Insect Management for Organic Vegetable Production

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► An overview of practices
  • Overall cultural practices ... rotations, altered planting dates, crop residue destruction, etc.
  • Pest exclusion and repellency
  • Recognizing and manipulating natural enemies (predators, parasites, and pathogens)
  • Organic insecticides: botanical and microbial insecticides, soaps, oils, and others
► A few specifics on ... sweet corn and cabbage

Learn about the pests ...

► Learn the life histories of major insect pests, disease, and weeds
► Learn to identify key insects, diseases, and weeds
► Understand WHY control is needed (if it is)
► Develop appropriate expectations
► Think critically ... do you really believe that a particular practice or product or organism can work as claimed? Is it harmless or appropriate just because it is organic?

Information sources

► Midwest Vegetable Production Guide
  • http://www.btny.purdue.edu/Pubs/ID/ID-56/
► Home, Yard, and Garden Pest Guide
  • Order from: https://webstore.aces.uiuc.edu/shopsite/C1391.html
► Home, Yard, and Garden Newsletter
  • http://www.ag.uiuc.edu/cespubs/hyg/html/

What about reduced tillage, weedy cultures, and interplantings?

► Stable habitats and crop residues favor survival of predaceous and parasitic insects
► Some plants are slightly repellent to certain insects
► “Complex” crop landscapes slow the buildup of some specialist pests
► Crop residues and weeds also favor the establishment and success of some pests
► Weeds may serve as winter / alternate hosts of crop viruses (CMV, for example)
► On the scale that affects insect movement and host plant identification and selection, ALL gardeners are practicing interplantings...
Natural enemies

- Predators, parasites, and pathogens
- To enhance their success...
  - Recognize them; know what they do
  - Minimize insecticide use
  - Use selective insecticides in selective ways
  - Maintain favorable habitats
  - Provide alternative foods (pollen, nectar, etc.)

Naturally occurring predators

- Aphid gourmets
  - Green lacewings
  - Lady beetles
  - Hover flies

Naturally occurring predators

- The unsung generalist
  - Insectivores
    - Ground beetles
    - Rove beetles
    - Predaceous bugs
  - Praying mantids
  - Birds and bats

Predators available for purchase

- Green lacewings
- Convergent lady beetle
- Spined soldier bug
- Praying mantids
- Predaceous mites (for greenhouses)

Parasites

- "Alien" in real life
- Most are very host-specific
- Importation, establishment, and conservation generally are more appropriate than purchase and release
- (Augmentation is more valuable in greenhouses than in most garden and field situations)

Parasites to purchase

- Encarsia formosa against greenhouse whitefly in greenhouse production
- Trichogramma ostrinia against Lepidopteran pests of vegetables, including sweet corn
  - Trichogramma spp. develop completely within the eggs of their host
Insect pathogens

► Viruses
► Bacteria
  • Bacillus thuringiensis (various subspecies)
► Fungi
  • Beauveria, Entomophthora, and Metarrhizium spp.
► Protozoa
  • Nosema spp.
► Nematodes
  • Steinernema & Heterorhabditis

Insecticides: Botanicals, microbials, and other alternatives

► Appropriate IF ...
  • they are low in toxicity to nontarget organisms ("selective")
  • they do not persist in the environment (and are not moved to unwanted destinations)
► Selectivity and short persistence are weaknesses as well as strengths

Insecticide references

► An Introduction to Insecticides, by George Ware, at
  • http://www.ent.agri.umn.edu/academics/classes/ipm/chapters/ware.htm
► Insecticides, Chemistries, and Characteristics, by Jeffrey Bloomquist, at
  • http://www.ent.agri.umn.edu/academics/classes/ipm/chapters/bloomq.htm

Botanicals

► Pyrethrins
  • From pyrethrin daisies
  • Axonic poisons
  • Low in toxicity to mammals
  • Very rapid breakdown ... no residual action
  • Used to kill fleas and lice on humans and pets; labeled for use on many fruits and vegetables
► Rotenone
  • From roots of Derris and other tropical legumes
  • Disrupts cellular respiration
  • Moderate toxicity to mammals (~ Sevin); very toxic to fish
  • Moderate persistence (~ Sevin)
  • Used against many pests, especially beetles
  • No longer on the NOP list of approved materials

