



UNIVERSITY OF ILLINOIS  
EXTENSION

Illinois Migrant Council

# PREPARING A NEW GENERATION OF ILLINOIS FRUIT AND VEGETABLE FARMERS

a USDA NIFA BEGINNING FARMER AND RANCHER  
DEVELOPMENT PROGRAM PROJECT  
GRANT # 2012-49400-19565

<http://www.newillinoisfarmers.org>





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## PESTICIDES AND PESTICIDE APPLICATION

Rick Weinzierl

May, 2015

Illinois Migrant Council



# Today's objectives

- Know the different categories of pesticides
  - by a few different ways of classifying them
- Understand how pesticides are applied
- Understand key aspects of pesticide use and stewardship for reducing negative side effects
- Understand the regulation of pesticide sale and use in Illinois

This lecture is not a substitute for Pesticide Applicator Training programs. See

<http://web.extension.illinois.edu/psep/> for information on the Illinois Pesticide Safety Education Program

# What I will cover

- Insecticides, fungicides, herbicides, \_\_\_icides
  - Formulations
  - Modes of actions and resistance management codes
  - Residual activity or not
  - Systemic or not
  - Selective or broad-spectrum (non-selective)
  - References for recommended uses
- Sprayers and other application equipment
  - Pesticide placement
  - Coverage



- Pesticide stewardship
  - IPM – agricultural practices, scouting, models, and more
  - Resistance management
  - Environmental protection – to prevent drift, run-off, leaching, pollinator losses, and more
  - Human health – pesticide registration, protective equipment, label restrictions, REIs, PHIs, and tolerances
- US and Illinois regulation of pesticides
  - US EPA and IL registrations
  - Restricted-Use versus General Use pesticides
  - Applicators and Operators
    - Private Pesticide Applicator licensing

# Types of pesticides ... by what they kill

- Insecticides, fungicides, herbicides, bactericides, rodenticides, antimicrobials, ...
- All are regulated as pesticides under FIFRA, the Federal Insecticides, Fungicides, and Rodenticides Act of 1947 (amended in 1972 and 1996)
- Remember that we categorize a chemical according to what we have manufactured it to kill ... acute and chronic toxicity may extend to other kinds of organisms.

# Formulations

- Active ingredients – the stuff that does the killing – are not usually applied in pure form
- They are mixed with “carriers” to reduce risk during mixing and loading, allow uniform dispersal in water, and provide a formulation that is convenient to handle

- Dusts
  - Sevin 5D
- Granules
  - Lorsban 15G
- Wettable Powders
  - Brigade 10WP
- Water-dispersable and water-soluble granules
- Water soluble powders

Dusts and some granules are applied dry; the other formulations are mixed with water. Constant agitation is required for products that do not dissolve. Numbers represent percent active ingredient by weight in the formulated product.

- Emulsifiable concentrates
  - Brigade 2EC
- Soluble concentrates
  - Belay 2.13SC

Liquid formulations that are diluted in water either become suspended or dissolve in water. Numbers that are part of the label name represent the number of pounds of active ingredient per gallon of formulated liquid product.

(And there are additional formulation types.)



# Chemical names, common names, and trade names

- Chemical name
    - 1-naphthyl methylcarbamate
  - Common name
    - carbaryl
  - Trade name
    - Sevin 80WP, Sevin 4EC, etc.
- Chemical name
    - dimethyl (2*aR*,3*S*,4*S*,*R,S*,7*aS*,8*S*,10*R*,10*aS*,10*bR*)- 10-(acetyloxy)-3,5-dihydroxy- 4-(1*S*,2*S*,6*S*,8*S*,9*R*,11*S*) - 2-hydroxy-11-methyl- 5,7,10-trioxatetracyclo[6.3.1.0<sup>2,6</sup>.0<sup>9,11</sup>]dodec- 3-en- 9-yl]-4-methyl- 8-{[(2*E*)- 2-methylbut- 2-enoyl]oxy}octahydro- 1*H*-furo[3',4':4,4*a*]naphtho[1,8-*bc*]furan-5,10*a*(8*H*)-dicarboxylate
  - Common name
    - azadirachtin
  - Trade name
    - Neemix 4.5



## RESTRICTED USE PESTICIDE

Toxic to fish and aquatic organisms.

For retail sale to and use only by certified applicators, or persons under their direct supervision and only for the uses covered by the certified applicator's certification.

**Brigade**<sup>®</sup> 2 EC  
Insecticide/Miticide

### Active Ingredient:

Bifenthrin: (2 methyl[1,1'-biphenyl]-3-yl)  
methyl 3-(2-chloro-3,3,3-trifluoro-1-propenyl)-  
2,2-dimethyl-cyclopropanecarboxylate\* .....

### By Wt.

25.1%

Other Ingredients:\*\* ..... 74.9%

100.0%

This product contains 2 pounds active ingredient per gallon.

\*\*Cis isomers 97% minimum, trans isomers 3% maximum.

\*\*Contains xylene range aromatic solvents.

