



Non-chemical Options for Pest Control in Urban Landscapes

Shaku Nair,

Entomologist, Associate in Extension-Community IPM

Arizona Pest Management Center



Agriculture, Life &
Veterinary Sciences &
Cooperative Extension

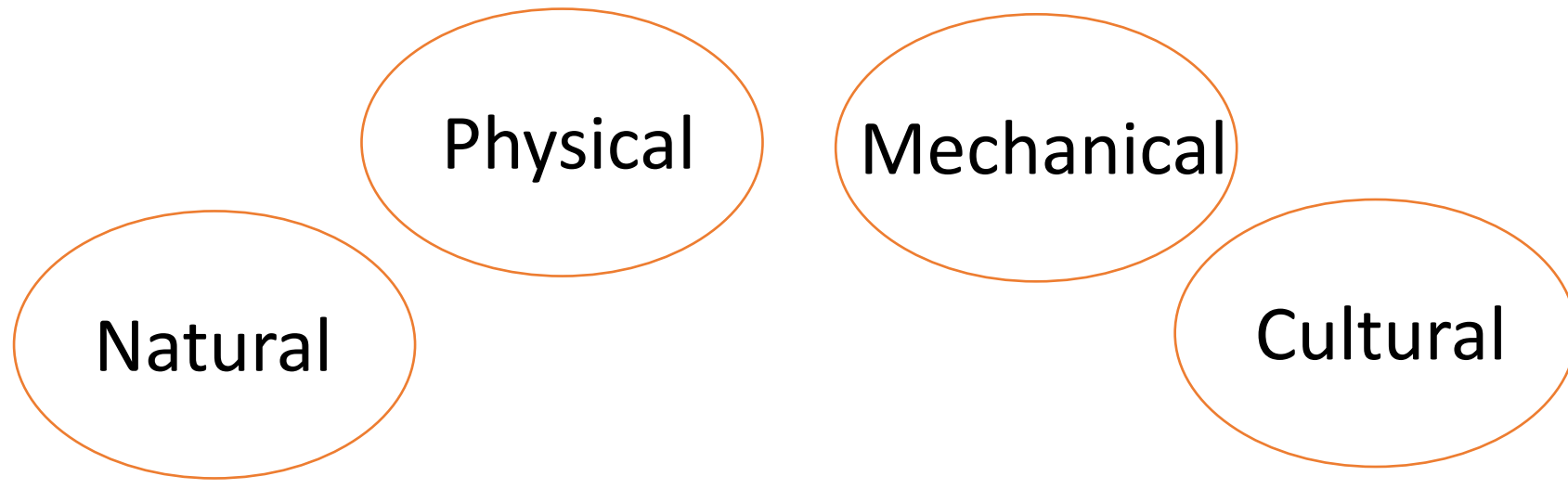
**What comes to mind when you hear
“NON-CHEMICAL” ?**



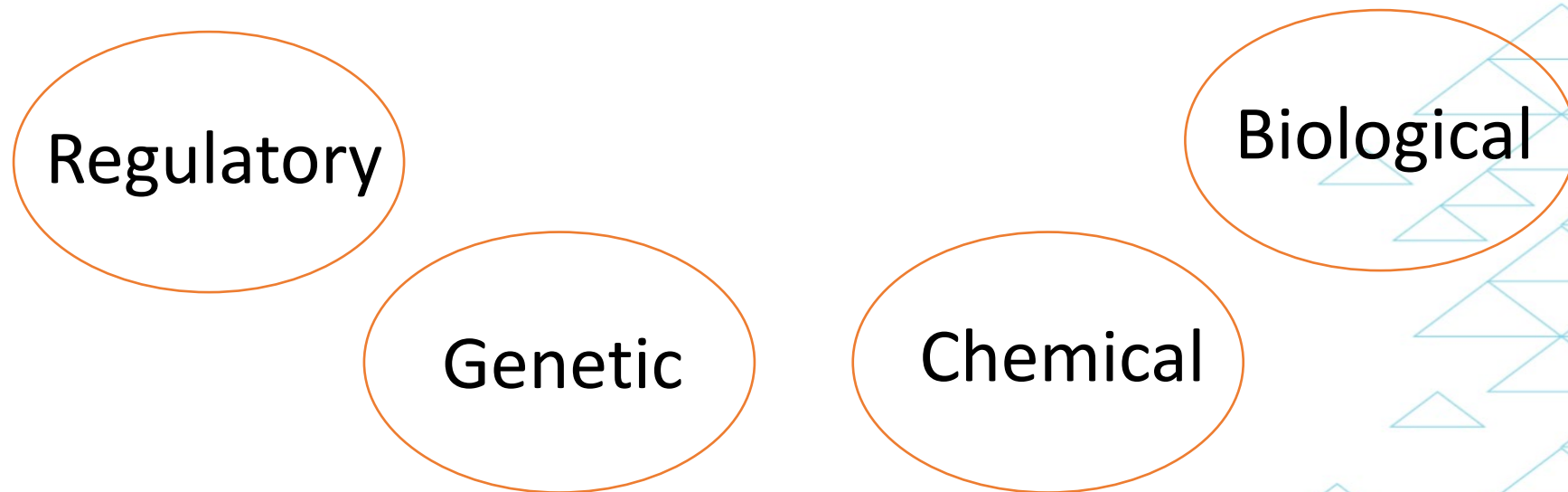


Integrated Pest Management IPM

Integrated Pest Management (IPM) is a science-based, sustainable decision-making process that uses information on pest biology, environmental data, and technology to manage pest damage in a way that minimizes both economic costs and risks to people, property, and the environment.



Pest management methods



Organic Vs Natural Vs Non-chemical

Natural

Derived from nature?
Occurring naturally?

Organic

No chemicals?
No man-made chemicals?
Only plant-derived?
Homemade?

Non-chemical

Plant-based?
Animal-based?
Cultural?
Physical? Mechanical?
Biological?



National Organic Program

[HOME](#) > [ABOUT AMS](#) > [NATIONAL ORGANIC PROGRAM](#)

Overview

Our Leadership

News & Announcements

Strategic Plan

Policies & Administrative Issuances

NOP is a federal regulatory program that develops and enforces consistent national standards for organically produced agricultural products sold in the United States.

NOP also accredits third-party organizations to certify that farms and businesses meet the national organic standards. These certifiers and USDA work together to enforce the standards, ensuring a level playing field for producers and protecting consumer confidence in the integrity of the USDA Organic Seal.



What is organic?

Organic is a labeling term that indicates that the food or other agricultural product has been produced according to the **USDA organic standards**.

