Pesticides and Pest Management in Illinois Agriculture

- IPM References
- Insects and Pest Management
  - The various roles of insects
  - Pests and practices introduced to the U.S. from Europe
  - Development of pest control in the U.S.
  - Integrated pest management
  - Current issues

General References

- Radcliffe's IPM World Textbook
  - http://ipmworld.umn.edu/
- The Transition To Agricultural Sustainability http://ipmworld.umn.edu/chapters/ruttan.htm

Integrated Pest Management

- The use of a range of practices that limit losses to pests while minimizing the environmental damage, human health risks, and dollar costs associated with pest suppression.
  - Tactics include biological control, cultural controls, pest-resistant varieties, regulatory programs … and pesticides where needed and in ways that minimize their adverse effects
- Education of farmers and consumers is key to advancement of IPM

Insects as Pests

- Over 1 million species of insects
- Over half of all living species are insects
- Over 75 percent of all animal species are insects
- Less than 3 percent of all insect species are pests (even by a loose definition)

How serious are insects as pests?

- Life threatening
  - Vectors of disease (mosquitoes that transmit malaria, fleas that carry plague, lice that carry epidemic typhus)
  - Crop destruction and famine (“locusts” of Biblical fame; somewhat less dramatic are the boll weevil, Rocky Mountain locust, Colorado potato beetle, and chinch bug in the U.S.)

- Economically damaging
  - Many crop pests, termites, etc.
- Displeasing to our sense of aesthetics; cosmetic or just annoying
  - Common densities of house flies, cockroaches, Asian multicolored lady beetles
  - Feeding scars on the surface of fruits and vegetables

So, how serious? From inconsequential to life-threatening … efforts to control them should reflect these differences.

From Europe (and elsewhere)


Brown marmorated stink bug

- Pests "introduced" with goods, animals, soil (in "the old days" used as ships' ballast)
  - European corn borer, Hessian fly, alfalfa weevil, codling moth, gypsy moth, cottony cushion scale, horn fly, face fly, and many, many more
  - More recently: Russian wheat aphid, Asian tiger mosquito, Mediterranean fruit fly, Asian longhorned beetle, soybean aphid, emerald ash borer, brown marmorated stink bug, spotted wing Drosophila
- "Indigenous knowledge" is still valuable, but new pests and crops provide new and different challenges than faced by native Americans and early immigrant farmers

Transgenic (GMO) corn was developed to prevent losses to European corn borer.

From Europe (and then elsewhere)

- Monocultures (though tiny in scale to what we now call a monoculture)
- Chemicals
  - Pyrethrins and rotenone
  - Chalk, wood ash, and smoke
  - Arsenic, sulfur, and mercury compounds

Safety??

- No drastic, immediate ill effects to crops, livestock, or humans

Ills caused by old pesticides?

- Talmud writings dated 200-600 A.D. set dose limits for insecticides used in granaries
- France, 1754: field worker poisonings from mercury used as seed treatments; 1786: prohibition against mercury and arsenic in seed steeps

Many other examples

Not all control relied on chemical pesticides

- Columella, A.D. 50: to protect against flea beetles, ants, snails, and caterpillars in the garden: An owl's heart should be hung in the garden, and "a woman, ungirded and with flying hair, must run barefoot around [the garden]."
- Prayers of Muhammad were posted in fields to protect against locusts (A.D. 600)
- 1400s … Swiss archbishop excommunicated cutworms

Francesco Redi, 1668: _____

Insect control in the U.S.

- R.V. Bruce, 1987. The Launching of Modern American Science, 1846-1876.
  - "Scientific emphasis, style, and institutions bear the stamp of a nation's culture and circumstance."

    - "Manifest destiny" … who and when??
    - Agriculture as the nation's champion
    - Insect <u>control</u> versus pest management
      - Pesticides of 1920s, then 1950s to present, accentuated this

Agricultural institutions

- 1862: Morrill Act – land grant universities for agricultural research and teaching
- 1887: Hatch Act – funding for agricultural research
- 1914: Smith-Lever Act – Cooperative Extension Service

Work at land grants led to development of MANY types of pest control practices … and the development of a "percent control" attitude.

