Chemical Control of Insect Pests

- Cultural
- Mechanical
- Biological
- Chemical

Pesticide Lesson Plan

- Theory (Lecture)
  - Issues surrounding pesticide use
  - Kinds of pesticides
  - How they are named
  - Insecticide families
  - Modes of action
- Practice (Lab)
  - Reading the label and legal use
  - Personal safety and pesticide hazards

Mixed Messages
Issues surrounding insecticides

- Personal safety
- Impact on environment
- Impact on beneficial insects
- Pesticide resistance
  - Rotate mode of action to reduce resistance

Responses to issues

- Vary in toxicity and modes of action
- Vary in effects on non-targets
- Vary in longevity
- Vary in compatibility with biological control and other non-targets

Most effective long-term use is to choose the least toxic material needed to get the job done

Definitions - Target Classifications

Pesticide = Killer of pests

What do each of these pesticides kill?

insecticide, herbicide, fungicide, miticide, rodenticide, molluscicide nematicide, bacteriacide, piscicide
Modes of lethal exposure to insect

- Contact insecticide - kills on contact
- Stomach poison – must be eaten

Fate of insecticide on plant

- Contact - stays where it is
- Systemic – is taken up by plant roots
- Lamellar systemic - moves through leaf tissue to the other side of the leaf.

Insecticide Nomenclature

- Carbamate - Pesticide Family
- Sevin - Brand (trade) name - Sevin
- Carbaryl - EPA approved common name -
- 70 WP - Formulation abbreviation
  - 70% wettable powder by weight
Classifications of Pesticides
- By source or chemical structure (Pesticide Family)
  - Physical properties, Origin
- By modes of action
  - Important for preventing resistance and assessing non-target effects
- Conventional vs Biorational
  - Legal implications -1996 Food Quality Protection Act
  - Compatibility with biological control

Chemical Families
- Inorganics
- Oils
- Salts of Fatty Acids (soaps)
- Botanicals
- Microbial toxins
- Synthetic organics
- PIPS – Pesticides in Plants (GMO’s)

http://ohioline.osu.edu/b504/b504_6.html

Chemical Families
- Inorganics
  - Boric acid
  - Diatomaceous earth
  - Sulfur
  - Calcium and Lead Arsenates
Chemical Families

- Oils
  - Dormant season grade
  - Summer season grade
  - Citrus oil
- Salts of Fatty Acids (soaps)
  - Insecticidal soaps
    http://ohioline.osu.edu/b504/b504_13.html

Chemical Families

- Botanicals
  - Neem (Azadiractin)
  - Pyrethrum
  - Rotenone
  - Nicotine
  - Ryania
    http://ohioline.osu.edu/b504/b504_13.html
    http://ohioline.osu.edu/b504/b504_6.html

Chemical Families

- Microbial toxins
  - Bacillus thuringiensis
  - Avermectin B
  - Spinosyns
    http://ohioline.osu.edu/b504/b504_13.html
**Synthetic organic Pesticides**

- Organochlorines - (DDT, Lindane,)
- Organophosphates (Malathion, acephate, diazinon)
- Carbamates (carbaryl, methiocarb)
- Pyrethroids (permethrin, bifenthrin)
- Chloronicotynils and Neonicotynils (imidacloprid)
- Insect Growth Regulators
  
  http://ohioline.osu.edu/b504/b504_6.html

**More synthetic organics**

- Fiproles -(fipronil)
- Pyrroles -Chlorfenapyr (Pylon))
- Pyrazoles (Fenpyroximate)
- Pyradizones -Pyradiben(Sanmite)
- Quinazolines (Fenazaquin, Hydramethalnon)

**Modes of action of insect toxicants**

- Physical toxicants
- Antifeedants
- Axonic poisons (nerve poison)
- Synaptic poisons (nerve poison)
- Metabolic inhibitors
- Cytolitic toxins
- Muscle poisons
- Alkylating agents
- Disruptors of molting, metamorphosis and cuticle formation (Insect Growth Regulators)
Kinds of toxicants - Physical