These methods integrate cultural, biological and mechanical practices that foster cycling of resources, promote ecological balance and conserve biodiversity. Synthetic fertilizers, sewage sludge, irradiation and genetic engineering may not be used.

[Learn more about organic standards](#)

Organic is a labeling term that indicates that the food or other agricultural product has been produced according to the **USDA organic standards**.

These methods integrate cultural, biological and mechanical practices that foster cycling of resources, promote ecological balance and conserve biodiversity. Synthetic fertilizers, sewage sludge, irradiation and genetic engineering may not be used.




OMRI – Organic Materials Review Institute

- ❑ Founded in 1997
- ❑ Provides organic certifiers, growers, manufacturers and suppliers, an independent review of products intended for use in certified organic production, handling and processing
- ❑ A 501 (c)3 nonprofit organization
- ❑ Reviews products based on National Organic Standards
- ❑ Accepted products are OMRI listed and appear on the OMRI Products List






OMRI Lists




Crop Products

- Sorted by Category
 [CropByCategory-NOP-EN.pdf](#)
- Sorted by Product Name
 [CropByProduct-NOP-EN.pdf](#)
- Supplier Contact Information
 [CropByCompany-NOP-EN.pdf](#)

Processing & Handling Products

- Sorted by Category
 [ProcessingByCategory-NOP-EN.pdf](#)
- Sorted by Product Name
 [ProcessingByProduct-NOP-EN.pdf](#)
- Supplier Contact Information
 [ProcessingByCompany-NOP-EN.pdf](#)




Livestock Products

- Sorted by Category
 [LivestockByCategory-NOP-EN.pdf](#)
- Sorted by Product Name
 [LivestockByProduct-NOP-EN.pdf](#)
- Supplier Contact Information
 [LivestockByCompany-NOP-EN.pdf](#)






OMRI Lists




Crop Products

- Sorted by Category
 [CropByCategory-NOP-EN.pdf](#)
- Sorted by Product Name
 [CropByProduct-NOP-EN.pdf](#)
- Supplier Contact Information
 [CropByCompany-NOP-EN.pdf](#)

Processing & Handling Products

- Sorted by Category
 [ProcessingByCategory-NOP-EN.pdf](#)
- Sorted by Product Name
 [ProcessingByProduct-NOP-EN.pdf](#)
- Supplier Contact Information
 [ProcessingByCompany-NOP-EN.pdf](#)

Livestock Products

- Sorted by Category
 [LivestockByCategory-NOP-EN.pdf](#)
- Sorted by Product Name
 [LivestockByProduct-NOP-EN.pdf](#)
- Supplier Contact Information
 [LivestockByCompany-NOP-EN.pdf](#)





Low-Risk Pesticides

- Safer Choice is an [EPA Pollution Prevention \(P2\) program](#), which includes practices that reduce, eliminate, or prevent pollution at its source, such as using safer ingredients in products.
- Safer Choice helps consumers, businesses, and purchasers find products that perform and contain ingredients that are safer for human health and the environment.





Low-Risk Pesticides

Search Products that Meet the Safer Choice Standard

Busque productos que cumplan con la norma Safer Choice

Looking for safer cleaning and other products? Use the search box below to find products that meet the Safer Choice Standard.

A downloadable spreadsheet of Safer Choice-certified products list is also available on [EPA Envirofacts](#).

Search Safer Choice-Certified Products

Product or Company Name (Optional)

Home or Business Use (Optional) ▼

Show only:

- Fragrance-free products¹
- Products with outdoor uses²

Product Type (Optional) ▼



Low-Risk Pesticides



Cornell **CALS**
College of Agriculture and Life Sciences

New York State Integrated Pest Management Active Ingredients Eligible for Minimum Risk Pesticide Use

What are Minimum Risk Pesticides?

The US EPA determines a product to be a Minimum Risk Pesticide, (MRP), when the risk to the public and the environment is sufficiently low as to not require all the data and review necessary for registration. Such products include the original 31 substances designated as allowable active ingredients in MRPs, under section 25(b) of the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) Conditions for Minimum Risk Pesticides.



Low-Risk Pesticides



Cornell **CALS**
College of Agriculture and Life Sciences

New York State Integrated Pest Management

Active Ingredients Eligible for Minimum Risk Pesticide Use

- [Overview of the Profiles](#)
- [2-Phenethyl Propionate Profile](#)
- [Castor Oil Profile](#)
- [Cedarwood Oil Profile](#)
- [Cinnamon & Cinnamon Oil Profile](#)
- [Citric Acid Profile](#)
- [Citronella & Citronella Oil Profile](#)
- [Cloves & Clove Oil Profile](#)
- [Corn Gluten Meal Profile](#)
- [Corn Oil Profile](#)
- [Cottonseed Oil Profile](#)
- [Dried Blood Profile](#)
- [Eugenol Profile](#)
- [Garlic & Garlic Oil Profile](#)
- [Geraniol Profile](#)
- [Geranium Oil Profile](#)
- [Lauryl Sulfate Profile](#)
- [Lemongrass Oil Profile](#)
- [Linseed Oil Profile](#)
- [Malic Acid Profile](#)
- [Mint and Mint Oil Profile](#)
- [Peppermint & Peppermint Oil Profile](#)
- [Potassium Sorbate Profile](#)
- [Putrescent Whole Egg Solids Profile](#)
- [Rosemary & Rosemary Oil Profile](#)
- [Sesame & Sesame Oil Profile](#)
- [Sodium Chloride Profile](#)
- [Sodium Lauryl Sulfate Profile](#)
- [Soybean Oil Profile](#)
- [Thyme & Thyme Oil Profile](#)
- [White Pepper Profile](#)
- [Zinc Profile](#)





Low-Risk Pesticides



Our Water Our World is an award-winning partnership between city- and county-based water pollution prevention agencies and garden centers and hardware stores that sell pest control products.