EPA Reg. No. 279-3313

EPA Est. 279-NY-1



**ALL-WEATHER FORMULA**

**If Inhaled:** Move person to fresh air. If person is not breathing, call 911 or an ambulance, then give artificial respiration, preferably by mouth-to-mouth, if possible. Call a poison control center or doctor for further treatment advice.

**If in Eyes:** Hold eye open and rinse slowly and gently with water for 15-20 minutes. Remove contact lenses, if present, after the first 5 minutes, then continue rinsing eye. Call a poison control center or doctor for treatment advice.

**If on Skin or Clothing:** Take off contaminated clothing. Rinse skin immediately with plenty of water for 15-20 minutes. Call a poison control center or doctor for treatment advice.

### HOTLINE NUMBER

Have the product container or label with you when calling a poison control center or doctor, or going for treatment. You may also contact 1-800-331-3148 for emergency medical treatment information.

### Note to Physician:

This product is a pyrethroid. If large amounts have been ingested, the stomach and intestines should be evacuated. Treatment is symptomatic and supportive. Digestible fats, oils, or alcohol may increase absorption and so should be avoided. Contains petroleum distillate - vomiting may cause aspiration pneumonia.



# Modes of action, insecticides

- Most are nerve poisons
  - Interfere with acetylcholinesterase or with sodium channel ion exchange to trigger tremors and death
    - Are poisonous to humans but our exposure is less and our detoxification systems are different
- Others are insect-specific pathogens or pathogen products, synthetic versions of arthropod growth or molting hormones, or compounds that interfere in a different way with insect physiology.
- IRAC numbers
  - Insecticide Resistance Action Committee (IRAC) numbers on insecticide container labels indicate the “mode of action group” for the active ingredient. To slow development of insecticide resistance in insects, do not use insecticides with the same IRAC number repeatedly
  - See <http://www.irac-online.org/content/uploads/MoA-classification.pdf>

# Modes of action, fungicides

- 12 mode of action groups of fungicides (with several subcategories in most) are recognized by the Fungicide Resistance Action Committee
  - See <http://www.frac.info/publication/anhang/FRAC%20Code%20List%202013-update%20April-2013.pdf>
  - Fungicide Resistance Action Committee (FRAC) numbers on fungicide container labels indicate the “mode of action group” for the active ingredient. To slow development of fungicide resistance in pathogenic fungi, do not use fungicides with the same FRAC number repeatedly
  - Many older protectant fungicides (Captan, for example) act in multiple ways to prevent fungal infections, and pathogenic fungi have not developed resistance to them
- Practically, fungicides are often viewed as either “protectants” or “eradicants”



# Modes of action, herbicides

- Over a dozen mode of action groups of herbicides (with several subcategories in most) are recognized by the Herbicide Resistance Action Committee
  - See <http://www.hracglobal.com/Portals/5/moaposter.pdf>
- HRAC numbers
  - Herbicide Resistance Action Committee (HRAC) numbers on herbicide container labels indicate the “mode of action group” for the active ingredient. To slow development of herbicide resistance in weeds, do not use herbicides with the same HRAC number repeatedly

# How long and where?

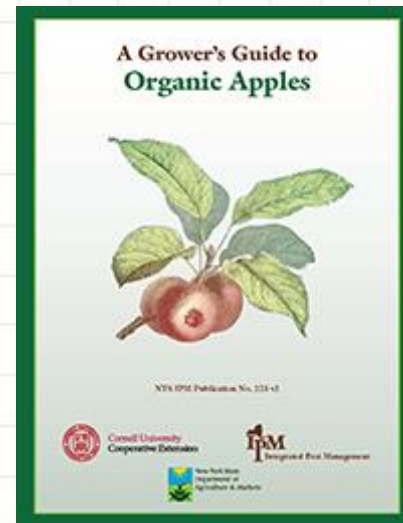
- Residual activity
  - May range from hours to years
  - Differs with temperature, moisture, and light
- Systemic or not
  - Is the pesticide taken into the vascular system of the plant and transported to other plant organs (roots to leaves or leaves to roots)
    - Admire (imidacloprid)
    - Roundup (glyphosate)