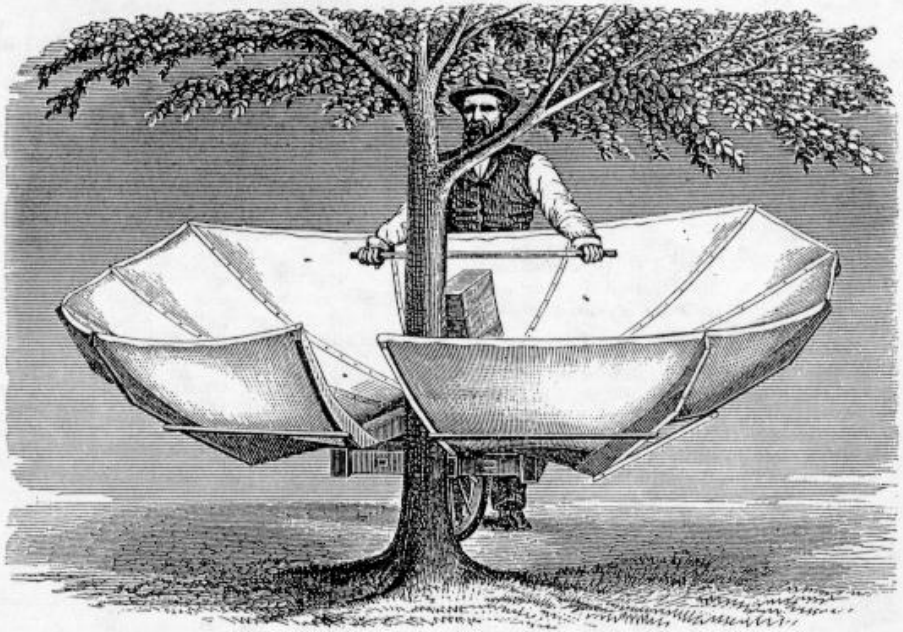
Early pesticides in the U.S.

- Paris green (containing arsenic and copper), against Colorado potato beetle in late 1800s and early to mid 1900s
- Calcium arsenate against boll weevil in cotton
- Lead arsenate in the 1920s against codling moth on apples
  - And codling moth resistance to it
- Oils, nicotine, Bordeaux, cyanide, etc.

Many insecticides were used as baits because they were toxic to plants as well as insects

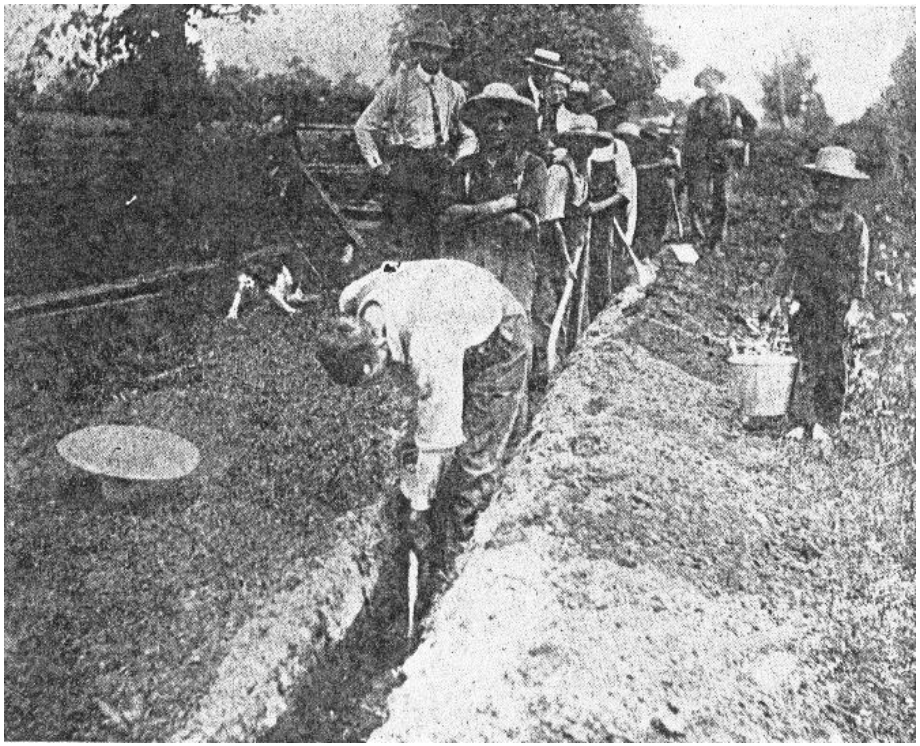
Still: "One for the cutworm, one for the crow, one for the grub, and one to grow."

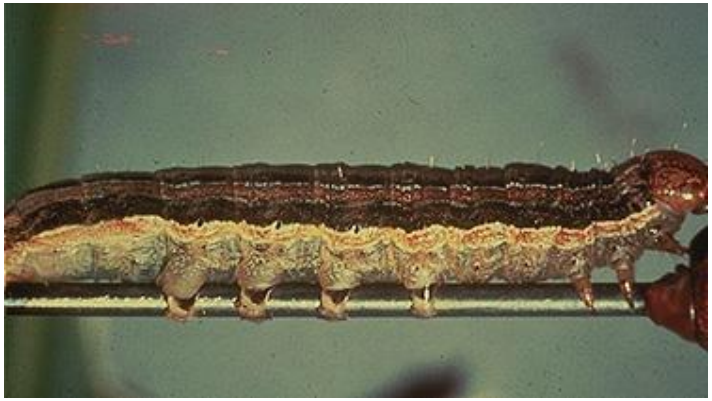
[Fig. 156.]