KNOW YOUR ACTIVE INGREDIENTS

List of less-toxic products, organized by brand

List of less-toxic products, organized by pest

List of less-toxic active ingredients

Criteria and process for developing less-toxic products lists

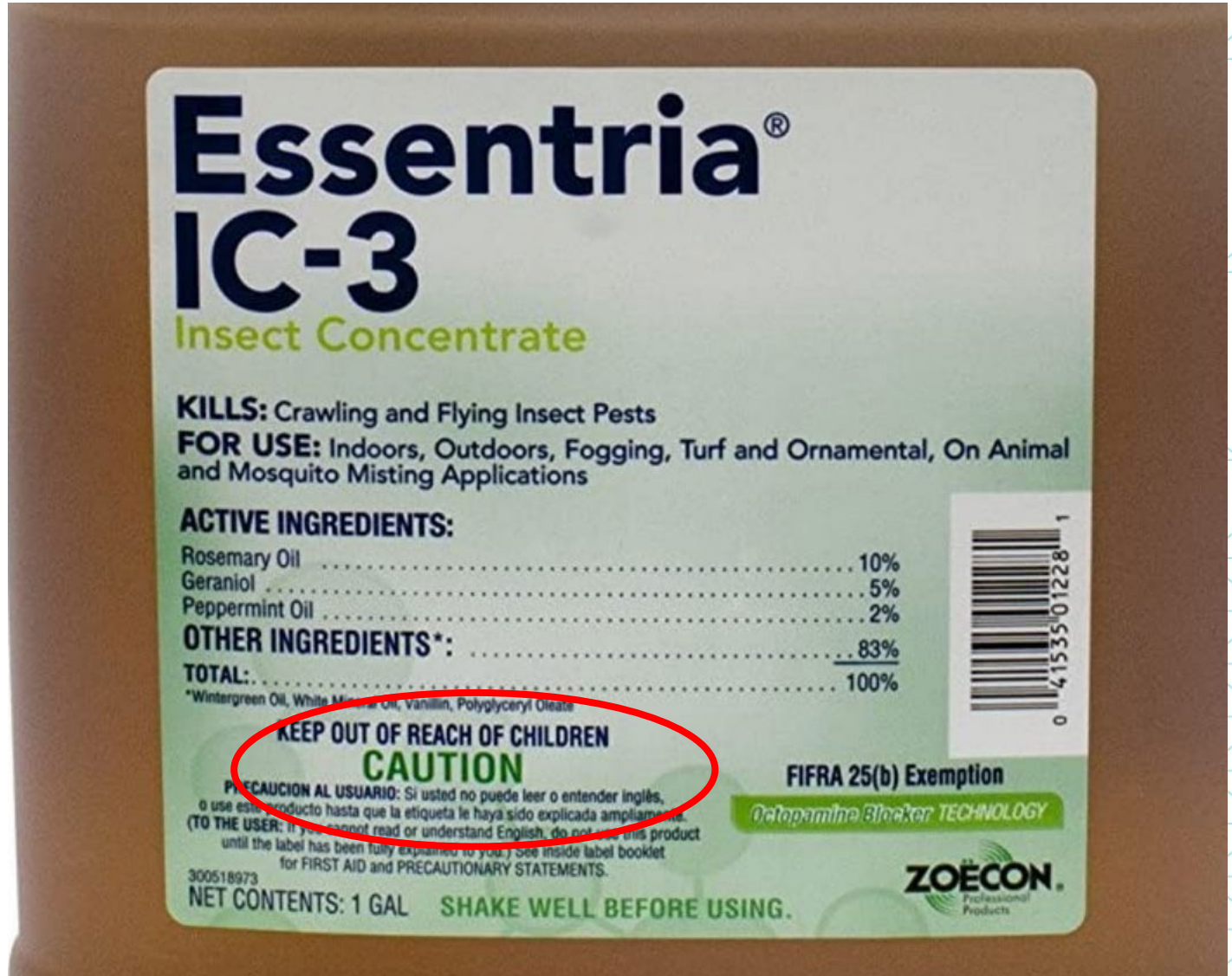




How to identify Low-Risk Products?

- Low-toxicity pesticide products are labeled with a **signal word** of "CAUTION", rather than "WARNING" or "DANGER".
- No matter how toxic a pesticide may be, it's important to follow all of the **label directions**.





Common “Organic” Pesticides

- ❑ Bt or Bacillus thuringiensis
- ❑ Copper
- ❑ Neem
- ❑ Oils
- ❑ Pyrethrum



True or False?

Organic pesticides are safe for me and the environment?

False!!!

No pesticide is “Safe”

Signal words?



Microbials

- Targeted host selection
- Kill, reduce reproduction, or shorten life span
- Environment controls effectiveness
- Relatively slow acting; may take several days and repeated applications



Bt



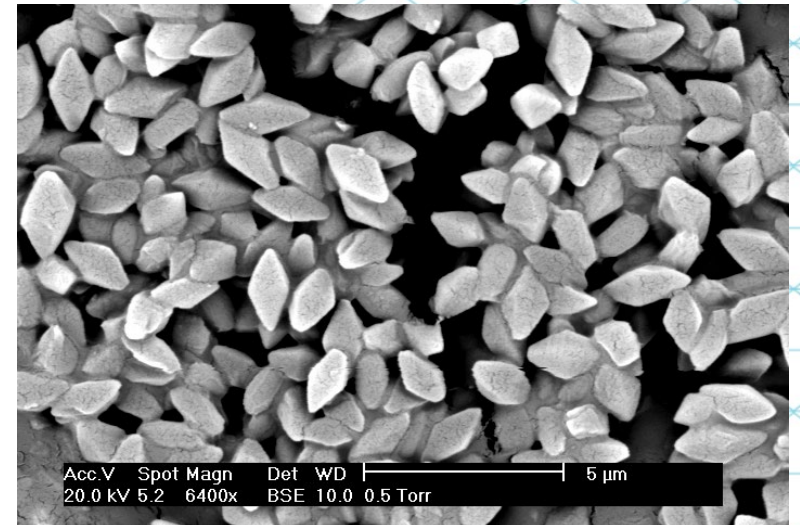
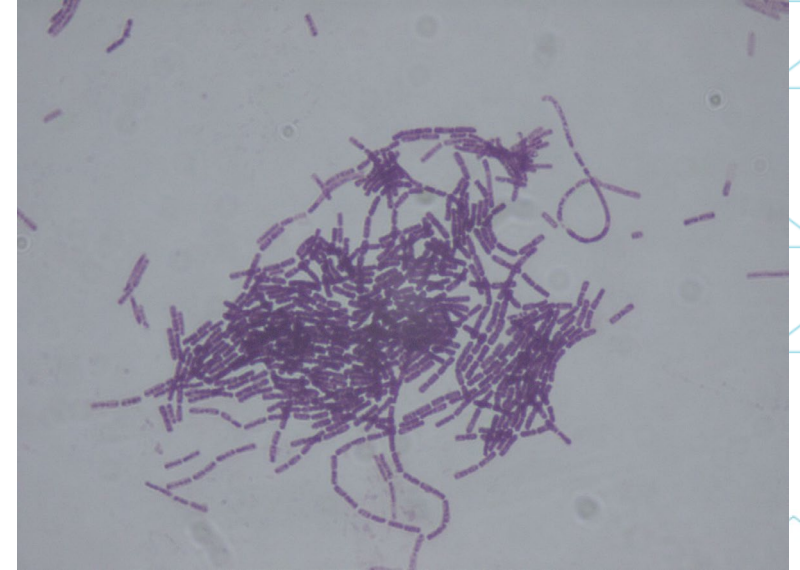
Nematodes



