage/fruit - very poor

Synthetic
- Chlorothalonil + Revus or Presidio or Gavel or Ranman or Tanos or Forum
6. Fusarium and Verticillium Wilts
Cultural

- Rotation-4-6 years to non solanaceous crops and if VW no straw- or raspberries, no weeds
- Destroy plant residue-sanitation
- Resistant tomato cultivars-for races 1, 2, 3, but few other vegetables have resistance

Organic

- Use cover crops to reduce incidence of fusarium

Synthetic

- Soil Fumigation
7. Gummy stem blight
Cultural
- Rotation-3 yrs no cucurbits
- Use clean seed
- Destroy crop residue

Organic
- Oxidate applied to foliage – moderate - poor

Synthetic
- Do not use FRAC 11 group-Cabrio, Quadris
- Use: Chloro + Pristine or Switch or Folicur or Inspire Super
8. Viruses and Bacterial wilt
9. Damping-off

*Rhizoctonia solani*, *Pythium* spp., *Phytophthora* spp., *Sclerotinia* spp., and *Botrytis* spp.
Cultural
• Plant seed in warm soil
• Do not over water
• Use clean seed

Organic
• **Mycostop:** *Streptomyces griseoviridis*
  • **Plantshield:** *Trichoderma harzianum* strain T-22
Both colonize plant roots to provide preventative biological protection

Synthetic
• Use treated seed
• Use in a band-mefenoxam or metalaxyl
10. Root knot nematode
Cultural
- Fallowing-no crop or weed for 3-5 months
- Crop rotation to broccoli, cauliflower
- Resistant cultivars-VFN

Organic
- Canola or brassicas as cover crops tilled under and allowed to sit for a few days-week

Synthetic
- Soil fumigation
- Vydate
Weeds

Physical

Chemical
Physical:

• Hand Pulling

• Cultivating Machine Hand

• Smother-mulching Organic Plastic
Chemical Controls
Preplant Incorporated
Apply 1 gallon per acre Alanap 2SC as a preplant incorporated (2 inches) treatment before seeding or transplanting. Weed control may not be satisfactory on sandy soils with less than 1 percent organic matter.

Apply 1 to 1.5 gallons of Prefar 4EC plus 1 gallon Alanap 2SC as a preplant incorporated (2 inches or less) treatment.
Preemergence

Apply 1 to 2 pints per acre Curbit 3E preemergence to control annual grasses and certain annual broadleaf weeds, including carpetweed and pigweed. Control of many other broadleaf weeds, including common lambsquarters, jimsonweed, morning glory, ragweed, mustard, and others may not be acceptable.

Dry weather following application may reduce weed control. Cultivate to control emerged weeds if rainfall or irrigation does not occur prior to weed emergence. **DO NOT** preplant incorporate. **DO NOT** apply under plastic mulch or tunnels. **DO NOT** use when soils are cold or wet. **Crop injury may result!**
Animal Pests
Benner's Deer Fencing is a high-strength, wire fence-like mesh (1.75 inch) material constructed of UV stable black polypropylene plastic. This deer fence comes in rolls that are 7.5 feet high ... and provides long-term deer protection without changing the appearance of the property.

The ultimate installed height of the fencing is approximately 7'. Six inches of the plastic fence grid is "flared" out onto the ground away from the protected area to keep deer from pushing underneath the fencing.

When Benner's Deer Fencing is first installed, white flagging streamers (included) need to be temporarily tied to the fencing every 10 feet so the deer do not run right into it.
DEER OUT™

DEER REPELLENT

SUPER LONG-LASTING - MINTY FRESH SCENT

100% NATURAL

“WORKS GREAT SUMMER, SPRING, WINTER, AND FALL”

WON’T WASH OFF!

MAKES 2.5 GALLONS
Questions

jbrust@umd.edu

http://extension.umd.edu/mdvegetables