# Selective versus broad-spectrum

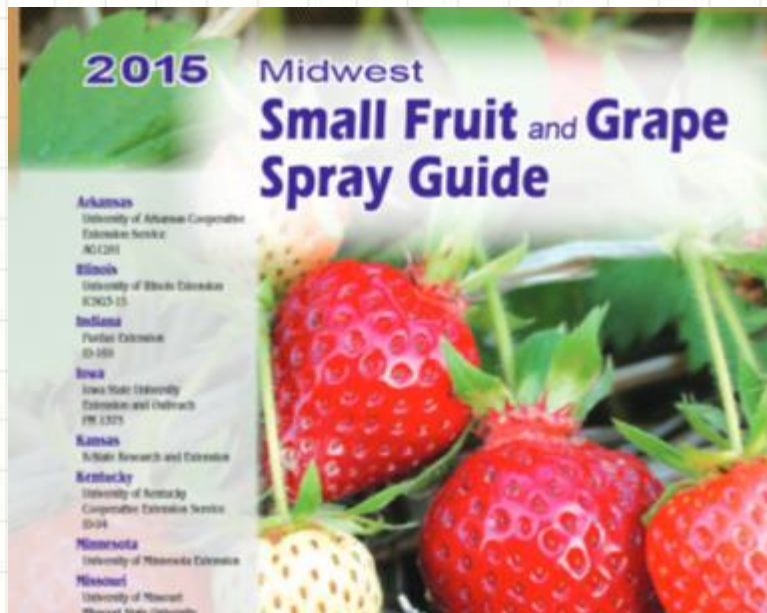
- Selective within a group of target organisms
  - Kills some kinds of insects but not others
    - *Bacillus thuringiensis* (BT) kills Lepidopteran larvae, not other insects
    - Many other examples; several are considered “Reduced-Risk” pesticides
  - Kills some plants but not others
    - 2,4-D kills broadleaf plants, not grasses
- Some pesticides are acutely toxic to a wide range of organisms
  - Methyl bromide (a fumigant) – kills insects, fungi, weed seeds, and people at commonly applied doses

# How do you know what to spray against what pest in a given crop?

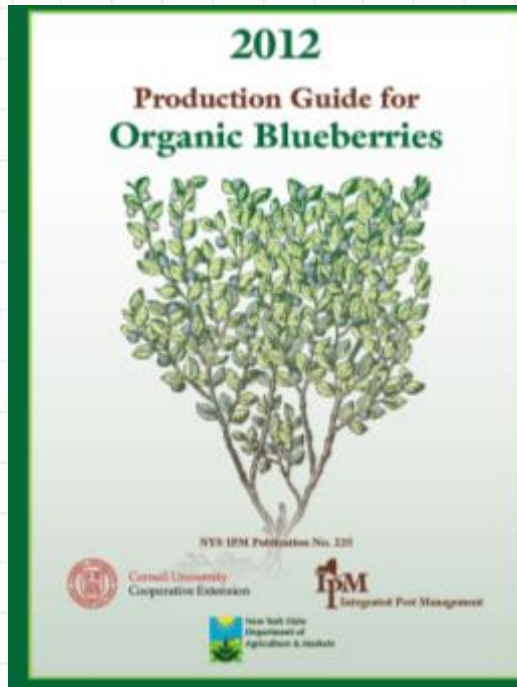
- Midwest Tree Fruit Spray Guide
  - [http://www2.ca.uky.edu/agcollege/plantpathology/ext\\_files/PPFShtml/MwTreeFruitSprayGuideID92.pdf](http://www2.ca.uky.edu/agcollege/plantpathology/ext_files/PPFShtml/MwTreeFruitSprayGuideID92.pdf)
- Cornell Production Guide for Organic Apples
  - [http://nysipm.cornell.edu/nysipm/organic\\_guide/fruit\\_org\\_guide.asp](http://nysipm.cornell.edu/nysipm/organic_guide/fruit_org_guide.asp)







## Spray Guides for Small Fruits



- Midwest Small Fruit and Grape Spray Guide:

<https://ag.purdue.edu/hla/Hort/Documents/ID-169.pdf>

- Cornell Organic Production Guides (blueberries, grapes, strawberries)

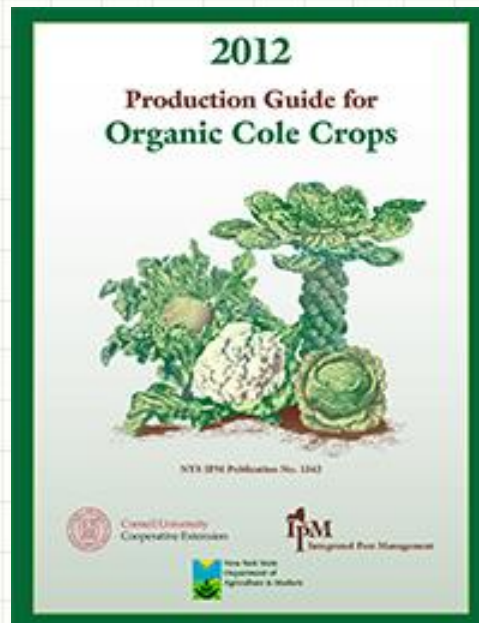
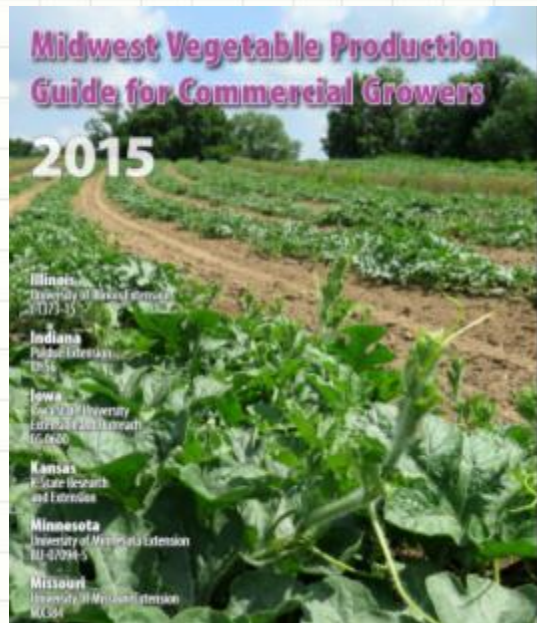
[http://nysipm.cornell.edu/organic\\_guide/](http://nysipm.cornell.edu/organic_guide/)