Fungi

Bt (“Caution”)

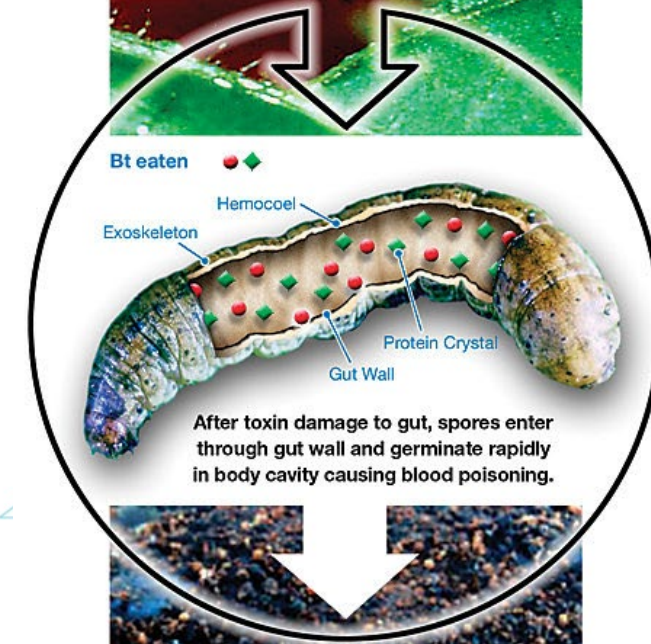
- Non-synthetic, most commonly used biological pesticide in the world
- Gram +ve, spore-forming bacteria
- Active ingredient (AI): proteins produced by Bt bacteria
- Common in terrestrial habitats (soil, dead insects, plants, granaries)
- Short residual
- Broken down in sunlight
- Can be used with UV blockers or stickers



How does Bt work?

- Must be eaten by susceptible pest
- Endotoxin binds to gut, creating a hole/pore
- Contents enter the body cavity/bloodstream
- No immediate knockdown, but slows feeding

Ingestion of Bt's crystal proteins from treated leaves.
Feeding stops within minutes after crystals are solubilized in the gut and the gut cells are damaged.



After toxin damage to gut, spores enter through gut wall and germinate rapidly in body cavity causing blood poisoning.



Larvae stop feeding in minutes and die in 1 to 3 days.

When does Bt work best

- Early detection – stage
- Proper application
- Timing
- Location
- Pest compatibility



Subspecies

- Bt kurstaki – Lepidoptera
- Bt tenebrionis – Coleoptera
- Bt israelensis – Diptera

Advantages of Bt ('Green' aspect)

- Humans (gut structure) – not affected
 - Rapid UV breakdown
- Wildlife
 - Safe to birds, mammals and fish
- Natural enemies
 - Parasites and predators are not harmed directly, but loss of hosts could be a problem
- Non targets
 - Other moths and butterflies



Copper

- Mineral-based fungicide/bactericide
- Considered synthetic (**Danger**, **Warning** and **Caution**)
- Allowed (as 'organic')
 - Fixed coppers – minimize accumulation in soil
 - Copper hydroxide, copper oxide
 - Copper sulfate
 - Terrestrial
 - Aquatic



Copper – the first fungicide

1807 Prévost and bunt of cereals: seed treatment

Demonstrated wetting wheat kernels in copper sulfate solution control bunt on cereals
(serendipitous finding when using a copper “vessel” to soak seeds)



1885 Millardet and grape downy mildew: foliar treatment

Described use of copper sulfate and lime to control downy mildew on grapevines
(serendipitous finding when he noticed a farmer in the Bordeaux region using the concoction to discourage “pilferers”)



How does copper work?

- Has to be applied before infection, needs water
- Best absorbed by germinating fungal spores
 - Multiple applications typically necessary to protect new plant growth
- Copper ions disrupt the functions of proteins after being absorbed into fungus or bacterium
- ‘Non-specific denaturation’ of cellular proteins, destroys critical enzymes
 - Good efficacy – listed on over 100 crop plants to control fungal and bacterial diseases
 - More effective on bacterial than fungal



Phytotoxicity due to Copper

- Copper is more soluble in low pH (releases Cu ions)
 - If applied with water with pH lower than 6, phytotoxicity can occur
- Bordeaux mixture has copper sulfate and hydrated lime to avoid this effect

The challenge:

To have copper ions present to kill the target (fungi, bacteria) while keeping concentration low enough to avoid phytotoxicity

→ Using copper products that are relatively insoluble in water

Source: Brian Lehman and Kari Peter, Ph.D. Department of Plant Pathology and Environmental Microbiology Penn State University Fruit Research and Extension Center Biglerville, PA



Advantages of Cu ('Green' aspect)

- Small amounts of Cu are needed for plant and animal life (excessive amounts are dangerous)
- Binds tightly to soil.
- Leaf persistence
 - Can remain for 1-2 weeks
 - Or until it is washed off (rain or irrigation)

Cu Fate in water and soil

- Leaches well because it is so soluble, especially in sandy soils
- Binds tightly to soil.
- High levels can accumulate in ag. settings after few decades of use.
- As soil levels build, soil life diminishes
 - Worms, Rhizobium bacteria
 - Also controls all forms of Bt



Cu In humans and animals

- Vineyard workers experienced liver disease after 3-15 years of exposure to CuSO_4 in Bordeaux mixture
- Vomiting is triggered but acidic stomach conditions cause absorption
- Highly toxic to fish, especially in acidic water
- Bees are endangered by Bordeaux mixture
- Toxic to sheep and chickens



Neem (Warning, Caution)

- Non-synthetic botanical pesticide
- Derived from the neem tree, *Azadirachta indica*
- Native to southern Asia (subtropical/tropical)
- Considered to cure all ailments
 - Used for centuries for medical, cosmetic and pesticidal purposes
- Insecticidal/deterrent properties discovered as early 1920
- 1959 – German entomologist noticed that neem trees in Sudan resisted attack by migratory locusts



Neem products

- Crushing neem seeds
- Water or solvent extraction (e.g. Alcohol) to obtain pesticidal constituents
- Different extraction processes lead to different amounts
- Neem seed cake is residual after extraction – also used as fertilizer and deterrent for nematodes and soil insects



