Integrated Pest Management (IPM)

for Master Gardener Volunteer Training




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The Ohio State University

Topics

- IPM definition
- Components of IPM
- Overview of tactics
- Examples

‘Pest’

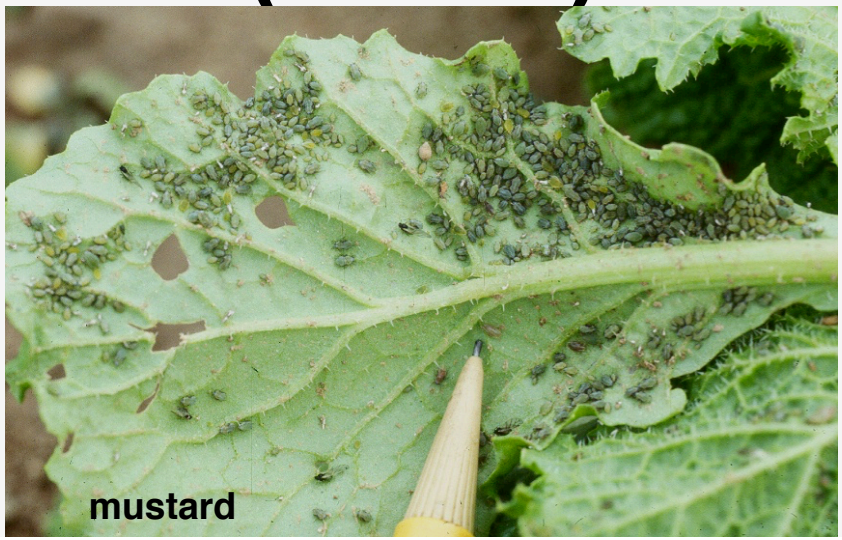
- **Insects**
- **Disease-causing microbes**
- **Weeds**
- **Vertebrates**

Insect roles

- The bad
  - –Pests
- The good
  - –Natural enemies
  - –Pollinators
  - –Decomposers
- The neutral

Types of pests: based on damage

- Direct damage
- Indirect damage
- Disease transmission (vector)
- Contamination



Types of pests: based on frequency of occurrence

- Key pest
- Occasional, sporadic pest
- Rare pest
- Potential pest

Strategies of Pest Management

- **Acceptance (do nothing)**
- **Eradication**
  - —eliminate pest populations
- **Suppression**
  - —reduce pest to tolerable levels

Approaches to pest management by suppression: Organic *vs* other

- More concern with restoring checks & balances
- Willingness to use tactics:
  - More knowledge intensive
  - More labor intensive
  - More expensive
- Use chemicals or not???

Integrated Pest Management (IPM)

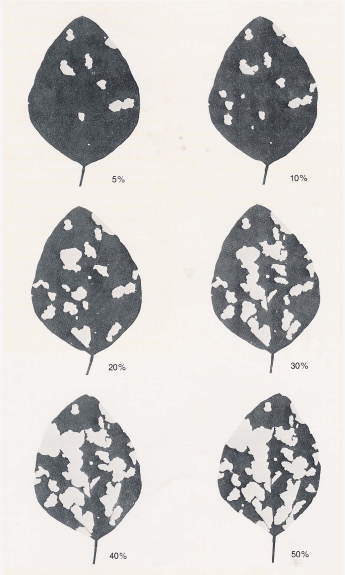
- a comprehensive approach to dealing with pests
  - strives to reduce pest status to tolerable levels
  - using multiple tactics
    - effective
    - economically sound
    - ecologically compatible

IPM

- Pros?
  - Potential for increased profit
  - Less hazardous
- Cons?
  - Information dependent
  - Can be labor intensive
  - Can be more expensive

Components of IPM

- **Monitoring**
- **Action thresholds**
- **Multiple tactics**

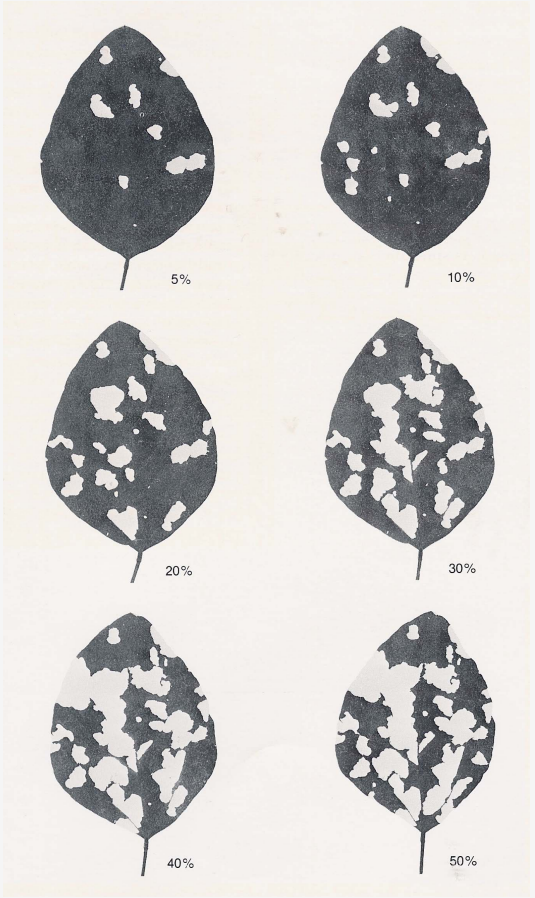


Monitoring

- **Techniques**
  - —Scouting
  - —Knockdown
  - —Sweeping
  - —Trapping

Monitoring by scouting

- **Evaluate pest:**
  - —presence/absence
  - —abundance
  - —life stage(s)
- **Evaluate damage** →
- **How often?**
  - —**Can be at regular intervals**
  - —**Can be at one critical time**

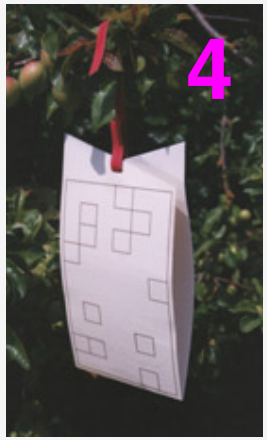


Monitoring by traps

- **Traps**
  - **for adults of species that damage as larvae**
    - **E.g.: Moth / caterpillar**

Pheromone Traps

- **Sticky**
  - 1 Open wing trap
  - 2 Closed wing trap
  - 3 Delta trap
  - 4 Scale trap
- **Bucket**
  - 5 Unitrap trap
  - 6 Multi-Pher trap
- **Net/cone**
  - 7 Heliothis trap *
  - 8 stink bug trap



Action Threshold

- **Pest density or amount of damage at which action should be taken to prevent an increasing pest population from causing economic damage**

Decisions on insecticide use in vegetable gardens

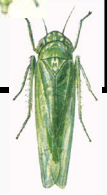
Treatment	*Action*
Low maintenance	Only if plant death imminent
Biorational	If above action threshold & some preventive
High input	Any sign of pest & some preventive

Preventive sprays:

alternative to threshold for some pests

Crop	*Target*	*Timing*
tomato	early blight & anthracnose	early July to mid-Sep
zucchini	powdery mildew	late July to mid-Sep
zucchini	squash vine borer	early July to early August

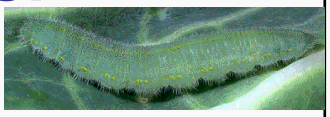
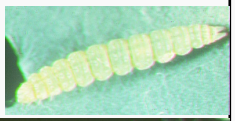
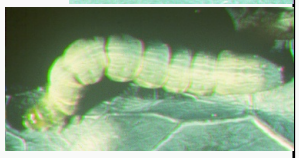
Action thresholds: beans

Pest	*Threshold*
Bean leaf beetle 	>1 beetle/seedling or >20% defoliation pre-pod or >10% defoliation after pods
Potato leafhopper  	1 nymph per 10 leaflets

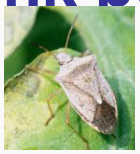
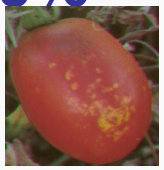
Action thresholds: zucchini

Pest	*Threshold*	*Insecticide*	
		Natural	*Synthetic*
Squash vine borer 	Preventive sprays as soon as moths active (1/wk for 4 wks)	pyrethrins + PBO	esfenvale-rate (Bug-B-Gon)
Cucumber beetles  	>0.5 beetle/leaf (seedling) >2 beetle/leaf (older)	pyrethrins + PBO	carbaryl (Sevin)
Squash bug  	>1 egg mass/plant	pyrethrins + PBO	esfenvale-rate (Bug-B-Gon)