# For Vegetables ...

## Midwest Vegetable Production Guide

- Midwest Vegetable Production Guide
  - <http://mwveguide.org/>
- Cornell's Organic Production Guides for Vegetables
  - [http://nysipm.cornell.edu/nysipm/organic\\_guide/veg\\_org\\_guide.asp](http://nysipm.cornell.edu/nysipm/organic_guide/veg_org_guide.asp)



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# Production guides and spray guides are great, but ...

## Read the label and follow directions ...

- Target pests – sometimes too inclusive
- Rates – Never exceed maximum rates
- Environmental cautions
  - Blooming crops or weeds, pollinators, water quality, wind speed and drift ... and more
- PHI – preharvest interval
- REI – re-entry interval
- Worker Protection – training, signage, personal protective equipment



# How are pesticides applied in fruit and vegetable production?

- To soil or seed for residual or systemic action
- To soil as fumigants
- To stems, leaves, and fruits for knockdown, residual, or systemic activity
- To closed spaces as fumigants to disinfest produce after harvest

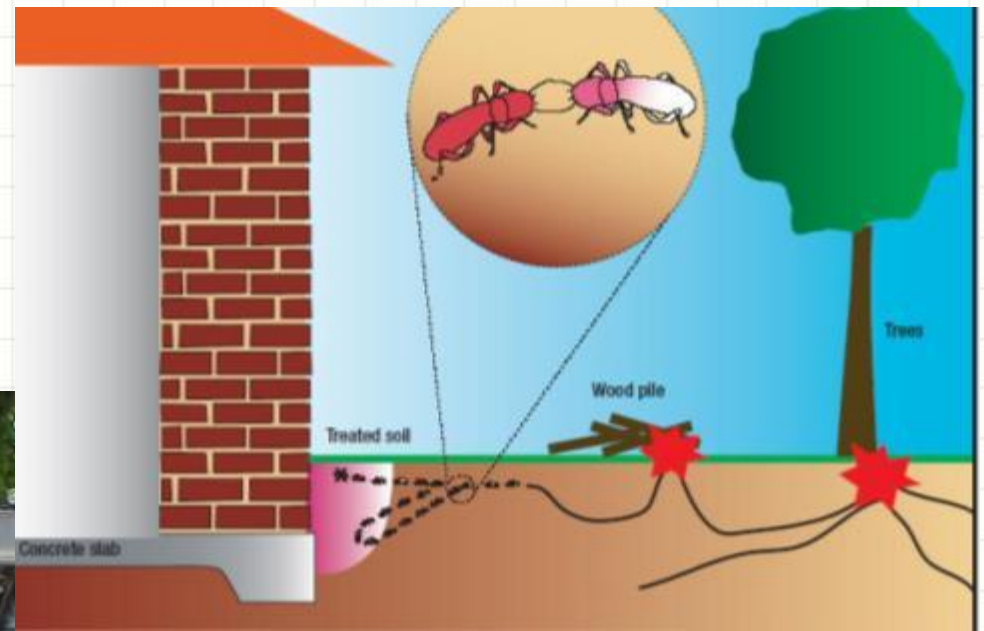


# Soil-applied & seed-treatment insecticides and fungicides

- Soil-applied for residual control:
  - Applied to kill insects or inhibit fungi in treated soil at time of application and for a period up to several weeks later; incorporated (at least lightly) or injected to mix with soil
  - Insecticides sometimes applied at planting for control of rootworms, cutworms, wireworms, grubs, seed and root maggots, etc. in field crops, vegetables, small fruits, gardens
    - Examples:
      - Organophosphates: Lorsban/Dursban, Counter, Diazinon
      - Pyrethroids: Force, Fortress
  - Band applications instead of broadcast applications are most common in crops

# Soil-applied & seed-treatment insecticides

- Soil-applied residual insecticides
  - Typically have (or should have) half-lives of (very roughly) 30 to 90 days
  - Typically are low to very low in water solubility (so that they do not leach out of the treatment zone in spring rainfall)
  - Are not bound too tightly to soil particles as to be unavailable in contact with insects
  - Historic problems have included too-great persistence (aldrin, dieldrin, heptachlor, chlordane, and other organochlorines) and too-great solubility (Temik)



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# Seed-applied residual insecticides and fungicides

- Insecticides and fungicides applied to seed at seed company facility or as a planter-box mixture
- Kill insects that feed directly on seeds and below-ground portions of seedlings
  - Common seed protectants have included diazinon, Lorsban, lindane, and permethrin
  - Targets: seedcorn maggot, other seed and root maggots, wireworms, white grubs, seedcorn beetles
- Prevent infection of seeds and seedlings by soil-borne fungal pathogens (damping off)
  - Captan and several newer fungicides
- IF effective, seed treatments are appealing because they use a lot less pesticide than band or broadcast applications





Treated seeds are also coated with dyes ... do not feed treated seed to animals.



