SAFE & EFFECTIVE USE OF ORGANIC PESTICIDES

UConn Extension Scaling UP for Beginning Farmers
East Windsor, CT
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Lisa McKeag
UMass Extension Vegetable Program
lmckeag@umext.umass.edu
They’re organic…what’s the big deal??

- Use is regulated by the Federal government

- Can cause eye irritation or be harmful if inhaled, swallowed, or absorbed by skin

- Can be toxic to bees and other non-target organisms

- Need to be applied to the right pest at the right time at the right rate to work

- Improper use can damage your crop

- They’re expensive! Waste of time and $$$ if not used correctly
Overview

• What is a pesticide?
• Pesticides & IPM
• Modes of action
• Efficacy…it’s complicated
• Types of pesticides & some examples for insect and disease control
• Helpful resources
What is a pesticide?

The EPA defines a pesticide as:

Any substance or mixture of substances intended for preventing, destroying, repelling, or mitigating any pest; or any plant regulator, defoliant, or dessicant.

For commercial agricultural use, MUST:

• have an EPA registration number, or...
• be classified as EXEMPT (minimum risk)
• be registered for use in the state where it will be used
• Consists of one or more active ingredients (AI) and inert ingredients
• Even if AI is allowed in organic production, inert ingredient(s) may prevent it from being approved by OMRI
• Organic pesticides are generally derived from natural sources with little or no processing, as opposed to “conventional” pesticides, which are generally synthetic.
ACTIVE & INERT Ingredients

ACTIVE:
The substance that is responsible for the pesticidal activity.

INERT:
• The inactive materials in a pesticide that make the product usable, but do not possess pesticidal activity, although some may be toxic or hazardous.
• Don’t have to be identified on label, just %.
• Generally same USDA-NOP standards apply for OMRI approval.

ACTIVE INGREDIENT:
*Bacillus thuringiensis, subsp. kurstaki, strain ABTS-351, fermentation solids, spores, and insecticidal toxins* 54%  
OTHER INGREDIENTS 46%  
TOTAL 100%

*Potency: 32,000 Cabbage Looper Units (CLU) per mg (14.5 billion CLU per pound).
The percent active ingredient does not indicate product performance and potency measurements are not federally standardized.

This product contains 0.34 pounds of azadirachtin per U.S. gallon.
OMRI

- Organic Materials Review Institute
- Non-profit 3rd party review board recognized by the USDA National Organic Program. Reviews inputs for use in organic production of food, fiber, and feed.
- OMRI products list: crop pest, weed, and disease control (pp 39 to 53: pesticides)
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Integrated Pest Management (IPM) is:

- an ecologically based pest control strategy that relies upon cultural practices to:
  - maintain crop health
  - encourage natural controls
  - prevent or minimize insect and disease incidence
- It is also a decision making process utilizing regular monitoring of the crop and pests, with least toxic pesticides used sparingly and at the right time.
- This approach is applicable to any scale of gardening and farming, and to any crop or plant management system.
Pesticides & organic IPM

Integrated Pest Management (IPM) is:

- an ecologically based pest control strategy that relies upon cultural practices to:
  - maintain crop health
  - encourage natural controls
  - prevent or minimize insect and disease incidence
- It is also a decision making process utilizing regular monitoring of the crop and pests, with OMRI listed pesticides used only sparingly and at the right time.
- This approach is applicable to any scale of gardening and farming, and to any crop or plant management system.
IPM

1. Knowledge (pests, crops, weather)

2. Prevention (cultural practices)

3. Monitoring & Thresholds

4. Intervention (biological, chemical)

All photos, Umass Ext
The Action Threshold: prevent losses from pest damage

above EIL, benefit > cost

control

below EIL, cost > benefit

pest population without control

EIL

Action threshold

Figure credit: Ed Zaborski, University of Illinois
Overview

• What is a pesticide?
• Pesticides & IPM
• Modes of action – how do they work?
• Efficacy…it’s complicated
• Types of pesticides & examples
  for insect and disease control
• Helpful resources
Mode of Action - Insecticides

- The way a pesticide exerts a toxic effect on the pest.