Action thresholds: collards

Pest	*Threshold*	*Insecticide*	
		Natural	*Synthetic*
Flea beetles 	>5 beetle holes per leaf & >5 beetles per plant	pyreth-rins + PBO	carbaryl (Sevin)
Caterpillars: • Imported cabbageworm 	>1 larva/plant	B.t. (DiPel)	esfenvale-rate (Bug-B-Gon)
• Diamondback moth 	>2 larvae/plant		
• Cabbage looper 	>0.5 larva/plant		
Aphids 	>1 colony/leaf	soap	endosulfan (Thiodan)

Action thresholds: tomato

Pest	*Threshold*	*Insecticide*	
		Natural	*Synthetic*
aphids 	>1 colony/leaflet & no natural enemies	soap	endosulfan (Thiodan)
whiteflies  	>1 nymph/leaflet or >4 adults/leaflet	soap	esfenvalerate (Bug-B-Gon)
horn-worms 	>10% defoliation	B.t. (Dipel)	esfenvalerate (Bug-B-Gon)
Fruit-worm 	Any larvae in fruit	B.t. (Dipel)	esfenvalerate (Bug-B-Gon)
stink bug 	Damage on >10% or fruit  	pyrethrins + PBO	esfenvalerate (Bug-B-Gon)

Components of IPM

- **Multiple tactics**
  - **Preventive options**
  - **Remedial options**

IPM uses a combination of tactics

- Cultural
- Mechanical
- Biological
- Microbial
- Chemical
- Behavioral
- Host Plant Resistance
- Genetic
- Regulatory

Do chemicals fit in IPM or not?

IPM Continuum

No Chemicals

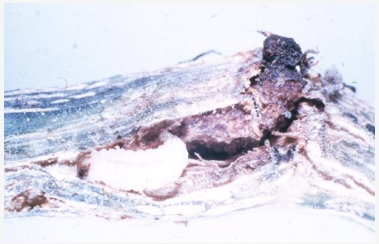
Intensive Chemicals

Cultural Control:

Minimize infestations by choosing appropriate crop management practices

- **Categories:**
  - —Crop selection
  - —Where crop is planted
  - —When crop operations occur
  - —How field is prepared & planted
  - —How crop is maintained

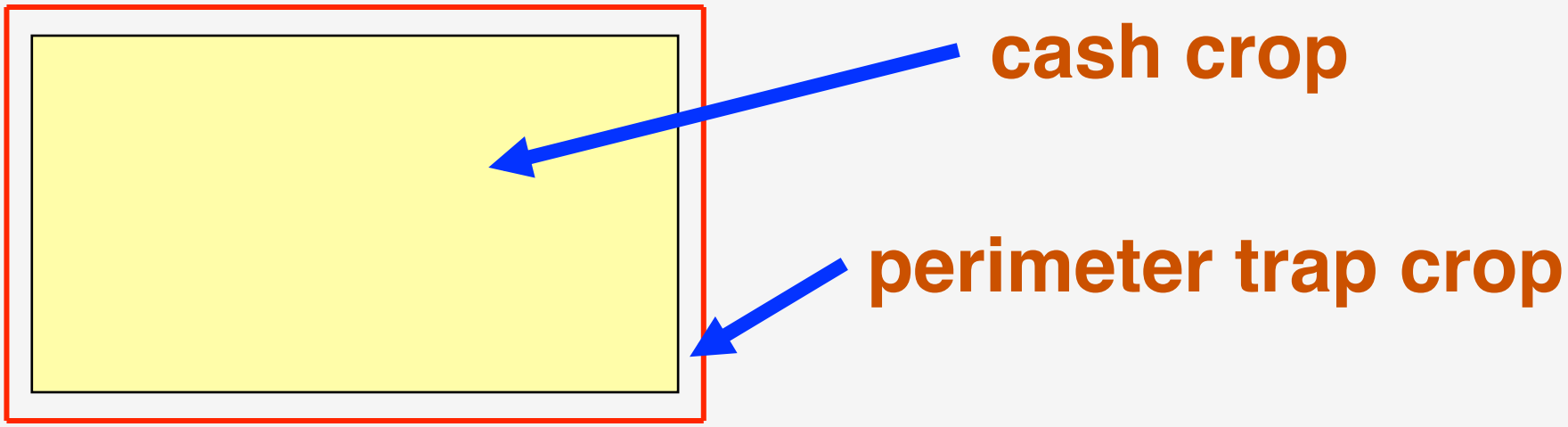
Delayed planting

- Cucumber beetle 
  - –Problem if plant in late May
  - –Less problem if plant in mid-June
- Squash vine borer 
  - –Same
- Bean leaf beetle
  - –Peak populations in May, July
  - –Fewer in June 

Trap cropping

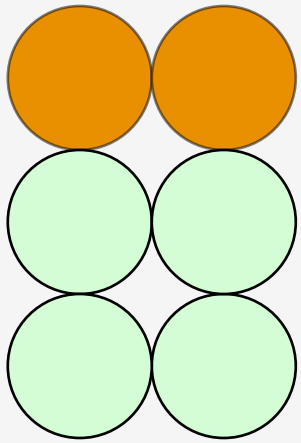
- Lure pest away from main crop to a more attractive crop
- Then kill the pest in trap crop
  - —Mechanical
  - —Chemical

Trap cropping



- **Planting time options**
  - **—Same time**
  - **—2 weeks early for trap crop**

Trap cropping adapted to garden scale



Squash, trap crop, planted 2 weeks early

Cantaloupe, Main crop

Trap cropping examples

Main crop	*Trap crop*	*Target pest*
cabbage	collards	diamondback moth
cabbage	kale	harlequin bug
cucumber	hubbard squash	cucumber beetles
peppers	sweet corn (late)	Europ. corn borer
potato	eggplant	Colo. potato beetle

Cultural control: trade-offs

E.g. Straw Mulch

- Benefits
  - —Moisture retention
  - —Weed suppression
  - —Reduces soil splash
  - —Reduces fungal spore dispersal
- Makes some pest problems worse
  - —E.g. cucumber beetles, slugs

Mechanical Control:

exclusion or removal practices that are done solely to control pests, not as part of routine cultural practices

Exclusion by barriers

- Row covers **
- Netting, screening
- Paper bags
- Localized shields
- Copper barriers
- Trenches (deep furrows)
- Plant collars
- Fences

Row covers to exclude pests

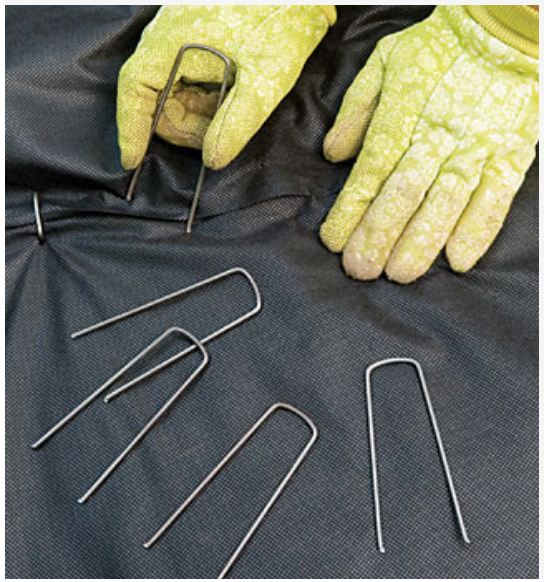
- Install on day of planting
- Remove
  - When first flowers appear (cucurbits)
  - At final harvest (broccoli, beans)

Row covers to exclude pests

- **Lightweight**
  - **—'Insect Barrier', 'Agri-bon 15'**
  - **—90% light transmission (vs 70-85% for heavier covers for frost protection)**
  - **—Sources:**
    - **Johnny's Selected Seed: $24. (10' x 50')**
    - **Gardens Alive: $10. (8' x 20')**

Row covers to exclude pests

- Use with or w/o hoops
- Must be anchored tightly



Cages to exclude garden pests

- **Bell cloche**
  - $30/3
- **Pest Control Pop-up**
  - $25 for 4’ x 4’ x 1’
  - $45 for 4’ x 4’ x 4’

(Gardeners Supply Company)

Exclusion by netting

- Periodical cicada
- Birds

Exclusion by fruit bagging

Paper bags:

- **Apples**
- **Grapes**

Exclusion of weeds: Weed block fabric

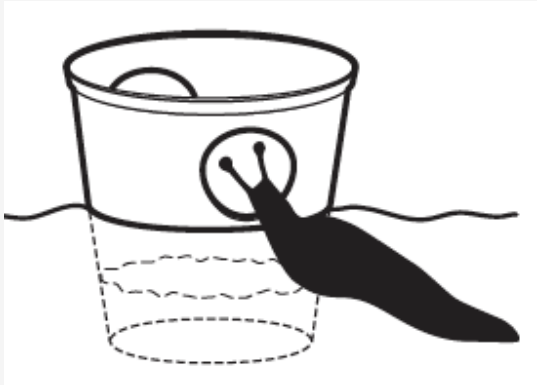
- ‘Heavy-weight woven ground cover, from A.M. Leonard, $96.49 per roll (6 ft x 300 ft)
- Held down by anchor pins (garden staples), $0.05 each