Mode of action

- Active ingredient: Azadirachtin (one of > 70 compounds)
- Acts as IGR, anti-feedant, oviposition deterrent, insecticide
- Contact or ingestion
 - Prevents molting (inhibits ecdysone production)
 - Stops feeding (physiological)
 - Egg laying (volatiles repel)

Efficacy

- Listed for over 200 insect species
- Efficacy can vary with species
- Multiple applications

NEEMOLE
AZADIRACHTIN - 1% W/W



'Green' aspects of Neem

- Relatively non-toxic to wildlife
- Little or no effect on adult beneficials and non-targets
- Very suitable for IPM inclusion
- Relatively non-toxic to non-targets
 - Neem leaves added to soil increased earthworm weight and survival
- No significant risk to humans
 - Irritation to mucus membranes from seed dust
 - Most studies are done using azadirachtin, not the entire extract



Oils (Caution)

- Synthetic and natural
- Active ingredients – 3 types
 - Petroleum (mineral)
 - Fish
 - Plant (seeds, leaves, bark)
- Petroleum has the most available information and products, has been developed the most
- Listed for a large number of soft-bodied insects
- **The only widely-used class of pesticides to which insects and mites have not developed resistance (Sams and Deyton 2002).**



Oils – Modes of action

- Petroleum oils – control egg sage by interfering with gas exchange or egg structure
- Other stages – can block respiratory system or break down cuticle
- Plant and fish oils – mostly mixed together and have additional effects (repellent)
- All oils disrupt insect behavior – feeding, oviposition
- Stylet oil – used for insect-vectored-virus control: highly refined oils that work in two ways 1) coats stylet in piercing-sucking insects, and 2) disrupts host recognition and prevents feeding.

Oils – Phytotoxicity

- Thick, heavy oils cause more damage, less used now
- Dormant oil – now refers to the time of application (dormant season for plants)
- The slower the oil evaporates, the higher the risk of damage
- Avoid application on humid days
- Visible leaf damage or yield reduction can occur



UGA5111089

'Green' aspect of oils

- Petroleum oils used on plants are light and generally evaporate quickly (effects of vapors are unknown)
- Negligible ability to contaminate groundwater
- Plant and fish oils not as volatile, break down quickly by microbes
- No effect on wildlife or non-targets
- Can affect natural enemies (e.g., beneficial mites) causing flareups in population
- Low toxicity to humans, typically disappear by harvest time

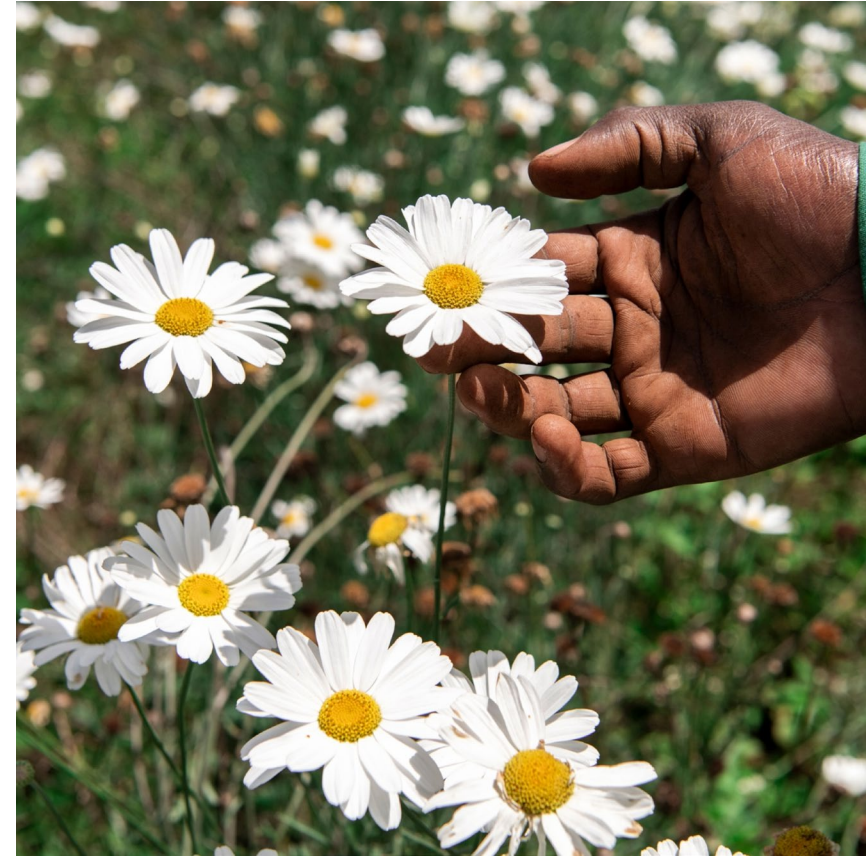
Efficacy

- Long history of dormant oil spray in fruit crops to control mites and scales
- Less used in vegetable crops
- Generally found to be more effective when mixed or used in combination with another pesticide



Pyrethrums (Caution)

- Non-synthetic botanical pesticide
- Pyrethrum – plant or the natural occurring insecticide
- Active ingredients - pyrethrins
- Pyrethroids – synthetic (not OMRI approved)
- Dried, powdered flowerheads of pyrethrum daisies, mainly *Chrysanthemum cinerariifolium*
- Native to SW Asia, Kenya is leading producer
- Broad spectrum activity – against a range of insects



Mode of action

- Knock down – fast acting contact poison to susceptible insects
- Affects nervous system, causing repetitive nervous discharges, finally paralysis and death
- Some insects can recover if dose is too low
- Work with synergists to provide enhanced mortality
 - non-insecticidal chemical heightens response (reduces ability to detoxify pyrethrum)
 - PBO – piperonyl butoxide is a common synergist, but not OMRI approved
 - Use care when shopping
 - Oils are also used as synergists



Application tips

- Broken down by acid and alkaline solutions, do not mix with lime, sulfur or soap
- Rapidly broken down by UV
- Needs to be contacted or ingested
- Spray flying insects in early hours while less active and before bee activity
- Extremely toxic to fish and bees, slightly toxic to birds
- Toxic to beneficials, but low residual



'Green' aspects

- Little or no leaf persistence
- Broken down in water to non-toxic products
- Soil persistence very low – half life 1-2 hours
- Unlikely to concentrate in food chain, easily metabolized
- Relatively non-toxic to humans, but use with caution (easily inhaled)