Botanicals

► Sabadilla
  • From seeds of a tropical lily & European Veratrum spp.
  • Axonic poison
  • Very low in toxicity to mammals, but a severe membrane irritant
  • Breaks down very rapidly
  • Effective against squash bug, harlequin bug, and citrus thrips
  • Sabadilla & ryania are not available now
► Neem
  • From woody stems of S. American Rynia shrubs
  • Calcium channel poison
  • Low mammalian toxicity
  • More persistent than rotenone but less potent
  • Used against caterpillars in fruits and vegetables
  • Used medicinally
  • Very short persistence
  • Labeled on many crops and landscape plants, especially against soft-bodied insects
► Citrus oil components
  • Limonene and linalool
  • From citrus oils
  • Very short persistence
  • Low acute toxicity to mammals, but some evidence of chronic toxicity
  • Less toxic than crude citrus extracts
  • Mostly in pet shampoos, etc.
**Botanicals**

- **Nicotine**
  - From tobacco, other *Nicotiana* spp., others
  - Acetylcholine mimic
  - Very toxic to humans, orally and dermally
  - Very short persistence
  - Used in greenhouses against aphids, thrips, and mites
  - Not on the NOP list of approved substances

- **Citronella**
- **Pennyroyal**
- **Garlic**
- **Rosemary oil**
- **Hot pepper**

**Oils**

- **Dormant oils for fruit and landscape trees**
- **Stylet oils**
  - Reduce virus transmission, may suppress powdery mildew
- **Summer oils**
  - Against mites, aphids, other soft-bodied pests
- **Coverage is essential (upper and lower leaf surfaces); oils kill by suffocating pests that are sprayed directly**

**Insecticidal soaps**

- Salts of fatty acids
- Kill insects by disrupting membranes (including tracheal linings)
- Work only against those insects that are wetted by the spray ... no residual action
- Effective against aphids, whiteflies, mites, and other soft-bodied, not-too-mobile pests
- Best-known brand names are Safer’s and M-Pede
- Make your own? Generally ... NO !!!

**Absorbents & abrasives**

- **Clays, diatomaceous earth, silica aerogels**
  - Disrupt the insect’s cuticle and kill by dehydration
- **Kaolin ... “Surround”**

**Elemental and naturally occurring chemicals**

- **Sulfur**
  - Effective miticide (may cause plant injury)
- **Copper**
- **Arsenic no longer used**

**Microbials**

- **Bacillus thuringiensis kurstaki and aizawai**
  - Toxic only to Lepidopteran larvae (caterpillars)
  - Must be ingested to be effective
  - Degraded by ultraviolet light ... short residual activity on treated foliage
  - Good targets: Leps on cabbage, hornworms and fruitworm on tomatoes, European corn borer on sweet corn, etc.
  - Not effective against: larvae that bore or tunnel into plants without much feeding on the surface
  - Dipel, Agree, XenTari, and many others
Microbials

- *Bacillus thuringiensis tenebrionis*
  - effective against Colorado potato beetle larvae
- *Bacillus thuringiensis israelensis*
  - effective against larvae of black flies, fungus gnats, and some mosquitoes
- *Bacillus popilliae and Bacillus lentimorbus*
  - effective against larvae of Japanese beetles (but not very effective against other white grubs)
  - Trade Names include Doom, Japidemic, Milky-spore

Microbials

- Spinosads ... Entrust™ by Dow
  - Derived from a soil actinomycete
  - Effective against a range of insects, including corn earworm, Colorado potato beetle, the "worms" on cabbage and related cole crops, apple maggot, and (less so) codling moth

Microbials

- Viruses
- Fungi
- Protozoans
- Nematodes ... might be used against soil insects where moisture can be maintained

Alternatives in Insect Management

Biological and Biorational Approaches

- http://www.ag.uiuc.edu/~vista/abstracts/aaltinsec.html

A few specifics ...