Exclusion of weeds: Newspaper mulch

- Cover by straw
- Also retains soil moisture

Mechanical Control by Removal

- Shelter traps →
- Attraction traps
- By beating/shaking *
- Removal by vacuum
- By aspirator
- Removal by hand



Removal by shelter traps

- **Board trap (shingle trap) for squash bug**
- **Tree bands for caterpillars**

Squash bug

Gypsy moth

Codling moth

Removal by attraction traps

- Dish of beer for slugs
  - Catches many slugs
  - Often not significant decrease in population

Removal by tapping or shaking

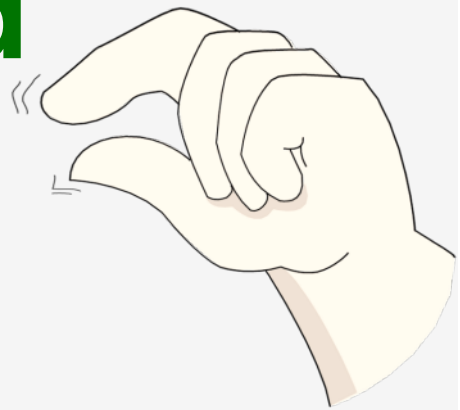
- Into bucket or tray
- By broom or snow shovel
- Daily
- Example: Colorado potato beetle (adults, larvae)

Removal by aspirator

- Aspirator = Mouth-operated suction device
- $8 – 14 from:
  - —BioQuip
  - —Forestry Suppliers
  - —Gempler's
- Good for flea beetles, bean leaf beetle, cucumber beetle

Removal by aspirator: Eggplant flea beetle

Removal by hand



- Labor intensive
- Target pests:
  - Conspicuous pests
  - Pests not too active
  - In relatively restricted area
- Examples
  - Spinach leafminer (infested leaves)
  - Hornworms
  - Asparagus beetle (eggs)
  - Japanese beetle

Sanitation

- Collect and destroy/compost:
  - —Culled fruit
  - —Crop residue (after harvest)
- Plant clean nursery stock

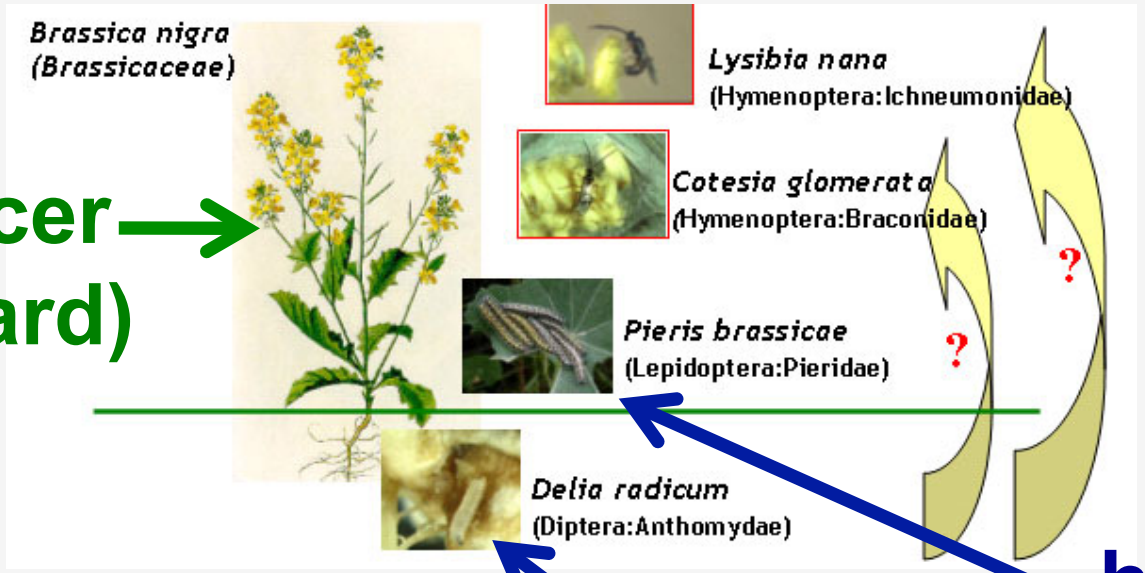
Biological Control

- Control of pest by other organisms that act as natural enemies

- Common natural enemies
  - –Predators

  - –Parasitoids

Garden ecology: is food chain balanced or unbalanced?

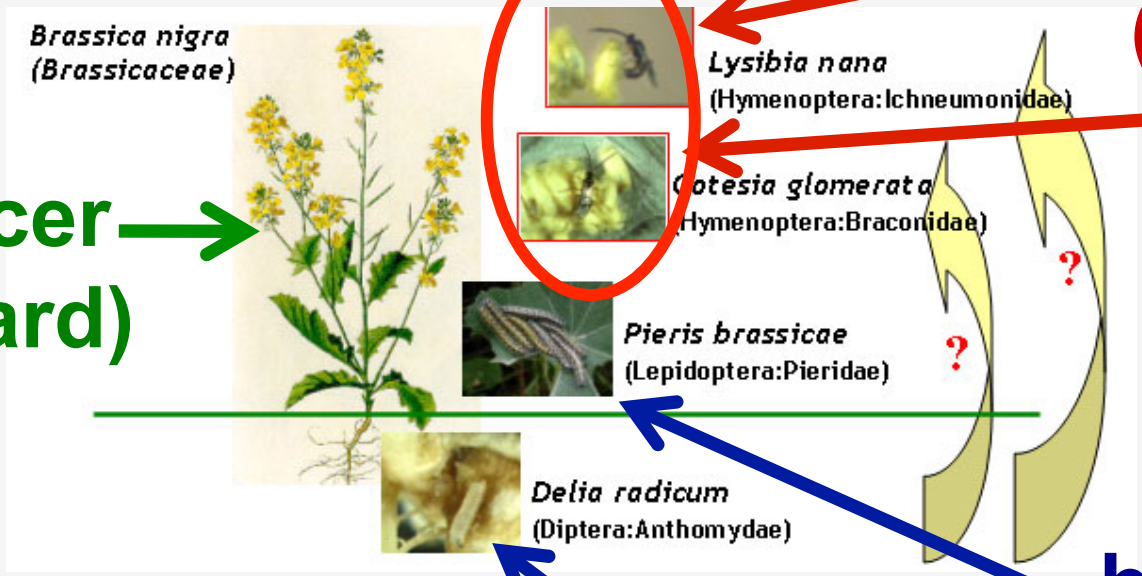


producer (mustard)

herbivore (cabbage maggot)

herbivore (imported cabbage-worm)

Garden ecology: is food chain balanced or unbalanced?



carnivores (parasitoid wasps)

producer (mustard)

herbivore (imported cabbage-worm)

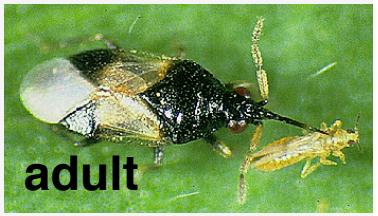
herbivore (cabbage maggot)

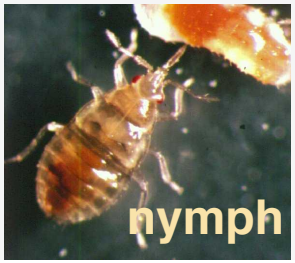
Biological Control: Predators

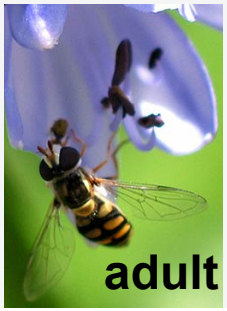
- Develop at expense of more than one prey item
- Predator often larger than prey
- Prey usually killed & consumed quickly

Predators

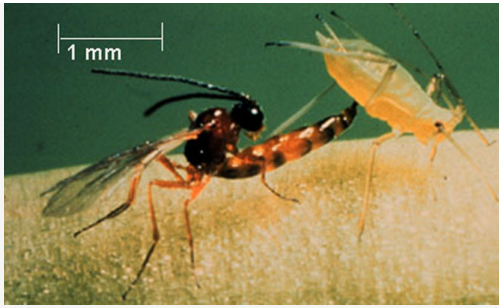
- Green lacewings
- Lady beetles
- Insideous flower bug
- Damsel bugs
- Hover flies