Growth and development

Nerve and muscle targets

Respiration targets

Midgut targets

And others...

Figure from E. Cook, Cornell Cooperative Ext. Pesticide Basics Course
Mode of Action – Fungicides & Bactericides

- The way a pesticide exerts a toxic effect on the pest.

**Plant defense activator:** stimulates plant immune response, defense signaling.

**Coppers:** kills microbial cells on contact.

**Biological, microbial pesticide:** fungi or bacteria that are antagonistic to pathogens directly or indirectly - antibiotic compounds, trigger plant immune responses, outcompete pathogenic microbes.

Trichoderma directly parasitizing other fungus
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Efficacy trials…it’s complicated

- When registering products, EPA evaluates materials for human and environmental safety risks, not efficacy
- Companies and outside researchers, Universities do trials to get information on efficacy
- Show whether an A.I. had a significant effect vs controls
- Trial field and laboratory conditions differ from on-farm
  - Include untreated control plots – increase pest #s or inoculum
  - May not reflect on-farm pressure – higher or lower
  - On-farm use should incorporate multiple pest mgmt strategies
- Need many trials and replications to get reliable data
- So many new products, and SO MANY pest:crop combinations, esp with diseases. Need an army of researchers!
Good = 75% or more control compared to untreated
Fair = 50-74%
Poor = <50%

Figure 1. Efficacy of spinosad against insect pests.
Good = 75% or more control compared to untreated
Fair = 50-74%
Poor = <50%

Figure 1. Efficacy of *B. subtilis* products against diseases of vegetable crops
COLORADO POTATO BEETLE IN POTATOES – LARGE LARVAE

2012: S. Menasha & D. Moyer
LIHREC, Riverhead
Colorado Potato Beetle Control in Potatoes – Defoliation & Yield

2012: S. Menasha & D. Moyer
LIHREC, Riverhead
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Types of organic pesticides
to control insects (insecticides) and diseases (fungicides, bactericides) all fit into general categories:

- Microbial and microbial-derived
- Minerals
- Inorganic chemicals
- Botanicals
- Oils
- Synthetics
- Elements

Photo from E. Cook, Cornell Ext, Organic Pesticides Course
## Common Organic Insecticides

<table>
<thead>
<tr>
<th>Active Ingredient</th>
<th>Product Example</th>
<th>Material Type/Source</th>
<th>How it works (MoA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spinosad</td>
<td>Entrust SC</td>
<td>Microbial-derived</td>
<td><strong>Contact &amp; ingestion:</strong> nerve targets</td>
</tr>
<tr>
<td>Pyrethrum</td>
<td>Pyganic EC5.0</td>
<td>Botanical</td>
<td><strong>Contact:</strong> nerve targets</td>
</tr>
<tr>
<td><em>Bacillus thuringiensis</em> sub. <em>kurstaki</em></td>
<td>Dipel</td>
<td>Microbial-derived</td>
<td><strong>Ingestion:</strong> Gut disrupter</td>
</tr>
<tr>
<td>Kaolin clay</td>
<td>Surround WP</td>
<td>Mineral</td>
<td><strong>Physical barrier,</strong> irritant, repellant, some disease suppression</td>
</tr>
<tr>
<td><em>Beauveria bassiana</em></td>
<td>Mycotrol O</td>
<td>Microbial (biological)</td>
<td><strong>Contact</strong> infection with fungal spores</td>
</tr>
<tr>
<td><em>Chromobacterium subtsugae</em></td>
<td>Grandevo</td>
<td>Microbial</td>
<td><strong>Ingestion:</strong> multiple targets</td>
</tr>
<tr>
<td>Petroleum oil</td>
<td>JMS Stylet Oil</td>
<td>Oils</td>
<td><strong>Contact,</strong> mainly respiratory targets</td>
</tr>
<tr>
<td>Neem (Azadirachtin)+ Pyrethrum</td>
<td>Azera</td>
<td>Botanical</td>
<td><strong>Contact,</strong> Neem: Insect growth regulator, feeding &amp; oviposition inhibitor; pyrethrum: nerve toxin</td>
</tr>
</tbody>
</table>
A.I. composed of spinosyns A and D, substances produced by aerobic fermentation of the bacterial actinomycete species *Saccharopolyspora spinosad*.