- Soil-applied for systemic uptake
  - Applied at planting or transplanting or later as a drench or in irrigation water
  - Insecticides ... Admire, Platinum, other neonicotinoids
  - Fungicides ... Ridomil Gold
  - Control usually begins a few days after application and persists 2 to 4 weeks; somewhat dependent on precipitation; neonicotinoids used around trees and shrubs may remain active for a year or more
- Seed-applied for systemic uptake
  - Systemic insecticidal seed treatments are sold under the trade names Cruiser, Gaucho, and Poncho – all are neonicotinoids
    - On sweet corn and cucurbit seed (as well as corn and soybean seeds) ... targets include corn flea beetle, cucumber beetles, leafhoppers, and aphids for 1 – 3 weeks after seedling emergence
    - Persistence and off-target movement may pose risks to pollinators, especially for vast acreages planted to corn and soybeans
  - Apron<sup>®</sup> fungicidal seed treatment on sweet corn to reduce damping off



# Soil fumigants

- Primary fumigant against insects, pathogens, and weeds in the soil has been methyl bromide
  - Applications usually made to raised beds tarped with plastic (for specialty crops)
  - Fumigant gas kills organisms present at the time of fumigation; dissipates in a few days
  - Cost = several hundred dollars to >\$2,000 per acre
  - In IL, crops are “plasticulture” strawberries; some peppers and tomatoes
  - Soil fumigation is rare in IL, but in FL, TX, and CA (and a few other areas), fumigating before planting high-value fruits and vegetables is common.
  - Phase-out of methyl bromide because of its ozone-depleting effects presents a major challenge





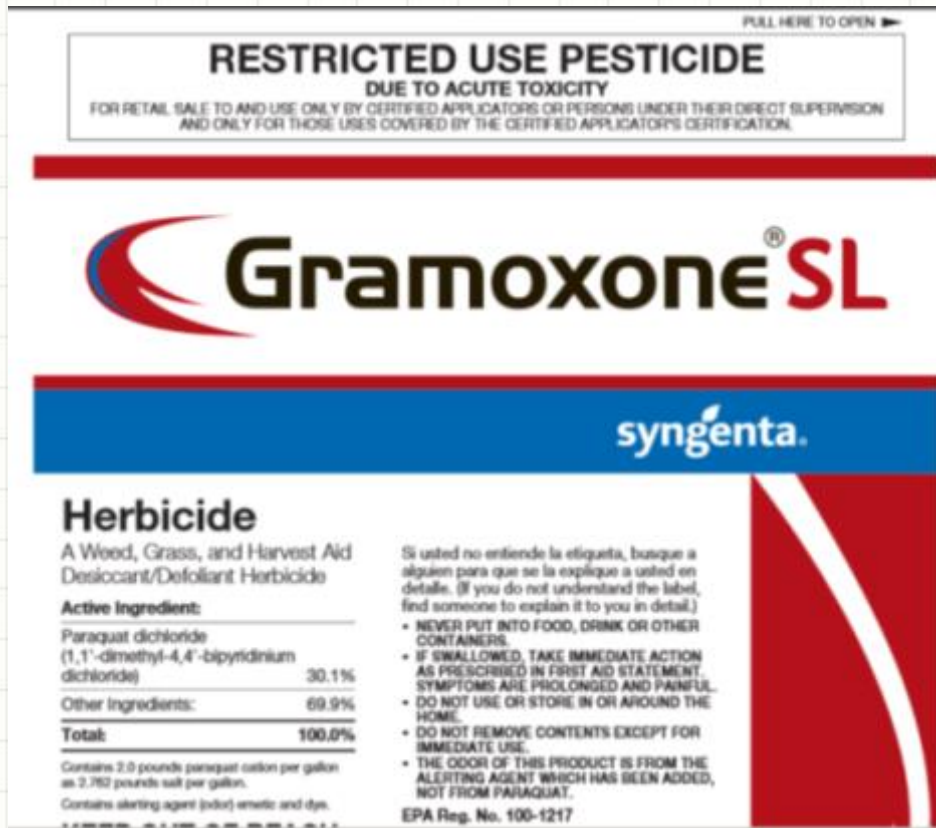
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# Preplant burn-down (nonselective) herbicides

- Gramoxone and Roundup



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# Preplant and pre-emergence selective herbicides applied to soil

- Preplant, incorporated
  - Atrazine in sweet corn
- Pre-emergence, applied to the soil surface after the crop is planted but before it emerges (may also kill small, emerged weeds)
  - Lexar or Lumax in sweet corn (pre-mixes that contain metolachlor, atrazine, and mesotrione)