DR. HULL'S CURCULIO CATCHER.

We recently paid a visit to Dr. Hull's fruit farm, which is situated on the bluffs of the Mister to those few of our readers who were present, and who alone will appreciate the joke, while we give a description of the machine in the Doctor's own words, for the general benefit:





Synthetic insecticides

- 1939: DDT
  - First used on soldiers at the close of WWII to kill body lice and prevent epidemic typhus, then widespread use in mosquito / malaria control
  - Nobel Prize for Mueller
- 1940s and 50s
  - Organochlorines, then organophosphates and carbamates
- ~1960: *Bacillus thuringiensis* (BT)
- 1970s – 1990s
  - Pyrethroids
- 1990s – 2000s
  - Neonicotinoids

Now more novel chemistries, modes of action

First assessments of synthetic insecticides

- Effective
- Not toxic to plants
- Not as toxic to humans as many older poisons
- Inexpensive

So

  – Used too often, too much!!

Problems with insecticides

- Kill beneficial species as well as pests
- Pests develop resistance
- Some persist too long on foods, have been found in milk, etc.
- Some persist a long time in the environment; are transported to water
- Toxicity to humans and other animals (acute and chronic)

Integrated Pest Management

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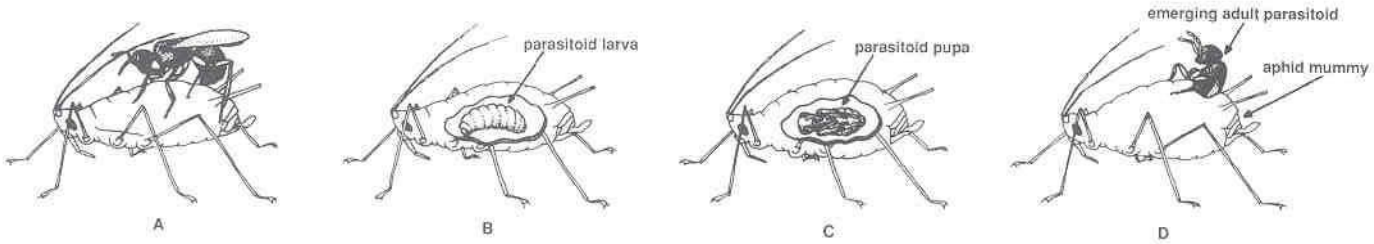
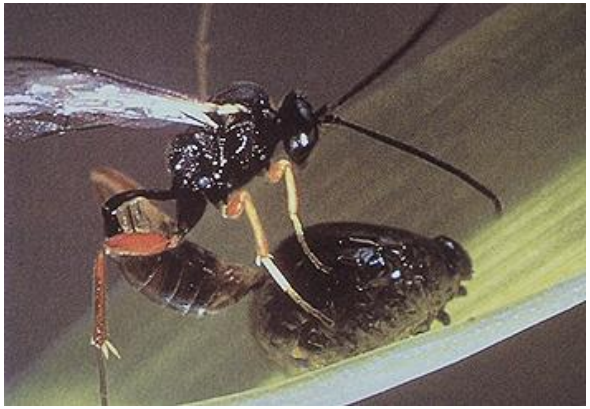
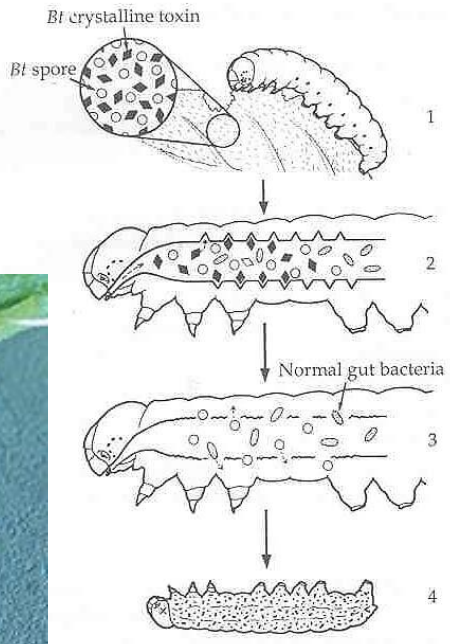
Biological Control