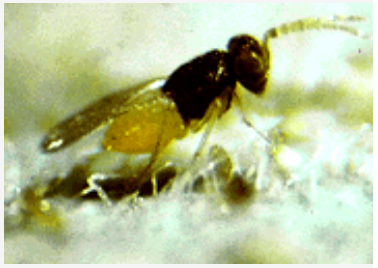






Biological Control: Parasitoids

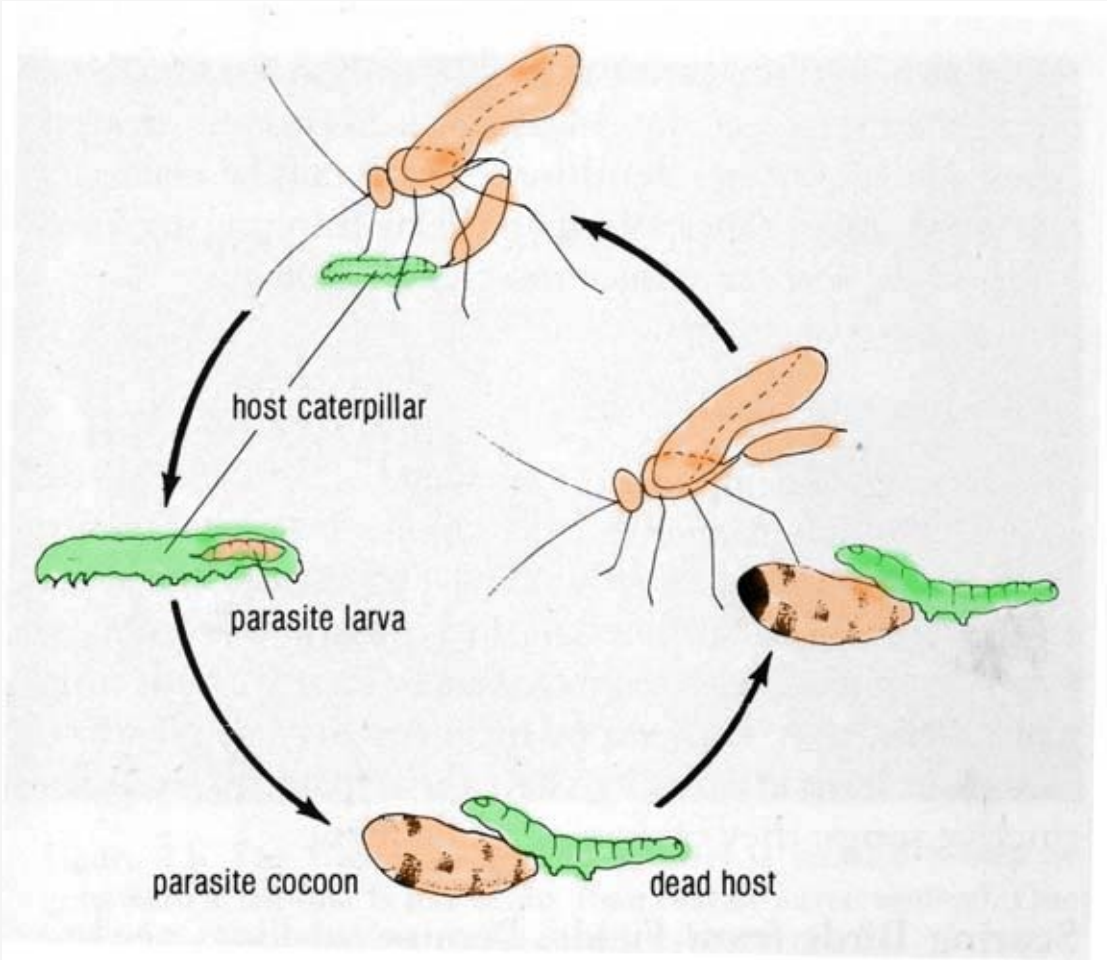




- Develop at expense of a single host
- Lay egg in or on host insect
- Host is usually killed slowly

Life Cycle of Parasitoid

Hyposoter **wasp attacking caterpillar**



Parasitoids

- Some wasps
  - Braconid wasps
    - On hornworm: *Cotesia congregata*
    - On imported cabbageworm: *Cotesia glomeratus*
    - On aphids: *Diaeretiella rapae*
  - Ichneumonid wasps
    - On diamondback: *Diadegma insulare*
- Tachinid flies
  - On squash bug: *Trichopoda pennipes*
  - On cucumber beetle: *Celatoria setosa*

& Vertebrate predators eat insects!

- Bats
- Toads
- Birds
- Geese
- Hogs

Biological control by conservation of local natural enemies

- **Tactics:**
  - —Avoid broad-spectrum insecticides
  - —Refuge planting for natural enemies
  - —Collect-&-transfer generalists

Insectary planting as refuge for natural enemies

- **Adult parasitoids need nectar**
- **Adult predators need pollen**
- **Plant flowering border to enhance biocontrol**

Biological control by augmentation of local natural enemies

- **Tactics:**
  - **—Buy from insectary →**
  - **—Collect and transfer**

Augmentation: Collect & transfer

- What to do?
  - —Hunt for generalist predators
  - —Collect them
  - —Transfer them to crop
- Who, where, when?
  - —Ladybug larvae on Spirea in May
  - —Lacewings & aphid midges on apple leaves in early June
  - —Damsel bugs on alfalfa, April-June

Chemical control

- Does chemical = nasty?
- Insecticides = chemicals that **kill** insects
- **'Chemical control'** can include chemicals that affect insects in ways <u>other</u> than <u>killing</u> them
- A widely used tactic

Pesticide Trends

- **Current type of products**
  - More ‘Reduced-risk’ products
  - More ‘Biological’ products
  - More options for organic gardens
- **Characteristics**
  - More expensive
  - More narrow-spectrum
  - Not as persistent
  - Smaller dose per area

Advantages of Chemical Control (conventional)

- Dependable
- Easy to obtain & apply
- Kill pest quickly
- Cheap (?)

Disadvantages of Chemical Control

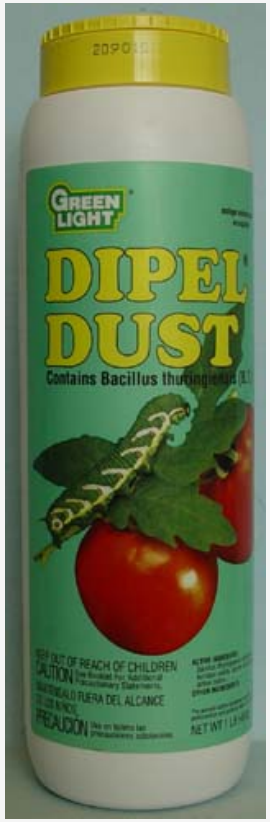
- Toxic to non-target organisms
  - Natural enemies
  - Pollinating bees
  - Humans
  - Wildlife & pets
- Environmental contamination
- Resistance can develop

Chemical control: categories

- By origin
  - Natural
  - Synthetic
- By mode of action
  - Nerve poisons
  - Suffocation agents
  - Respiration disruptors
  - Insect growth regulators

Insecticide choices

soap



B.t.

pyrethrins + PBO

Sevin

Bug-B-Gon (bifenthrin+zeta-cypermethrin)

Fungicide choices

copper soap

sulfur

Serenade
(*Bacillus subtilis*)

Fung-onil
(chlorothalonil)

OMRI: The Organic Materials Review Institute

- Certified organic growers
- List of products
- Crops & processing

Example of label with OMRI logo

Insect control products on OMRI List

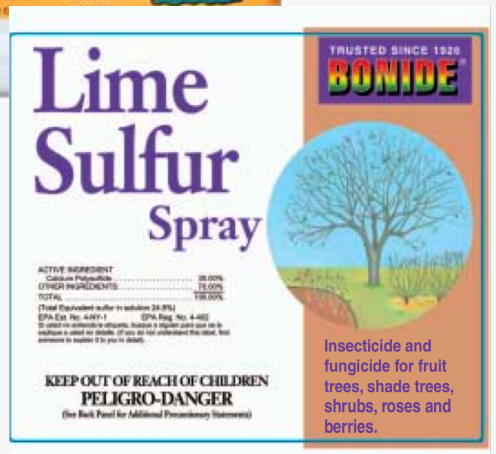
- **Behavioral control**
  - pheromone mating disruption
- **Microbial control**
  - viruses
  - bacteria: B.t. (DiPel)
- **Smothering agents**
  - soaps
  - oils
- **Nerve poisons**
  - spinosad (Entrust)
  - pyrethrins (PyGanic)
- **Repellents**
  - kaolin (Surround)
  - neem
  - garlic