# Post-emergence herbicides

- Selective
  - Callisto, 2,4-D, and Aim in sweet corn
- Nonselective except to GMO crops ...
  - Roundup on Roundup-Ready sweet corn
- Nonselective but applied in a selective manner
  - Roundup or paraquat (or other products) applied with shielded sprayers between crop rows or beds or in sprays to tree rows but without contact on green tissue

# III. Foliar-applied insecticides

- Foliar “knock-down” insecticides (with little or no residual control intended)
  - Very few insecticides are applied with the intent that they NOT last at least a few days, but insecticides that kill only the insects that are present at the time of application or persist for only a short time include: dormant oils, soaps, pyrethrins, and malathion.
  - Most insecticides that break down rapidly have short **preharvest intervals**; this can be especially important in fruits and vegetables where control may be necessary right up to the time the crop is picked.
    - PHIs are related to rate of breakdown and residues on crops ... NOT safety to applicator



# Foliar-applied insecticides

- Foliar residual insecticides ... Most applications of insecticides to plant foliage, by aerial or ground sprayers, are intended to last for a few to several days as residues on plant foliage
  - Most last from 3 to 10 days as effective residues
  - Treatments remain effective if sprays dry before rainfall of up to 1 inch (generally)
  - In general, most foliar residual sprays are effective as contact poisons ... insects that crawl across treated surfaces are killed when insecticides are absorbed through the insect's cuticle



# Pesticide sprayers

At the smallest scale, pump-up canister sprayers, hand-pump backpack sprayers, and gas-powered backpack mist blowers are low-cost options.





15- to 30-gallon small tank sprayers powered by a 12-volt battery can be mounted on 4-wheelers or utility vehicles. Small pull-behind or 3-point hitch-mounted boom sprayers may be appropriate for larger acreages of low-growing vegetable crops.





For growers with a few acres of sweet corn, a high-boy sprayer that can pass through rows even when corn is 4 to 6 feet tall is usually a necessary investment. For orchards and vineyards, an airblast sprayer – either a pull-behind or 3-point hitch-mounted model – becomes a necessity as plants become large enough that spray penetration into the plant canopy requires air as an additional carrier. It's difficult and time-consuming to treat lots of trees effectively with a hand-sprayer, and applicator exposure is also a concern.



# Foliar (and fruit) applied fungicides

- Many! See the tree fruit and small fruit spray guides and the vegetable production guide
- “Protectant” versus “eradicants”
- Coverage is extremely important

# Systemic insecticides and fungicides applied to foliage

- Movento in apples for woolly apple aphid control
- Fontelis in apples for apple scab control

# Aerosol space sprays

- Examples include “bombs” for fly and fruit fly control in packing houses or cider rooms ... usually pyrethrins or pyrethroids with short residual and low toxicity
- These are not fumigants ... the active ingredient is dispersed in very small droplets of liquid that float through the air and deposit on exposed surfaces (including insects’ cuticles). They do not move as a gas into closed spaces such as cabinets, drawers, etc.





# Space and commodity fumigants

- Examples: methyl bromide, phosphine, chloropicrin, sulfuryl fluoride, and even carbon dioxide.
- In agriculture, used to disinfest stored grains, flour, flour mills and other food processing plants, and ripe fruits and vegetables (Mediterranean fruit fly and similar pests).
- In general, fumigants are EXTREMELY toxic and require special training and equipment for safe handling



Fumigation chamber



# Pesticide stewardship

- Because
  - Pesticides are toxic to nontarget organisms
    - Pollinators, natural enemies of pests, wildlife, fish, humans, other crops and plants
  - Pesticides may reach nontarget organisms through direct application, drift, run-off, leachate, and residues on foods
  - Pest species develop resistance when pesticides are overused
- So ... how to minimize the negatives?



# Use integrated pest management (IPM)

- Use integrated pest management
  - Design farming systems to reduce pest problems
    - Crop rotations, cover crops, diversity
  - Use optimal cultural practices
    - Pruning, thinning, plant densities, planting and harvesting dates, resistant varieties
  - Monitor (“scout”) crops and spray when needed
  - Use least disruptive pesticides

# Use resistance management practices

- Spray only when needed
- Spray only the areas where control is needed
- Rotate among modes of action of pesticides based on IRAC, FRAC, and HRAC code numbers

# Prevent off-site contamination

- Prevent drift
  - Environmental conditions
  - Application methods
- Prevent run-off
  - Waterways, field borders
- Prevent leaching
  - Obey labels regarding sensitive sites
- Do not use pesticides that are highly toxic to bees on blooming crops **or weeds** (or allow their drift onto blooming crops or weeds)