Other “Soft” Pesticides

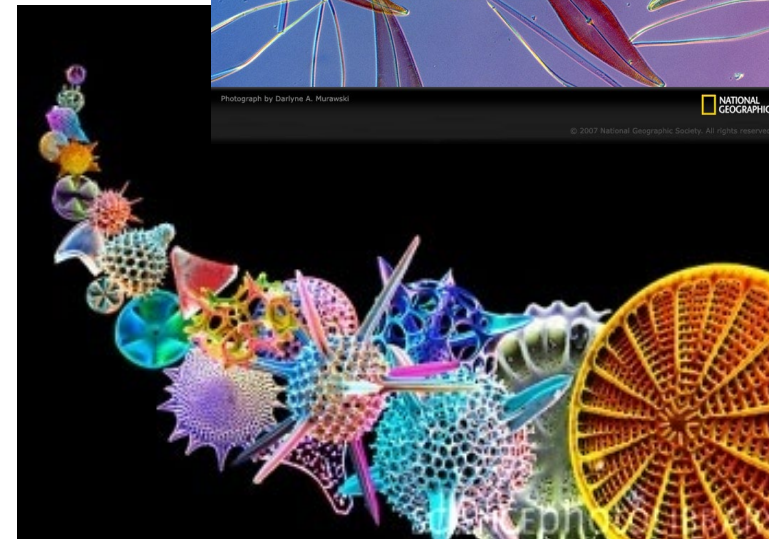
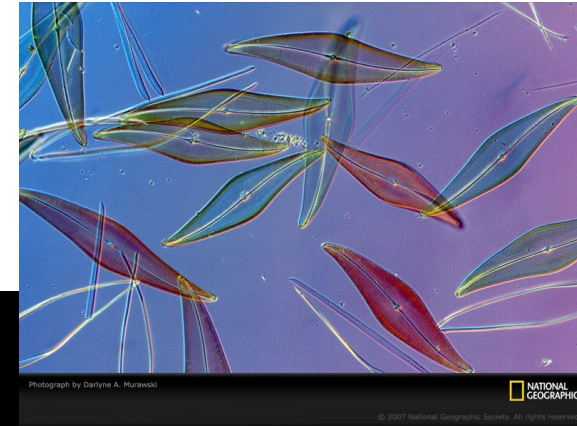
- ❑ Short residual
- ❑ Narrow spectrum (selective)
- ❑ Generally preserves beneficial organisms
- ❑ Can be rotated with traditional insecticides to slow resistance build-up
- ❑ Some are physical toxicants to which resistance can't be developed
- ❑ Some are more expensive!

“Soft” Insecticide Options

Desiccants

Best against soft-bodied insects such as: aphids, caterpillars, whiteflies, thrips, etc.

- Diatomaceous earth (DE)
- Boric acid (stomach poison)
- Silica gel/Aerosilica
- Sucrose esters



Desiccants



- May lose effectiveness when wet (DE)
- Some contain insecticides for faster knockdown



Soaps: Potassium Salts of Fatty Acids

- Disrupts cell membranes/cuticle
- Most effective against soft-bodied insects
- Only effective when wet
- Can cause phytotoxicity
- Spray in morning or evening



Eating Disruptor

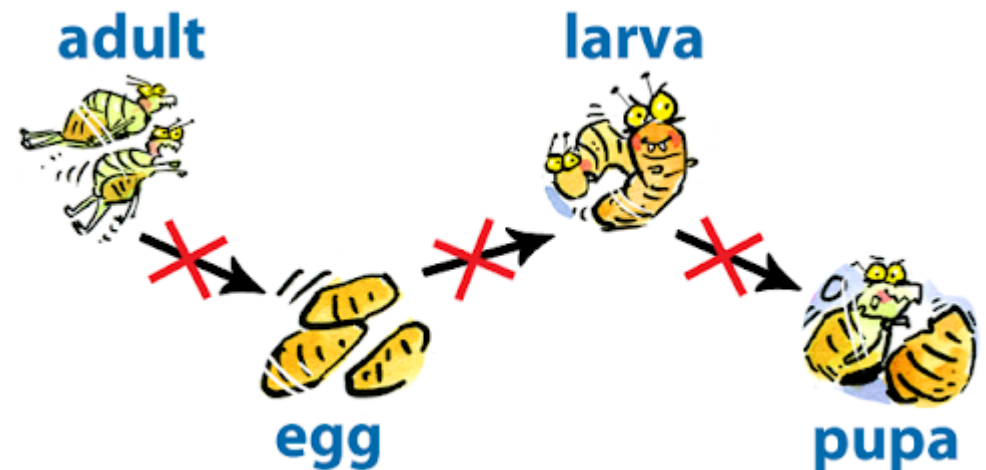
Kaolin clay (Surround[®])

– Physical barrier, excessive grooming



Insect Growth Regulators (IGRs)

- Affect growth and development of insects
- Don't kill immediately but keep insects in juvenile stage or affect their ability to mature normally – mimic the juvenile hormones of insects
- Can also affect fertility, embryonic development, and molting
- Disrupt the pest population buildup



'Natural' Herbicides

- ❑ Cinnamon and lemongrass oil
- ❑ Clove and eucalyptus oils
- ❑ Herbicidal soap
- ❑ Limonene
- ❑ MGM or CGM
- ❑ Soybean oil
- ❑ Vinegar (20% acetic acid)



Maize/Corn Gluten Meal

- ❑ High N byproduct of corn milling, does not contain true gluten
- ❑ Patented as preemergent herbicide in the 1990s at Iowa State Univ.
- ❑ No effect on established weeds, may help turfgrass to outcompete weeds due to high N effect, and also act as a mulch
- ❑ Not selective, can inhibit germination of desirable plant seeds as well as weeds
- ❑ May be effective in the Midwest but not as effective in other climate zones
- ❑ No scientific data from field trials in the Western US
- ❑ Other environmentally friendly weed-control treatments (such as sub-irrigation, mulch, or soil solarization) are cheaper and often more effective than CGM



Oregon State
University

OSU Extension Service

Enter keywords to search...