Smothering or suffocation agents

- oils:
  - —from petroleum
  - —from plants
- insecticidal soaps:
  - —potassium salts of fatty acids

Minerals & elementals

- kaolin
- iron phosphate
- sulfur
- lime-sulfur



‘Surround At Home’

- A.I. = kaolin (clay)
- ‘Particle film technology’
- Broad spectrum crop protectant
- Photosynthesis not affected

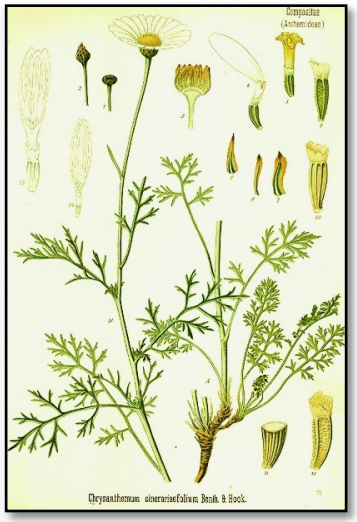
Abrasion agents: Diatomaceous earth

Insecticides from plants (botanicals)

- **pyrethrum** (chrysanthemum)
- **azadirachtin** (neem tree)
- **sabadilla**

Not on OMRI list:

- **nicotine** (tobacco)



Repellents from plants:

capsaicin & garlic

Microbial insecticides:

cause disease in insects

- Bacteria
- Viruses
- Fungi
- Protozoans
- Nematodes

Insecticides derived from microorganisms: spinosad

- Dow: **Entrust**
- Bonide: **Capt. Jack's Deadbug Brew**
- Fertilome: **Borer, Bagworm, Leafminer & Tent Caterpillar spray**
- GreenLight: **Lawn & Garden Spray Spinosad Concentrate**
- Monterey: **Garden Insect Spray**
- Gardens Alive: **Bulls-Eye Bioinsecticide**

Insecticides derived from microorganisms:

spinosad in 'Entrust'

- Excellent for caterpillar control
- Use 3 - 6 fl oz/acre
- $489/quart!

Nerve poisons

Carbamates
carbaryl (Sevin)

Organo-phosphates
(malathion)

Pyrethroids: 5 for food crops

permethrin

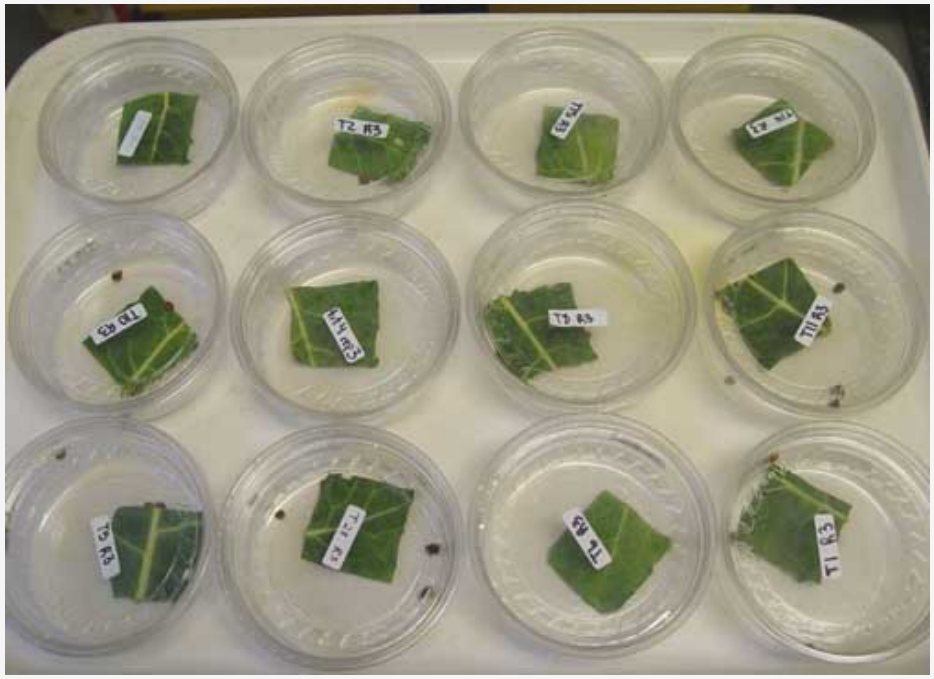
esfenvalerate

bifenthrin

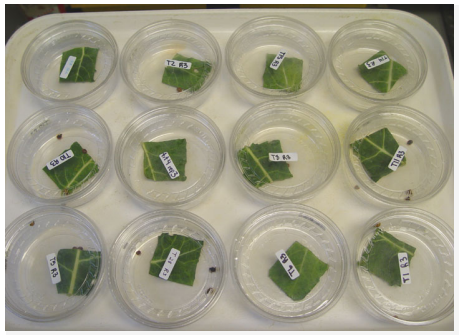
lambda-cyhalothrin

cyfluthrin

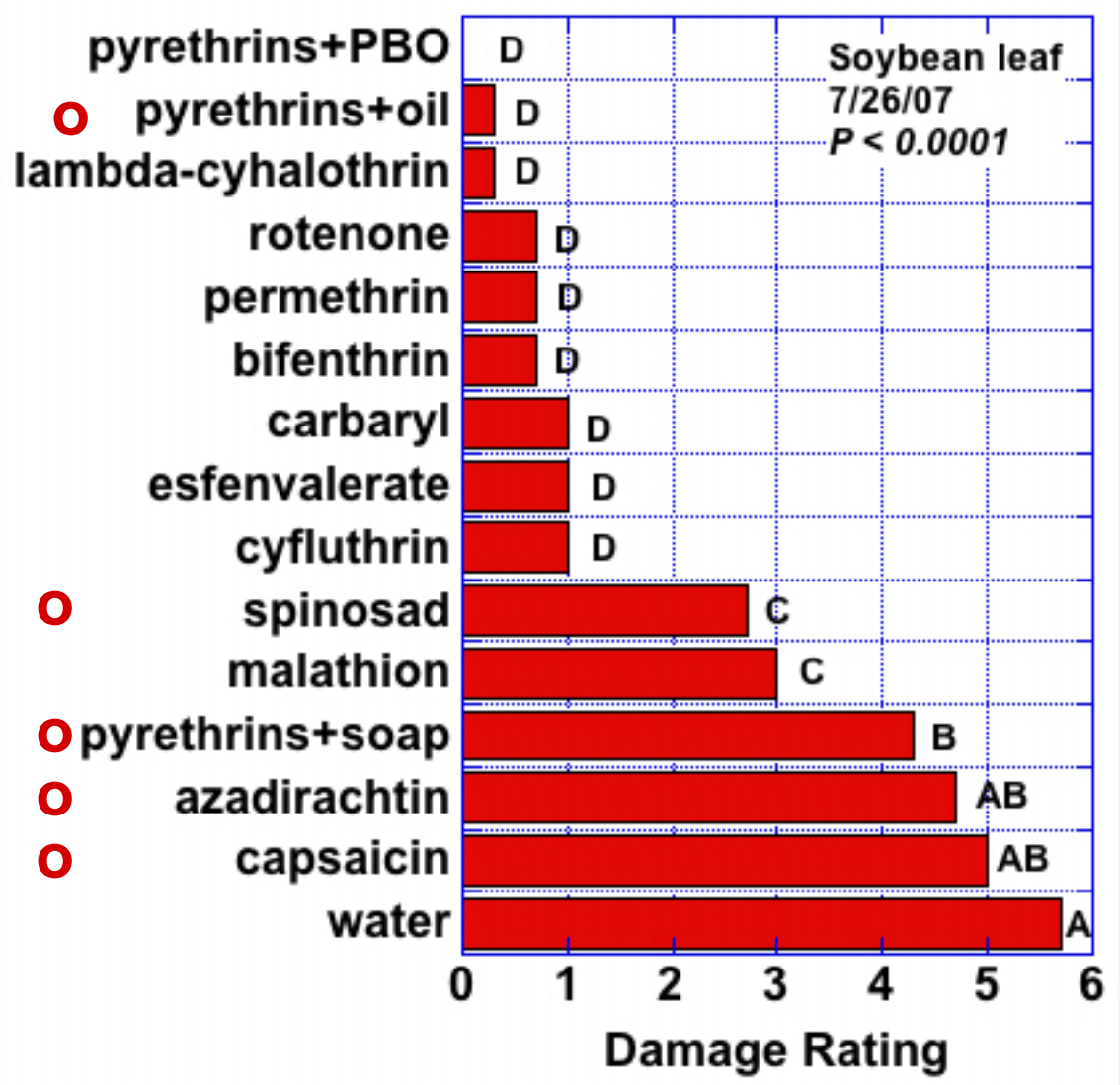
Lab bioassays to evaluate insecticide efficacy