Register on DriftWatch,  
<http://il.driftwatch.org/>

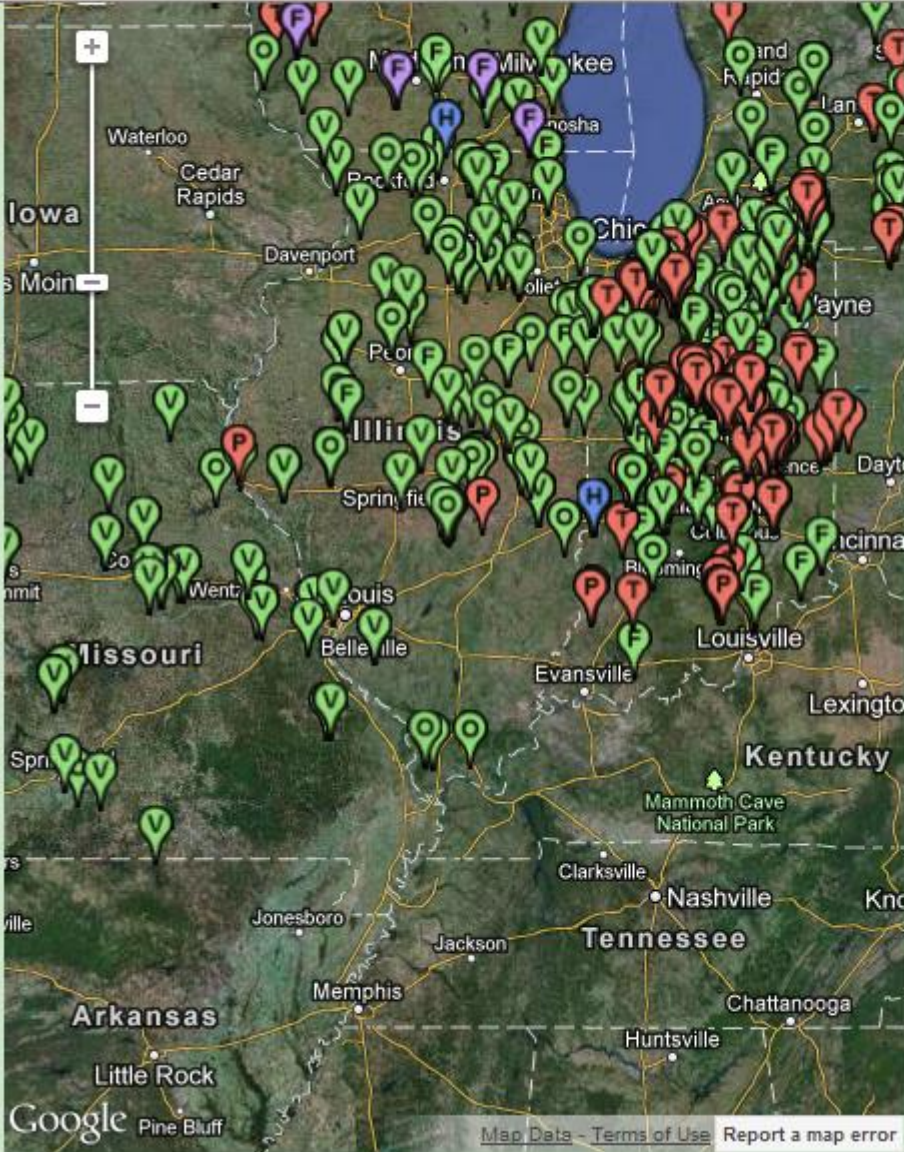
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AVG Secure Search

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Search Safe Do Not Track Weather Facebook



- ☐ Christmas Trees
- ☐ Cranberries
- ☐ Fish Farm
- ☐ Floriculture
- ☐ Floriculture or Greenhouse
- ☒ Fruits
- ☒ Fruit trees
- ☐ Grapes
- ☒ Greenhouse - high tunnel
- ☐ Hardwood Plantation
- ☐ Hops
- ☐ Legumes
- ☐ Mint or Herbs
- ☐ Nursery Crops
- ☐ Onions
- ☒ Orchard
- ☒ Organic Crops
- ☐ Organic Livestock
- ☐ Other
- ☐ Potatoes
- ☒ Pumpkins or Melons
- ☐ Sugarbeets
- ☐ Sunflowers
- ☐ Tobacco
- ☒ Tomatoes
- ☒ Vegetables

These data are meant to facilitate communication between applicators and growers.

Note: bounding lines indicate approximate positions of sensitive lands submitted to the site, not property lines.