**HOW IT WORKS:** acts on insects through ingestion or by direct contact. It affects the nervous system, causing loss of muscle control. Continuous activation of motor neurons causes insects to die of exhaustion within 1-2 days.

**USE CONSIDERATIONS:**
- Resistance concerns
- Breaks down in sunlight, but has some residual and some translaminar activity
- Highly toxic to bees when wet, low toxicity to beneficials when dry

In laboratory and field trials, Has shown control of:
- VERY GOOD Colorado Potato Beetle – larvae only
- VERY GOOD Caterpillars
- GOOD Cabbage Flea beetles
- FAIR- GOOD Onion thrips
Pyrethrum

PRODUCTS: Pyganic 1.4, 5.0; Azera

A.I. composed of dried flower heads of the pyrethrum daisy, chiefly Chrysanthemum.

**HOW IT WORKS:** On contact, affects insects’ nervous system causing paralysis

**USE CONSIDERATIONS:**
- Breaks down rapidly in sunlight, little residual ~1 day. May last longer in GH.
- Non-selective: toxic to beneficials
- Spray early in morning before pollinators are out

In recent university field trials, has shown 61-100% pest reduction relative to untreated control:

<table>
<thead>
<tr>
<th>IN</th>
<th>ON</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cabbage</td>
<td>Imported Cabbage Worm</td>
</tr>
<tr>
<td>Tomato, Cuke, Lettuce</td>
<td>Greenhouse whitefly</td>
</tr>
<tr>
<td>Cabbage</td>
<td>Cabbage aphid</td>
</tr>
<tr>
<td>Potato</td>
<td>Potato aphid, potato leafhopper, CPB, potato flea beetle</td>
</tr>
<tr>
<td>Onion</td>
<td>onion thrips</td>
</tr>
</tbody>
</table>
**Bacillus thuringiensis** (Bt)  
**PRODUCTS:** Agree, Dipel, Javelin, Gnatrol (different species of Bt).

**A.I.** composed of proteins produced by Bt bacterium. (subsp *aizawi* & subsp *kurstaki*)

**HOW IT WORKS:** Eaten by insect, crystalline protein destroys gut

**USE CONSIDERATIONS:**
- Breaks down in sunlight within a few days
- Must be ingested, Apply where and when insects are feeding
- Minimal impact on natural enemies, though will kill non-target caterpillars
- Resistance may be an issue
- Many species. *Bt var. san diego* and var *tenebrionis* are effective against CPB larvae. Not produced in US, but US companies have patents, and may bring to market if a need is demonstrated.

**Shown to have good efficacy in trials against:**  
Cabbage looper, cross-striped cabbage worm, diamondback moth, imported cabbage worm, and various other lepidoptera. Also CPB for those specific strains.
**Kaolin Clay**  
**PRODUCTS: Surround WP**

**A.I.** is a naturally occurring clay, ground and processed into uniform particles

**HOW IT WORKS:**
Physical barrier, repellent, irritant, interferes with insect’s host finding capability by masking color cues. Possible suppression of diseases; reduces plant heat stress.

**USE CONSIDERATIONS:**
- Do not mix with copper or sulfur
- Big particles, agitation necessary
- Can clog equipment
- Inhalation of dust can cause lung damage

**In field trials:**
- Effective against many orchard pests. Inconclusive data on many veg crops.
- Significantly reduced feeding & oviposition, and increased larval mortality of onion thrips
**Beauvaria bassiana**  
PRODUCT: Mycotrol O

**A.I.** Living spores of *Beauvaria bassiana*, a fungus commonly found in soils

**HOW IT WORKS:** Fungal spores attach to insect’s cuticle by direct spray or treated surface. Fungal hyphae penetrate body and infect. 3-5 days to kill insect. Also spread through mating.

**APPLICATION CONSIDERATIONS:**
- High humidity, cool-moderate temperatures, and free water enhance infection = evening spray; after rain.
- Good coverage to ensure contact with insect essential (undersides of leaves).