- Sweet corn
- Cabbage and broccoli

Sweet corn

- Target pests
  - Seedcorn maggot
  - Cutworms
  - Corn flea beetle
  - Northern and western corn rootworms
  - Corn leaf aphid
  - Corn rootworm beetles, Japanese beetle
  - Corn earworm, European corn borer
**Site selection**

- Crop rotation
  - Any rotation except corn after corn used to avoid damage by corn rootworm larvae, BUT ...
  - Wireworms and white grubs most numerous following sod

- Avoiding seedcorn maggot damage
  - Greatest in soils high in organic matter, recently manured (including green manures); also greatest in cool, wet soils

**Planting dates**

- Earliest plantings ...
  - are least susceptible to EAR damage by corn earworm and fall armyworm

- Earliest plantings ...
  - are most susceptible to damage by seedcorn maggot (and cutworms)

**Hybrid selection**

- Plant Stewart’s wilt resistant hybrids
- No OMRI- or NOP-listed insecticides will control corn flea beetles well enough to reduce transmission adequately

**Controlling insect infestations**

- Rotenone
  - Some effectiveness against flea beetles, Japanese beetle, and rootworm beetles
- *Bacillus thuringiensis*
  - As sprays or granules, effective against European corn borer on whorl-stage corn
- (Rynia) + rotenone + pyrethrins
  - Sold to control ear-feeding Leps, but not very effective

**What about? ...**

- Corn earworm and corn borer ear damage
  - BTs and standard botanicals are generally NOT effective, especially against CEW (though transgenic BT sweet corns are less damaged by earworms and related pests)
  - Entrust
  - *Trichogramma ostriniae*
  - Oils (garlic, SunSpray, etc.) on ear tips?
  - Early plantings escape peak infestations
  - Chopping ear tips
  - Hybrid selection
Cabbage and broccoli

- Target pests
  - Cabbage maggot
  - Flea beetles
  - Cabbage aphid, turnip aphid, green peach aphid
    - Virus transmission is NOT an issue in the midwestern US
  - "Leps" ... cabbage looper, imported cabbage worm, diamondback moth

Site selection and residue management

- Crop rotation
  - More important for disease than insect control
  - Some benefit against maggots and cabbage aphid

- Residue destruction
  - Removes host plant material for root maggots, diamondback moth, others

Planting dates and varieties

- Earliest plantings are more susceptible to cabbage maggot damage (more a northern than southern pest)
- Lepidopteran pests and aphids are more numerous in later plantings

Early-season practices

- Buy transplants free of aphids and diamondback moth larvae
- For flea beetle control ... rotenone or floating row covers
- Row covers also exclude egg-laying adults of cabbage maggot and Lepidopterans (caterpillars)

Cabbage aphid

- Row covers provide early protection
- M-Pede (insecticidal soap) or neem
- Little or no data support use of garlic oil
- Rogue out infested plants
**“Leps”**

- Larvae of moths and butterflies
  - cabbage looper
  - imported cabbage worm
  - diamondback moth
- Populations increase through the summer

**Thresholds:** based on % plants infested with live larvae of any of the 3 species ...
- Seedbed: 10%
- Broccoli and cauliflower
  - Before flowering: 50%
  - Maturing heads: 10%
- Cabbage
  - Before cupping: 30%
  - Cupping to early head: 20%
  - Maturing heads: 10%

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**For Lep control ...**

- Row covers provide early protection
- *Bacillus thuringiensis kurstaki / aizawai* ... Dipel, Agree, XenTari, and others
  - Most effective against young larvae
  - Least effective against cabbage looper
  - Diamondback moth resistance to Bt evolved in Hawaii and Florida as a result of field use in crucifers

**In all vegetable crops, what benefits do weedy cultures and interplantings offer?**

- "Homes" and food sources for beneficial insects (predators and parasites)
- Nonfood "dilution" for specialist pests
- Sources for pest insects
- Sources of crop viruses
- Small-flowered plants are best for natural enemies ... umbelifers and clovers