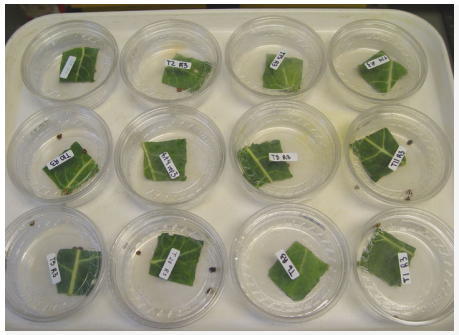


- **Defoliation**
- **Mortality**

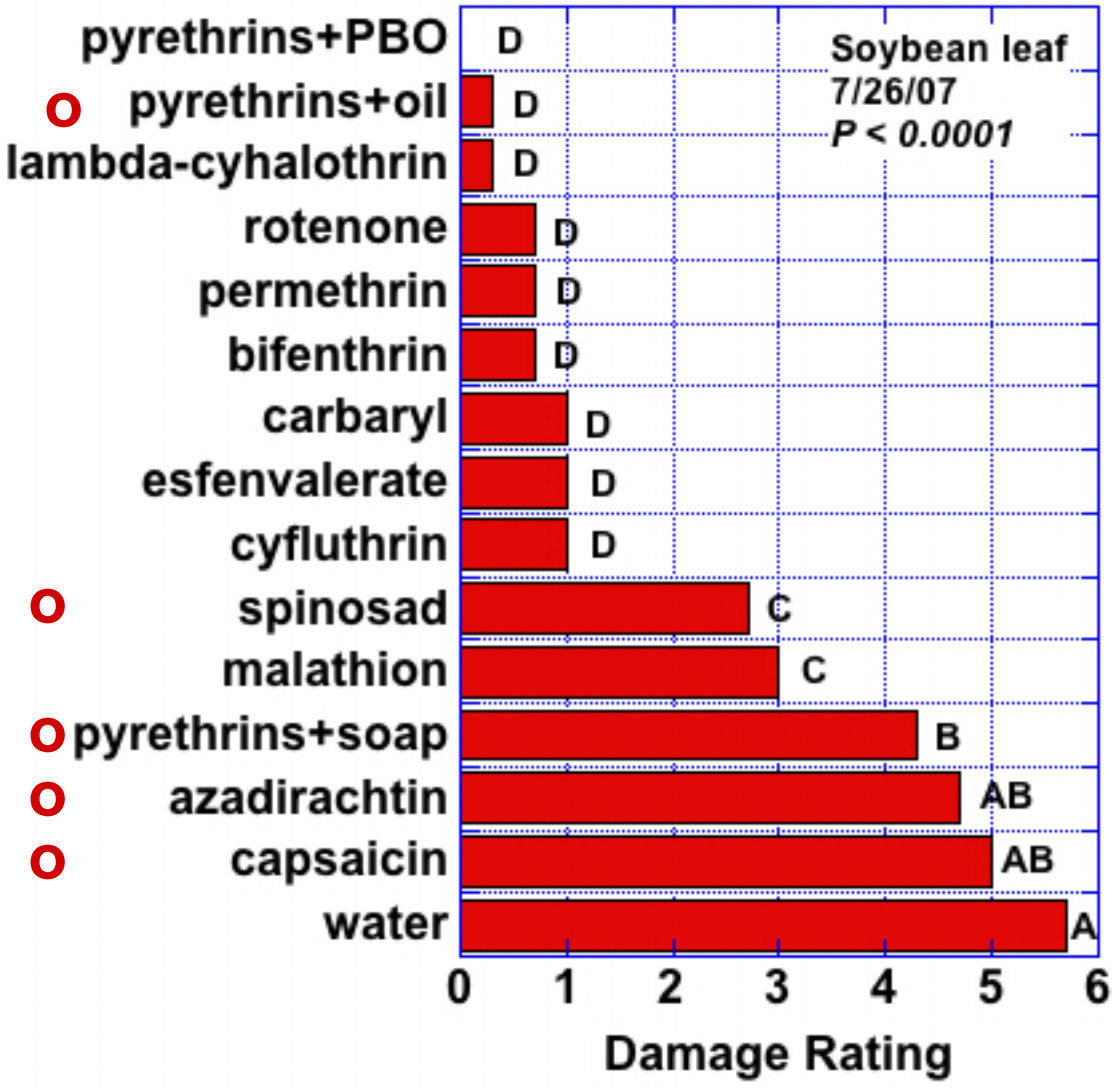


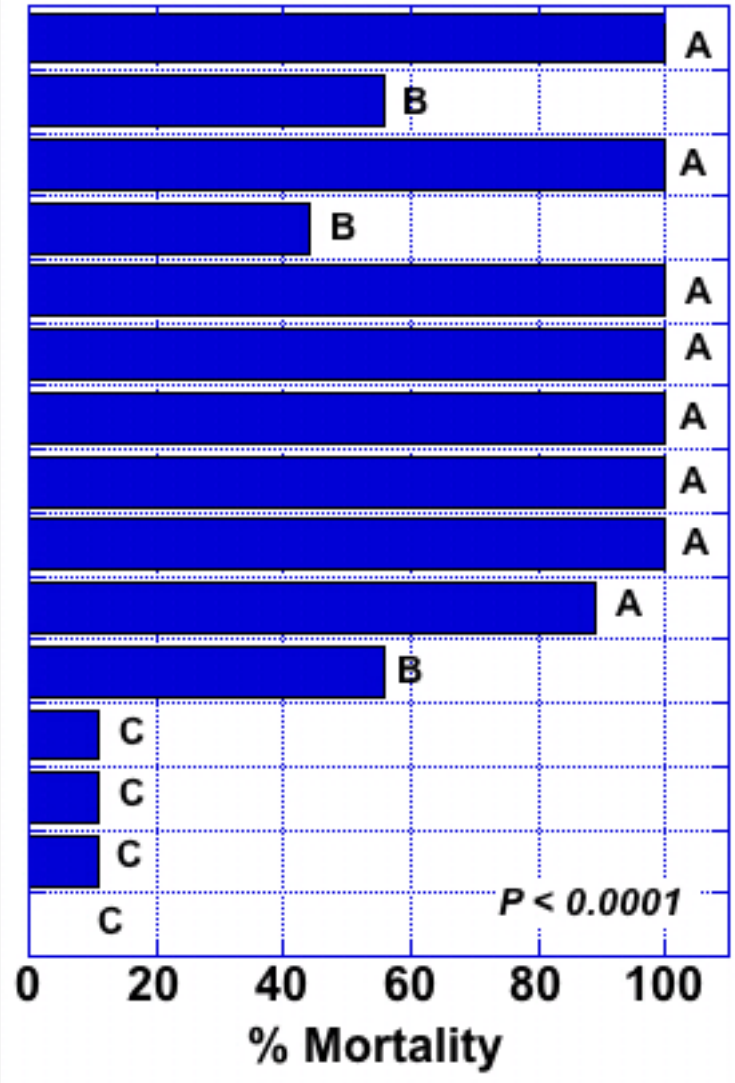
Bean leaf beetle





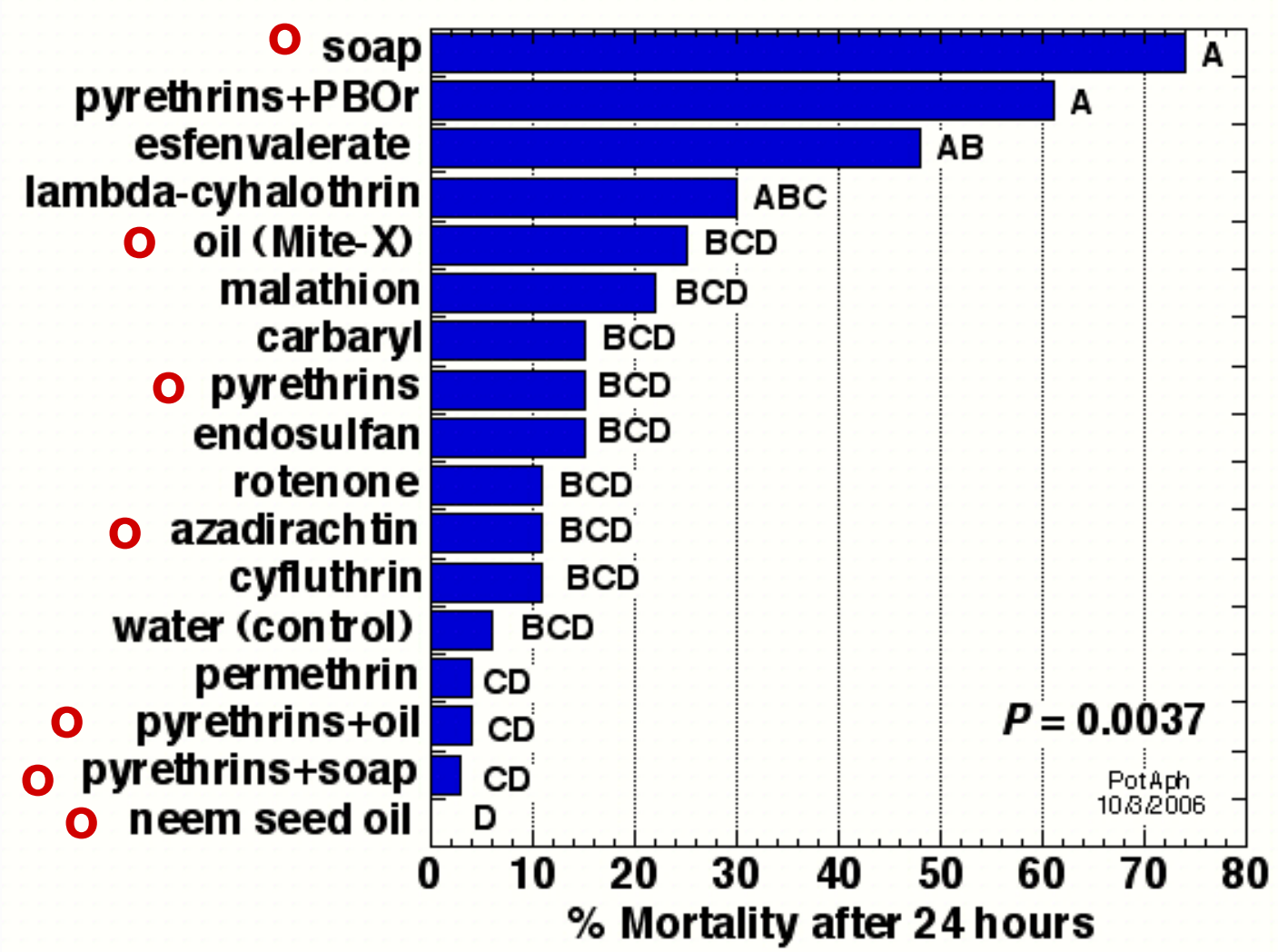
Bean leaf beetle





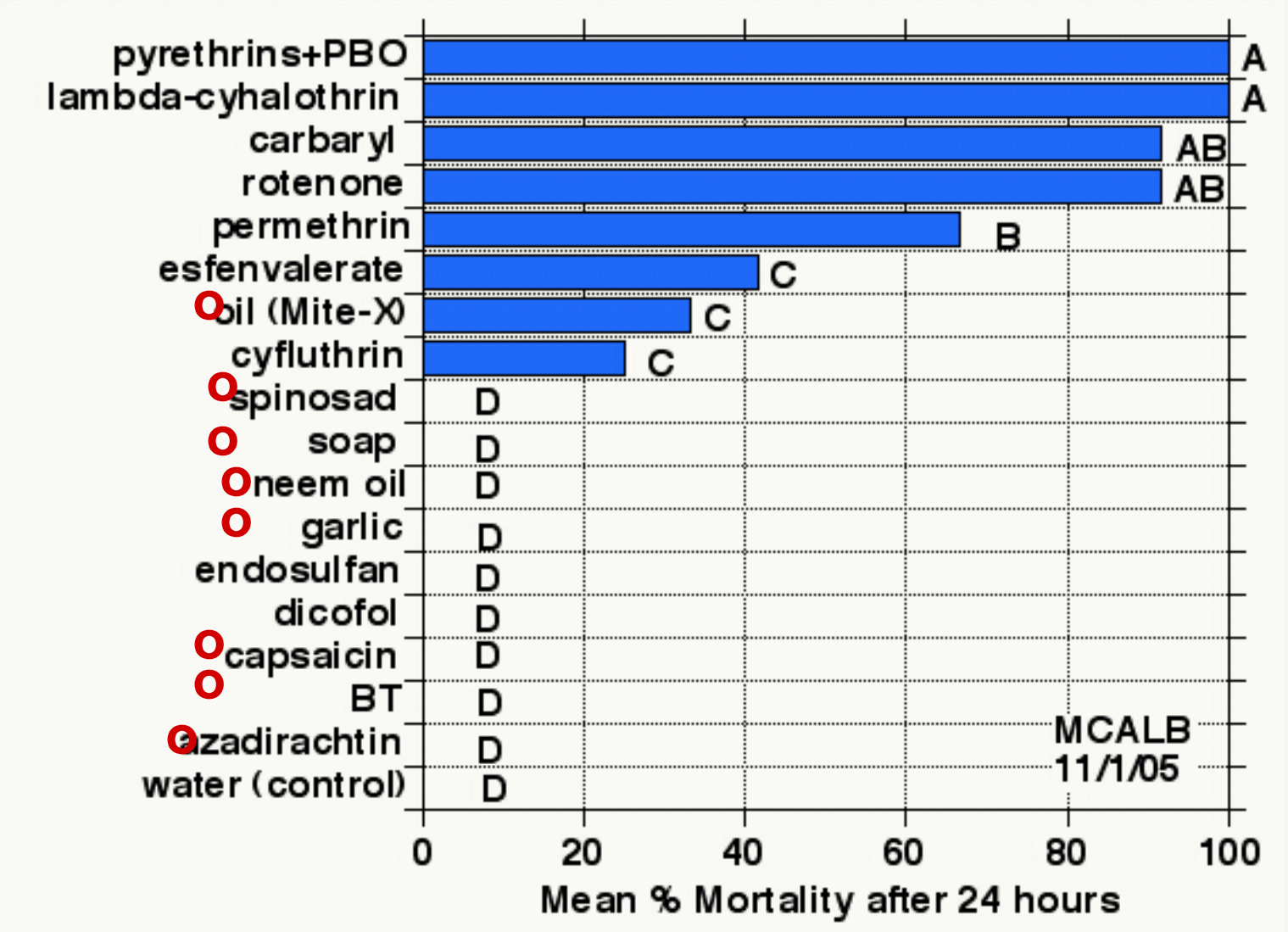
Potato Aphid

tested on tomato leaves, 10/3/2006
3 replicates/treatment, 10 aphids/replicate



What about harm to natural enemies?

Ladybug



Trends in efficacy

spectrum	*Exc./Good*	*Good/Fair*	*Fair/Poor*