**In field trials:**
- Affects many insect groups, but inconsistent results
- Promising results on caterpillar complex on cabbage
- CPB: May be good rotational tool where spinosad resistance
Neem PRODUCTS:

**Azadirachtin-based products**
Include AZA-Direct, Azatrol, Neemix, Azera.

**Neem oil products**
Trilogy is neem oil that has had the azadirachtin and at least some other components separated from it.

**ACTIVE INGREDIENT:** Azadirachtin

**HOW IT WORKS:** Insect growth regulator; anti-feedant and egg-laying deterrent. May have systemic properties when applied to root zone.

**APPLICATION CONSIDERATIONS:**
- Make multiple applications starting when plant is young - does not persist well on plant surfaces.
- Target pests in larval form, as it is a growth regulator.

**In trials:**
Generally good control of aphids, fair to good against CPB, promising against squash bugs.
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<tr>
<td>Copper hydroxide</td>
<td>Champ WG</td>
<td>Mineral</td>
<td>Denaturation of cell proteins on contact</td>
</tr>
<tr>
<td><em>Bacillus subtilis</em></td>
<td>Serenade Soil – soil</td>
<td>Microbial</td>
<td>Produces proteins that outcompete or kill pathogen</td>
</tr>
<tr>
<td><em>Trichoderma harzianum</em></td>
<td>Serenade Max – foliar</td>
<td>Microbial</td>
<td>Outcompetes pathogen on root or leaf surface, parasitizes or kills pathogen</td>
</tr>
<tr>
<td>Hydrogen peroxide</td>
<td>Oxidate</td>
<td>Inorganic chemical</td>
<td>Oxidizes &amp; disrupts cell membranes on contact</td>
</tr>
<tr>
<td>Potassium Bicarbonate</td>
<td>MilStop</td>
<td>Mineral</td>
<td>Disrupts pathogen cell walls on contact</td>
</tr>
<tr>
<td><em>Coniothyrium minitans</em></td>
<td>Contans</td>
<td>Microbial</td>
<td>Destroys pathogen sclerotia (resting structures) in soil</td>
</tr>
<tr>
<td>Sulfur</td>
<td>Dusting Sulfur</td>
<td>Element</td>
<td>Contact, Inhibits pathogen spore germination</td>
</tr>
</tbody>
</table>
Copper

**PRODUCTS:** Cueva, Champ WG, Nordox 75 WG, Nu Cop

A.I. is any of a number of forms of coppers - copper hydroxide, copper oxide, copper octanoate, copper sulfate

**HOW IT WORKS:** Toxic copper ions absorbed by germinating spores which disrupts protein function.

**APPLICATION CONSIDERATIONS:**
- Apply preventively; reapply to new plant growth or after rain
- Remains on leaf 1-2 weeks if no rain
- Can be phytotoxic
- Kills bio-pesticides (Bacillus, Trichoderma, etc)
- Toxicity to humans varies with form. Copper sulfate is acutely toxic to humans.

- Most effective material available for organic growers
- Labeled for use on over 100 crops against fungal and bacterial pathogens
- More effective against bacteria, but widely used to control both bacterial and fungal pathogens of tomato, as well as oomycete pathogen that causes late blight
- **POOR** results in trials in cucurbits for Phytophthora, downy mildew, anthracnose onions for purple blotch, brassicas for black rot, bacterial spot & Alternaria
**Bacillus subtilis**

**PRODUCTS:** Serenade Max, Serenade Soil

**A.I.:** *Bacillus subtilis*, a ubiquitous, naturally occurring, saprophytic bacterium that is commonly recovered from soil, water, air, and decomposing plant material.

**HOW IT WORKS:**
Lipopeptide antibiotics produced by B. subtilis inhibit pathogen spore germination, interfere with attachment to host, and destroy cell membrane of plant pathogens.