- Physical toxicants – mechanically block physiological process
  - Smothering agents – oils, soaps
  - Abrasive substances that scratch exocuticle
    - diatomaceous earth, silica gel

Kinds of toxicants - Antifeedants

- Antifeedants – repell or are distasteful to insects
  - Neem- Azadirachtin active ingredient

Nerve Poisons: Review of nerve impulse transmission

Axonic poison disrupts flow of charge through axon
Kinds of Toxicants – Nerve Poisons

- Axonic poisons
  - Sodium channel blockers (Pyrethroids-, DDT)
  - Disrupt movement of sodium through axon by clogging axon

Review of nerve impulse transmission

Synaptic poison disrupts flow of message between axons

Impulse transmitted by polarization wave in sodium/ potassium channel

Source: [http://courses.washington.edu/conj/membrane/chan.gif](http://courses.washington.edu/conj/membrane/chan.gif)

Blocking the sodium gate blocks the message
Aceytlcholine and Acetylcholinesterase mediated synaptic transmission

Five general types of synaptic neurotransmitters are known

- Cholinergic
- Glutaminergic
- Indoaminergic
- Catecholinergic
- Octopaminergic

Kinds of Toxicants – Chemical families of nerve poisons

- Synaptic poisons – Block chloride channel by interfering with synaptic neurotransmitters
  - Chloronated hydrocarbons (some)
  - Organophosphates
  - Carbamates
  - Avermectins, Fiproles
  - Nicotinoids, neonicotinoids, spinosyns
Example: Nicotine blocks acetylcholine receptors

Examples:
- Nicotene sulfate

Anyone really need a cigarette????

Carbamate vs Organophosphate modes of action

- Both reduce ability of acetylcholinesterase (Ach_ase) to cleave acetyl choline BUT,
- Organophosphate phosphorylation of Ach_ase is not reversible.
- Carbamylation of Ach_ase is reversible.
Kinds of Metabolic Inhibitors

- Mitochondrial electron transport system blockers
  - Insects unable to exchange biochemical energy (HCN), Rotentone, Organotins, Pyroles, Pyrazoles
    Pyridazaones, Quinazolines)
- Mixed function oxidase inhibitors
  - Disrupt ability to produce detoxification enzymes
    (added as synergists to prevent pesticide breakdown)
- Glycolysis inhibitors (examples??)
  - Poison sugar digestion pathway

Kinds of Toxicants

- Cytolytic
  - Destroy tissue of critical cells
    (eg. Intima-lining of insect gut)
- Muscle poisons
  - Stop muscle contraction
- Alkylating agents
- Insect Growth Regulation Disruptors (IGRs)

Plant Incorporated Pesticides (PIPS)

Genetically modified plants that produce their own pesticides
- BT Corn…etc…
FQPA defined categories

- Conventional- tend to be broad spectrum killing pests and natural enemies, and have long residual activities many are neurotoxins.
- Biopesticide (biorational)- tend to be more selective and with short residual activities. Includes PIPS.

See EPA website:
http://www.epa.gov/pesticides/biopesticides/

Toxicity and compatibility of common insecticides

http://www.entomology.umn.edu/cues/IPM-Pesticides/IPM-pesticides.html

disulfoton vs dimilin?

Study Questions

- Distinguish between a pesticide family and pesticide mode of action.
- Know differences between modes of action associated with neurotoxins, physical toxicants, metabolic inhibitors and insect growth regulators.
- Know how the EPA distinguishes between conventional and biorational pesticides and its relationship to FQPA.
- How does using the least toxic material, reduce environmental problems associated with pesticide use?
- How does rotating with pesticides of different modes of action reduce problems with pesticide resistance.
- Know that the ability of different pesticides to attack different parts of each neurotransmitter system allows the potential for pesticides with different modes of action.