broad	pyrethrins + PBO carbaryl esfenvalerate lambda-cyhalothrin cyfluthrin bifenthrin	permethrin malathion pyrethrins +oil	neem seed oil azadirachtin capsaicin garlic pyrethrins +soap
less broad	spinosad endosulfan rotenone		
narrow	dicofol soap oil	B.T.	

in red if on OMRI list

Conclusions: insecticide choices

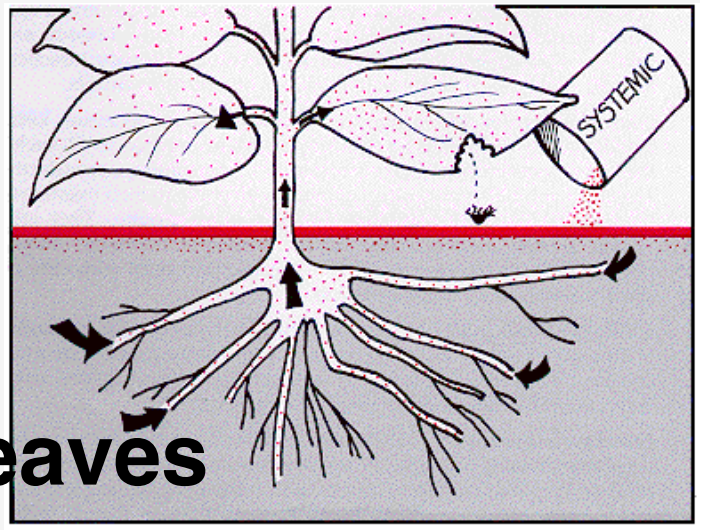
User's general preference	*Best bets*
Natural products only (OMRI)*	1) spinosad 2) soap
Natural products only (non-OMRI)	1) pyrethrins+PBO 2) rotenone
Conventional products only	carbaryl (Sevin) or permethrin (Eight)
Anything goes	pyrethrins+PBO