TOPICS

GET INVOLVED

ABOUT

CONTACT US

BEAVER HEALTHY

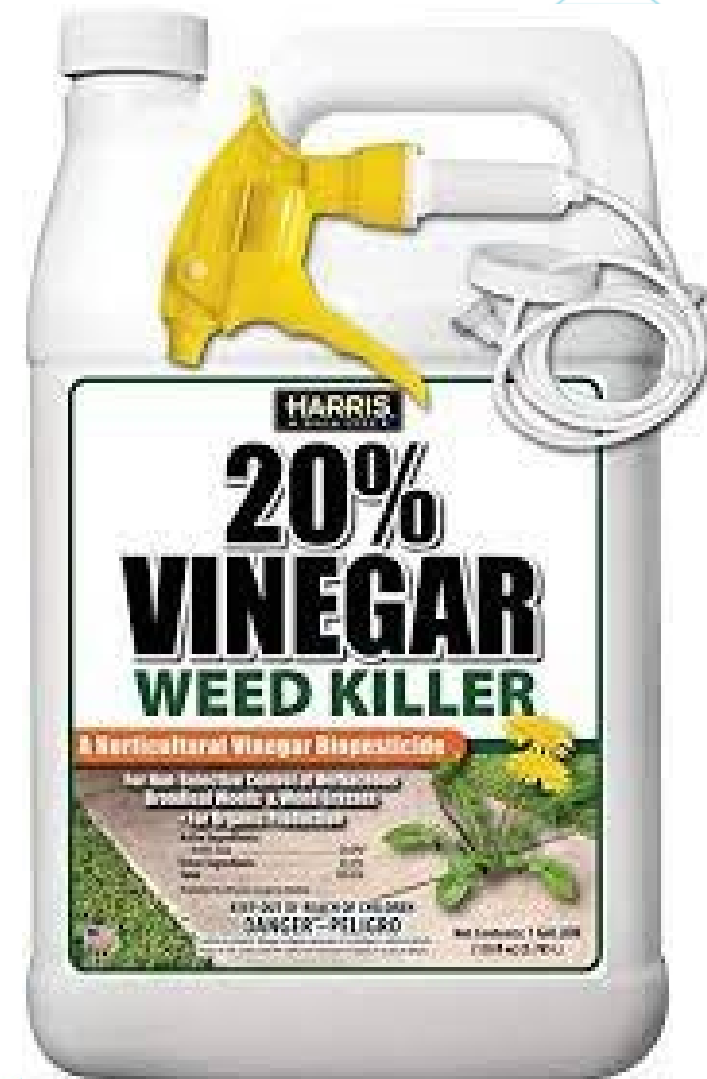
Home / Pests, Weeds, and Diseases / Weeds

Corn gluten meal did not prevent weeds from germinating in OSU study



Vinegar

- ❑ Contact, burndown action, but weeds resprout from the roots
- ❑ May lead users to use higher concentrations
- ❑ Over 11%, acetic acid can burn skin and cause eye damage
- ❑ 20% and above - corrosive to tin, aluminum, iron, and concrete and can even cause blindness
- ❑ Such herbicides should be applied while wearing goggles and protective clothing.
- ❑ Signal word “Danger” misleading – user only sees ‘Vinegar’



Other non-chemical IPM methods

Cultural Control

- Manipulation of cultural practices to reduce or avoid pest damage

Advantages

- No costly inputs
- No specialized equipment
- Minimum cost of labor
- No health hazards
- No effects on non-targets

Disadvantages

- Timing is everything
- No complete control
- Requires long term planning
- May need to repeat multiple times



Cultural

- Correct planting (site selection)
- Seek resistant/tolerant plants
- Avoid susceptible plants
- Start out with pest-free plants
- Plan ahead, diversify plant selection; plant for good bugs
- Rotate plants
- Keep plants healthy
- Monitor/scout



Mechanical/Physical

- Barriers, screens
- Traps, bands
- Mulch
- Tillage
- Sanitation
- Hand removal



Biological control



Bugs get bugs too!

Not all insects are bad!



Lady beetle

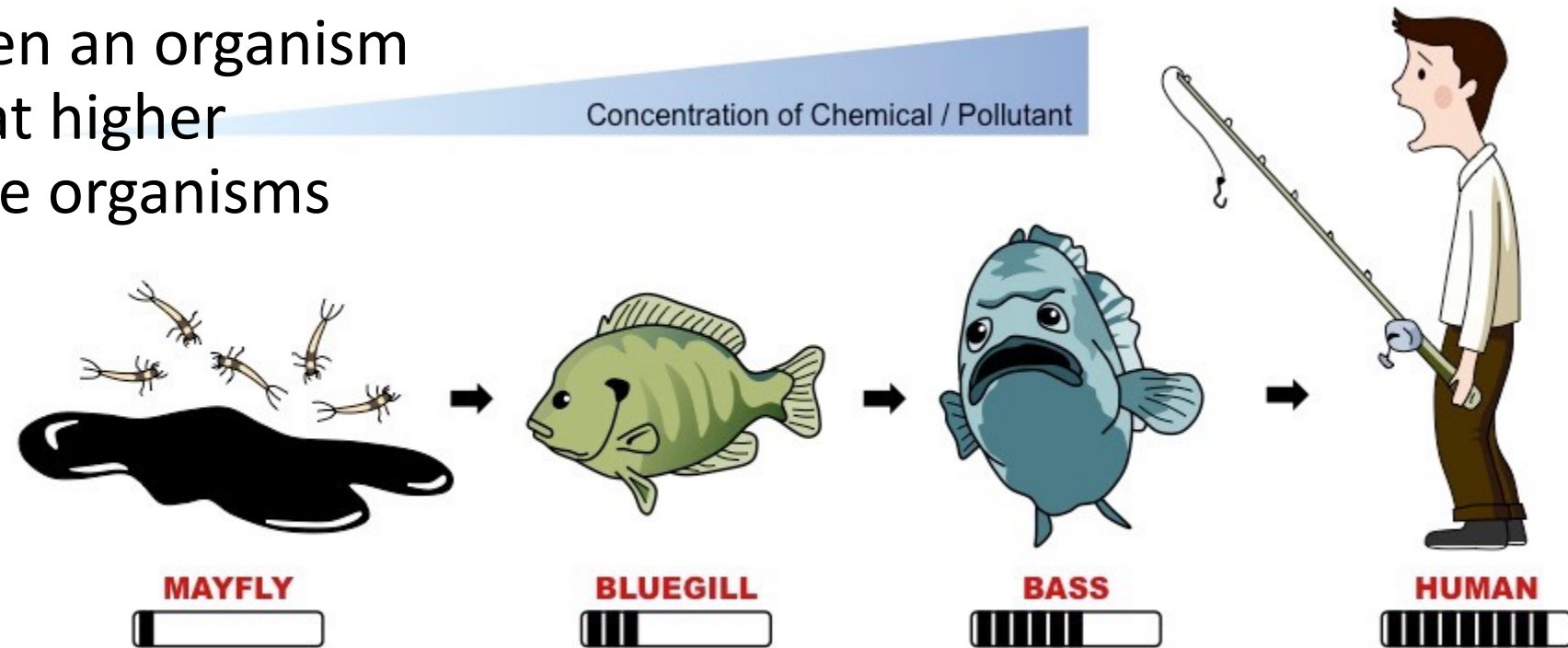


Hover fly

Chemical control

Concerns with pesticide dependence

- **Pest resistance**
- **Environmental persistence**
- **Bioaccumulation:** when a chemical accumulates in animal fat (historical fact)
- **Biomagnification:** when an organism accumulates residues at higher concentrations than the organisms they consume