Google

Map Data - Terms of Use Report a map error

Disclaimer





Search



Safe



Do Not Track



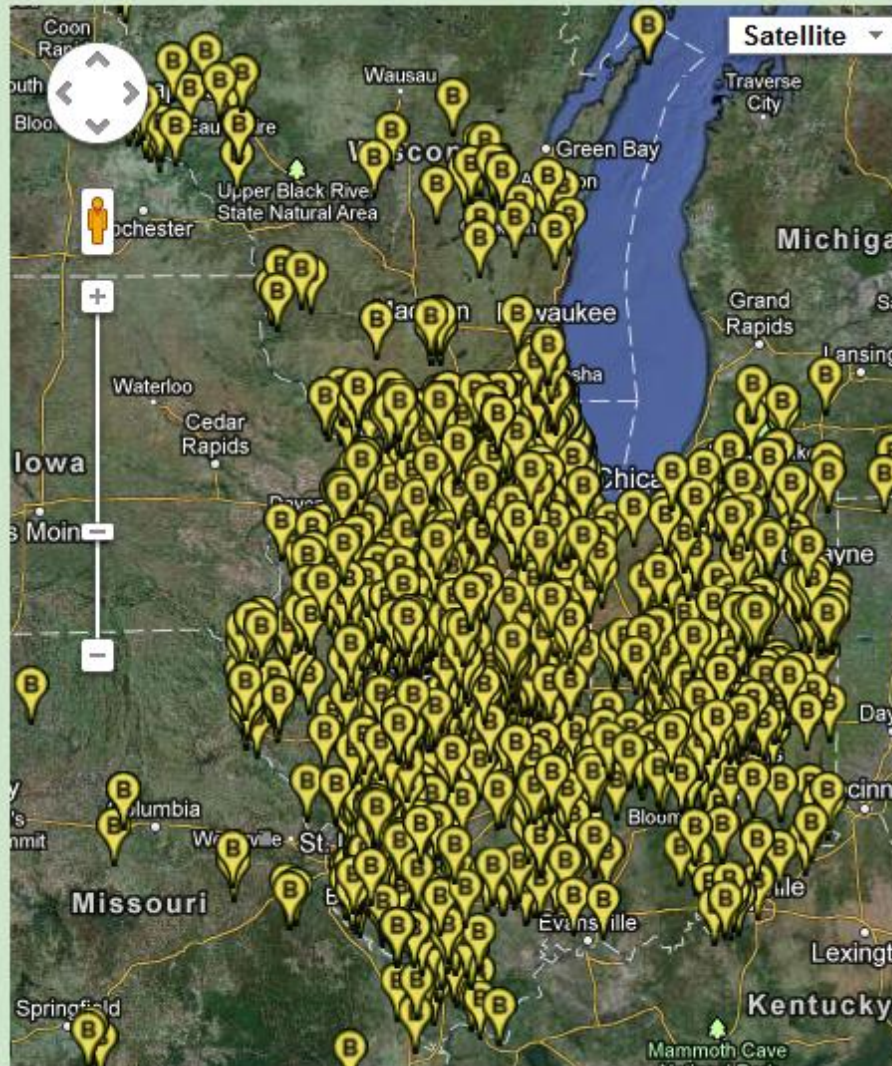
Weather



Facebook



producers | applicators | maps | sensitive crops | user guide | contact us |



### Sensitive Areas Filters

- ☐ All
- ☐ Alfalfa
- ☒ Beehives
- ☐ Berries
- ☐ Certified Organic
- ☐ Christmas Trees
- ☐ Cranberries
- ☐ Fish Farm
- ☐ Floriculture
- ☐ Floriculture or Greenhouse
- ☐ Fruits
- ☐ Fruit trees
- ☐ Grapes
- ☐ Greenhouse - high tunnel
- ☐ Hardwood Plantation
- ☐ Hops
- ☐ Legumes
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- ☐ Potatoes
- ☐ Pumpkins or Melons
- ☐ Sugarbeets
- ☐ Sunflowers
- ☐ Tobacco
- ☐ Tomatoes
- ☐ Vegetables



# Human health

- Pesticide registrations consider
  - Toxicity (acute and chronic) to nontarget species, including humans
  - Persistence of residues on crops and in the environment
  - Pesticide solubility and likelihood of movement in water
- Product labels require practices that reduce risk

- Use only on specified crops ... do not exceed listed rates or apply closer to harvest than specified (PHI) so that residues do not exceed allowable tolerances
- Use personal protective equipment and obey specified re-entry intervals (REIs) and Worker Protection requirements
- Obey restrictions regarding blooming weeds, pollinators, wildlife, and water supplies

A pesticide label is the law ... you may be punished severely for off-label uses



# Pesticide registration (approval)

- Responsibility of the US Environmental Protection Agency
  - Requires data on environmental fate of ingredients and toxicity to test animals. Tolerances (allowed amount of residue on food) reflect these data.
- States can be more restrictive. (IL is not.) Illinois charges a fee per company and product to fund pesticide safety education programs and testing.



# General versus restricted use

- General use pesticides can be purchased by anyone, with no proof of training
- Restricted use pesticides (because of greater risks) may be sold only to licensed applicators
- Labels on pesticides sold to homeowners may state “Not for Commercial Use.” Do not sell produce treated with these pesticides.

# Private versus commercial licenses

- Private applicator  
(= farmer)
- Commercial
  - Applicator (responsible)
  - Operator (worker)
- Several categories
  - Field crops
  - Right-of-way
  - Turf
  - Ornamental
  - Fruit & vegetable

# The Illinois PSEP program

- Training by U of I Extension
- Testing by the Illinois Department of Agriculture

<http://web.extension.illinois.edu/psep/>



## Contacts

Rick Weinzierl

## Contact information

[weinzier@illinois.edu](mailto:weinzier@illinois.edu)





# If you have questions ...

- University of Illinois Extension Local Food Systems and Small Farms team
  - <http://web.extension.illinois.edu/smallfarm/>
- USDA's Start2Farm site
  - <http://www.start2farm.gov/>