**** Note lack of effective beetle control product***

Systemic pesticides

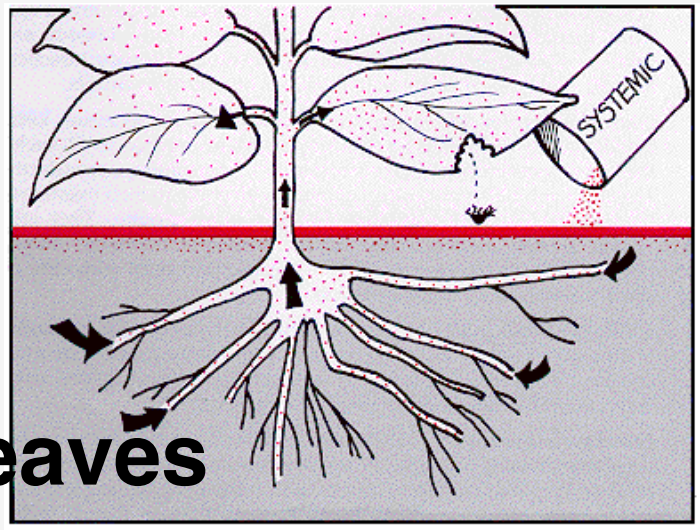
- Chemical that moves from the point of application to another part of target
- Two types
  - —True
  - —Translaminar

Types of Systemics

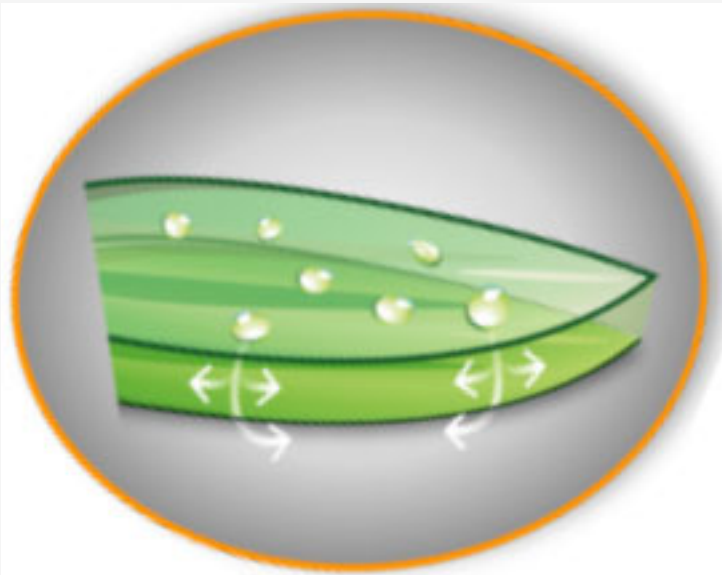


- **True systemic**:
  - —Apply to root, moves to leaves
  - —Apply to leaf, moves to root

Types of Systemics



- **True systemic**:
  - —Apply to root, moves to leaves
  - —Apply to leaf, moves to root
- **Translaminar**:
  - —Or ‘limited systemic’
  - —Apply to top of leaf
  - —Moves inside leaf or to underside of leaf



Types of Systemics

- Some products can be **both** types
- E.g. imidacloprid insecticide:
  - —True systemic when applied to **roots**, active for several weeks
  - —Translaminar when applied to **foliage**, active for only 1-2 weeks

Systemics for gardens

- imidacloprid

- acetamiprid

How to use insecticides in presence of natural enemies?

Choose product:

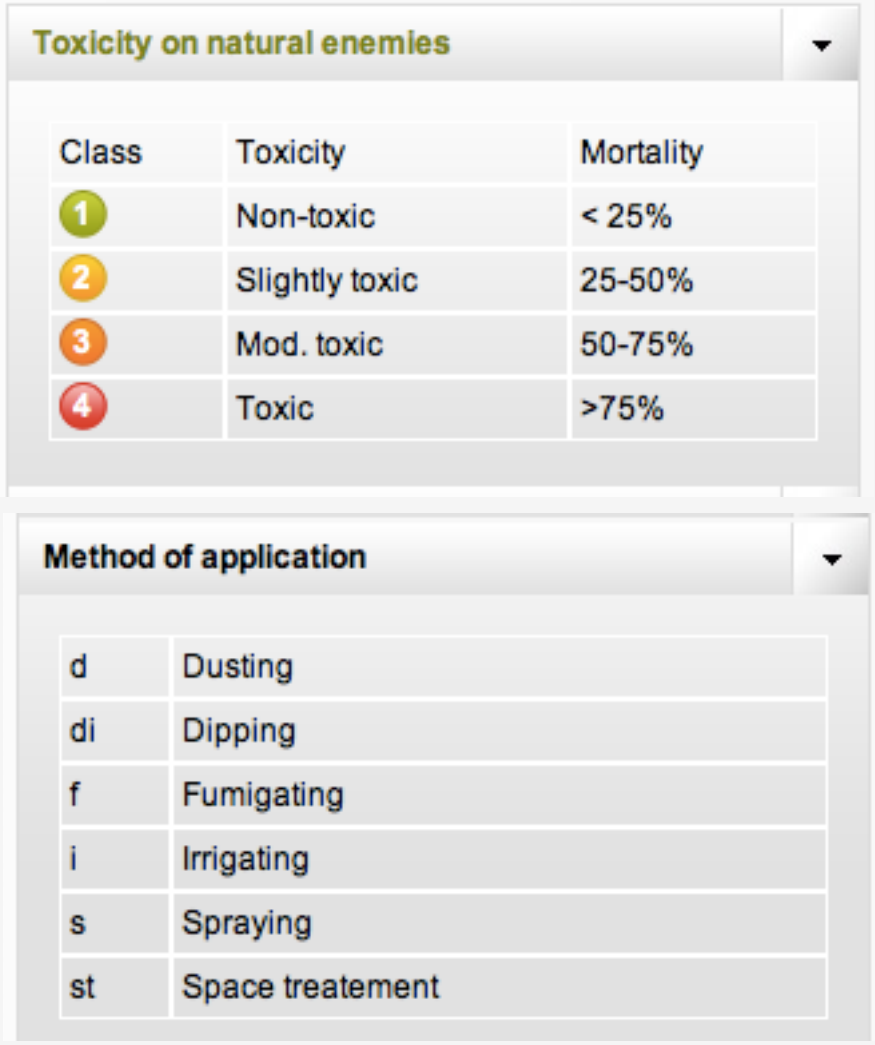
- Selective (by mode of action)
  - —Kills pest but *not* the natural enemies

or

- Very short residual activity
  - —Most botanicals

Biobest:

Webpage & mobile app on ‘side effects’ for 21 natural enemies & 263 chemicals



Toxicity on natural enemies

Class	Toxicity	Mortality
1	Non-toxic	< 25%
2	Slightly toxic	25-50%
3	Mod. toxic	50-75%
4	Toxic	>75%

Method of application

d	Dusting
di	Dipping
f	Fumigating
i	Irrigating
s	Spraying
st	Space treatement

Biobest: 4 predators & 5 OMRI products

		azadirachtin	mineral oil	potassium salts of fatty acids	rape seed oil / vegetable oil	spinosad	
		s	s	s	s	s	i
Phytoseiulus persimilis	nymph/adult	2	3	4	3	2	1
	persist	?	?	3 d	?	1 w	-
Orius spp.	nymph	2	3	?	2	4	2
	adult	1	3	?	2	3	1
	persist	?	3 d	?	?	1 w	?
Aphidoletes aphidimyza	larva	1	1	2	?	1	1
	adult	1	1	4	1	1	1
	persist	-	-	3 d	?	-	-
Chrysopa carnea	larva	1	1	2	1	1	1
	adult	1	1	3	1	1	1
	persist	-	-	?	-	-	-

Koppert Biological Systems,
Webpage on ‘side effects’
for 47 natural enemies &
137 chemicals

Green = good

Red= bad

Legend close

Natural enemies

1 Harmless < 25% reduction
2 Slightly harmful 25 - 50% reduction
3 Moderately harmful 50 - 75% reduction
4 Very harmful > 75% reduction
? Effect/persistence unknown

Persistence is indicated in number of **weeks**!

Bumblebees

O No action
Cover
Remove
Incompatible
? Effect/persistence unknown

Persistence is indicated in number of **days**!

Application methods

HVS = high volume spray; DR = drench; DUS = dust; FOG = fog; GRA = granulate; LVM = low volume method; O = various; PA = paint; SM = smoke; SPK = sprinkle; TMX = tankmix

Pest management:
the search for a weak link
in pest's life cycle

So how can pests be managed organically?

- **Maximize non-chemical tactics:**
  - —Knowledge & labor intensive
- **Can include chemical control**
  - —Only if biorational products chosen
  - —Usually as last resort
  - —Efficacy mostly fair to poor
  - —Do not assume that “natural” = good

For beginners:
Which veg crops have fewest pests?

- **Lettuce**
- **Peas**
- **Parsley**
- **Basil**

Info on vegetable & fruit pest management

u.osu.edu/pestmanagement/

Questions?

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phone: **614-292-2803**