Chemical control

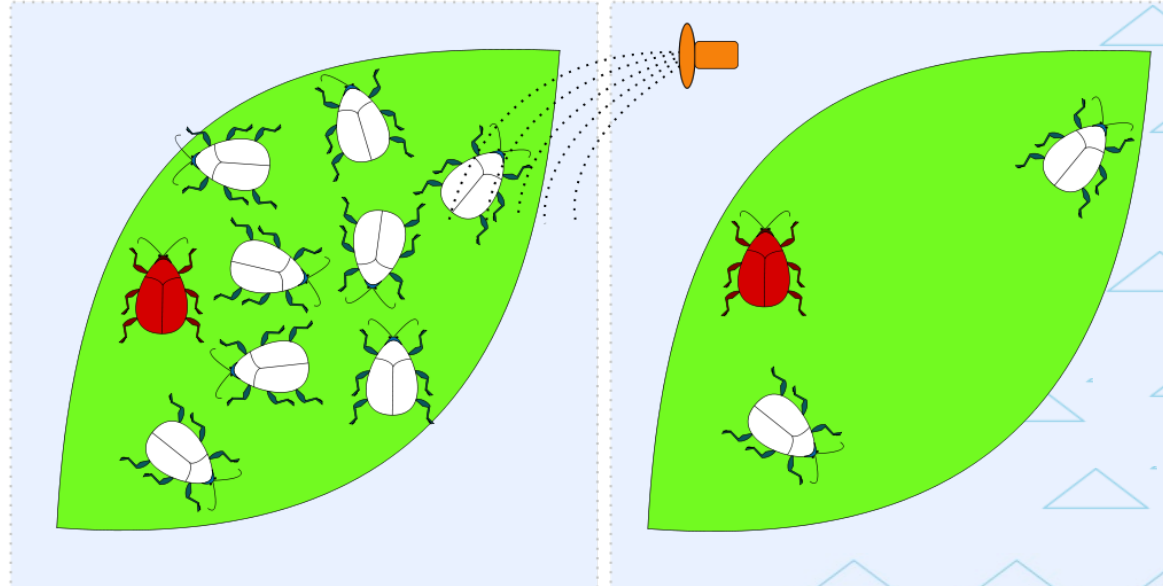
Insecticide Resistance

Occurs when a population of insects builds up a tolerance to a specific chemical, or group of chemicals with the same Mode of Action.

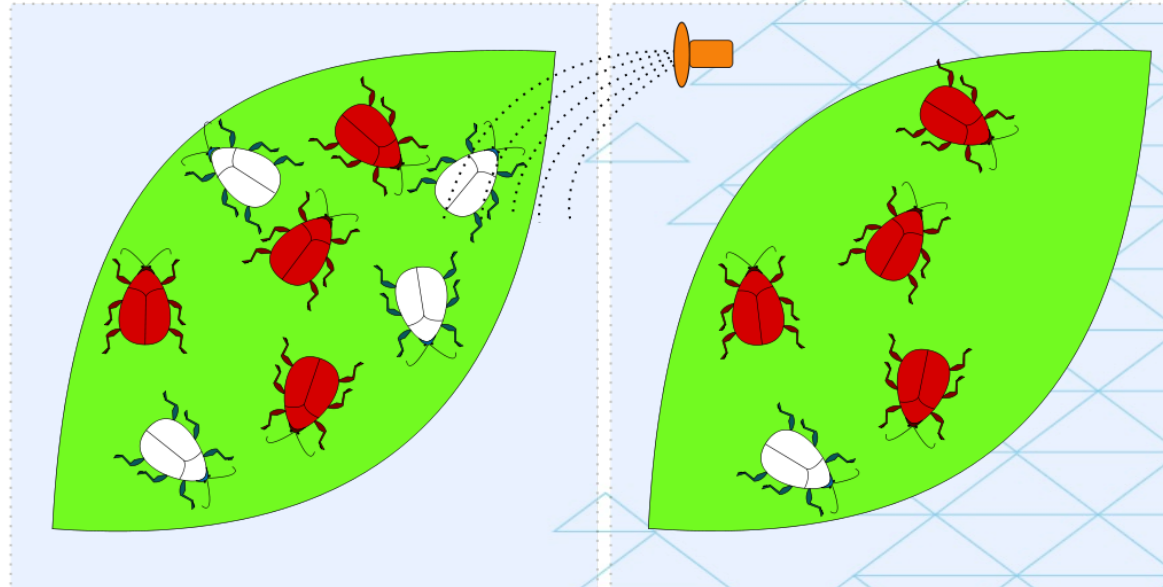
First generation

Before pesticide application

After pesticide application



Later generation



“Safe” Pesticide Realities

- Home remedies and other unregistered pesticides can be harmful to people, pets and the environment
- Pesticide registration does not include product efficacy testing
- Success in lab testing does not guarantee success in the field
- Improperly used products can contaminate the environment
- Improperly used products can create resistant pest populations
- Broad-spectrum pesticides can kill beneficials and non-targets
- More frequent application is often necessary with organics
- Some products are phytotoxic

Bottom line: “Natural” or “non-chemical” does not equal safe

Spot treatments

- ❑ Great way to prevent infestations from spreading
- ❑ Don't always mean spraying something
- ❑ Hand-pulling of weeds is spot treatment
- ❑ Hand-picking of pests is spot treatment
- ❑ Placing a sticky trap is spot treatment
- ❑ Inspecting one plant or one area of your landscape is spot treatment



What is a pest?



What is a pest?



Acknowledgments

- ❖ Linda Chalker-Scott, Washington State University
- ❖ Brian Lehman and Kari Peter, Penn State University



Contact



Shaku Nair, Ph.D.

Entomologist,

Associate in Extension, Community IPM

Arizona Pest Management Center

Maricopa Ag. Center

37860 W. Smith-Enke Road

Maricopa, AZ 85138-3010

Office: (520) 374-6299

nairs@arizona.edu