**In trials:**
- Good results against onion diseases & powdery mildew on GH tomatoes
- Use may allow for reduced application of other fungicides, such as copper

**Untreated root and root treated with biocontrol bacterium. Lipopeptides, polysaccharides and antibacterial compounds activate the plant’s own defense mechanisms.**
Trichoderma harzianum

PRODUCTS: RootShield, PlantShield

- There are many different Trichoderma species, and different product names
- Very little data as to efficacy

Typical coiling action of *Trichoderma harzianum*, around a plant root, providing protection from root-attacking pathogens.

cf. Matt Krause, BioWorks

*Trichoderma harzianum*, attacking a hyphal strand of *Rhizoctonia solani* using enzymes to degrade the cell wall of the pathogen.
Sulfur

PRODUCTS:  Micro Sulf; Microthial Disperss, ProNatural, Micronized Sulfur, Sulfur DF; Rex Lime-Sulfur Solution

A.I.  elemental sulfur, lime sulfur

HOW IT WORKS: inhibits spore germination and growth by permeating the cell wall. Some evidence sulfur is a component of induced defense mechanisms of some plants.

APPLICATION CONSIDERATIONS:

- Best applied preventatively, some curative ex. Apple scab
- Non-toxic to birds, honeybees, aquatic organisms.
- Lime sulfur can be fatal if inhaled, swallowed, or absorbed through the skin. It is extremely caustic and can cause irreversible eye damage and skin burns.
- Phytotoxicity potential. Do not spray with or close to an oil application.

- Most effective against powdery mildews in several fruit and vegetable crops
The take-home

- Organic pesticides are a useful tool when incorporated with other crop health and pest management strategies.
- Efficacy trials provide very useful data for decision-making, but many more trials are needed for the many organic products available – results so far are variable and not conclusive – and efficacy depends on proper use.
- If you are going to use a pesticide, do a little research – know how and why it works, so you know how and why to use it.
- Consider:
  - Source – Mineral? Microbial? Is it alive? How does it work on the pest?
  - Rate – Always follow labels; recommended rates based on trials.
  - Time – Use action threshold, based on scouting.
  - Place – Know crop and pest life cycles; right crop, right pest, right time.
Other considerations for improving efficacy

• Choosing the right (organically-approved) adjuvant can be key – a whole other talk!

• Test & adjust pH

• Get good coverage
  ✓ Sprayer calibration
  ✓ Know your nozzles
  ✓ Test coverage with droplet cards

• Follow label recommendations for minimum gal/A
UMass Resources on Organic Pest Mgt.

- New England Vegetable Management Guide
  - www.nevegetable.org
  - Photo ID guide
  - OMRI listed products, IPM, biocontrols, organic fertility, cover crops

- UMass Vegetable Notes
  - www.umassvegetable.org
  - Subscribe to free email
  - Weekly during growing season
  - ‘heads up’ on what to watch for, how, when, what to do, cultural practices, etc.
  - And more!
  - ~50% of subscribers are organic
Cornell Resource Guide for Organic Insect and Disease Management

• Resources

  Crop chapters

  Pest biology and cultural practices

  Material fact sheets

  Toxicity, efficacy, use recommendations

  Available as a free download or for purchase as hard copy

http://web.pppmb.cals.cornell.edu/resourceguide
Organic Pesticide Application

There is a frequent misconception that organic pesticides are safe and natural for anyone or anything beyond the target pest they kill. The reality is that organic pesticides can be just as dangerous—and are subject to the same rules and regulations—as conventional pesticides.

This self-directed course provides safety and compliance information to anyone who will be applying organic pesticides.

- Pesticide Basics
- Pesticide Rules and Regulations
- Pesticide Safety & Risk Management
- Interpreting Pesticide Labels
- Organic Pesticide Products

- Free, but need to create a login.
- Some regulatory info specific to New York State

Emily Klamberg Cook
Cornell Cooperative Extension of Ulster County
ekc68@cornell.edu
845-340-3990
MDAR Pesticide Program
http://www.mass.gov/eea/agencies/agr/pesticides/

Crop Data Management Systems
http://www.cdms.net/

Database of pesticide labels & supplemental labels

National Pesticide Information Retrieval System

Search up-to-date EPA registrations by state
Thank you

Ruth Hazzard, Katie Campbell-Nelson, & Susan Scheufele
UMass Vegetable Program

Emily Cook, Cornell Cooperative Extension

Cornell Resource Guide for Organic Insect and Disease Management for material info & efficacy data and figures