- Manipulation of predators, parasites, and pathogens, by …
  - Importation: Vedalia beetle as predator of cottony cushion scale (1880s), parasites of alfalfa weevil, leaf beetles that feed on purple loosestrife, and many others
  - Conservation: Avoidance of insecticides that kill the predators of European red mite in apples; tillage and cover cropping practices
  - Augmentation: *Encarsia* as a parasite of greenhouse whiteflies; sprays of BT and other "microbial insecticides" (but skip buying lady beetles for gardens)

So why is biocontrol not used more widely?


parasitoid larva
parasitoid pupa
emerging adult parasitoid
aphid mummy
A
B
C
D




Bt crystalline toxin
Bt spore
1
2
Normal gut bacteria
3
4

Cultural Controls

- Crop rotations (corn rootworms, Colorado potato beetle, many plant diseases)
- Optimum planting dates (Hessian fly)
- Tillage

Window screens, caulking, wetland drainage, sanitation, etc.

Resistant Varieties

- Especially to diseases of agronomic crops
- Also
  - Hessian fly in wheat
  - Potato leafhopper in soybeans
  - Greenbug in sorghum
  - And now of course … transgenic BT crops (and transgenic crops that are resistant to otherwise broad-spectrum herbicides)

Regulatory actions

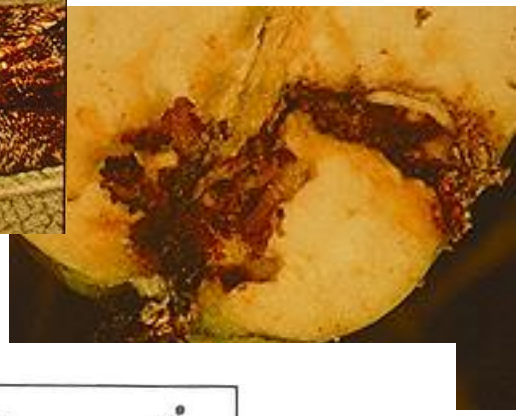
- Quarantines
- Border inspections
- Phytosanitary certificates
- (And USA EPA regulation of pesticides)
  - With some notable exceptions, great progress in shifts to pesticides with much lower human and environmental toxicity

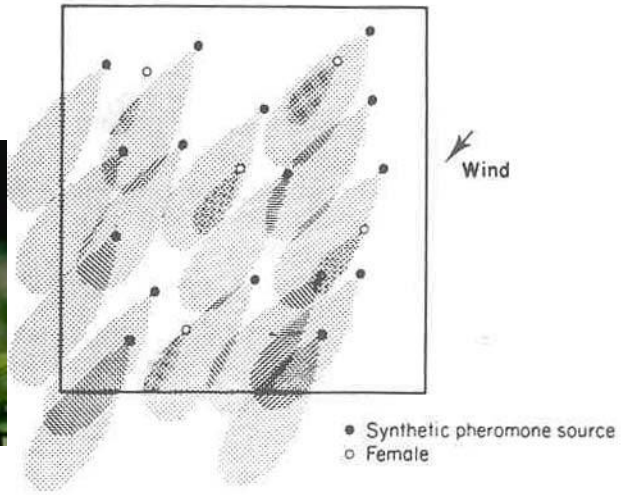
Pesticides

- Consider
  - Toxicity (acute and chronic) to nontarget organisms
  - Persistence in the environment
  - Propensity for transport (solubility and movement in water)

Progress in IPM

- Establishment of economic thresholds and "scouting" programs
- Prohibition of use of "worst" pesticides
  - Current EPA emphasis on "reduced risk" pesticides
- Incremental gains in resistant varieties, cropping systems (mixed cropping, etc.)
- Semiochemicals (pheromones) in monitoring and disruption of mating
- Transgenic Crops




Wind
Synthetic pheromone source
Female

Impediments to nonchemical IPM in the U.S.

- Chemical and mechanical infrastructure
- “Expensive” labor (on an international scale)
- Vast acreages of crops
- Uncertainties about whether or not ALL pesticides are so bad
- Pesticides (and transgenic crops) are easier to sell than knowledge

Current Issues

- Pesticides as carcinogens, neurotoxins, hormone disruptors, etc.
  - Bruce Ames, Mothers and Others, NRDC …
- Transgenic Crops
- Pollinators, including issues with neonicotinoids and bees
  - Neither Bt crops nor Round-up (glyphosate) applications in crop fields are toxic to bees
- Organic foods, local foods
- Water !!!
- Polarization of debates on environment versus development

A scientific attitude

- Davis, I.C. 1935. The measurement of scientific attitudes. Science education 9:117-122.
  - Willingness to change opinion on the basis of evidence
  - Desire to search for the whole truth regardless of personal, religious, or social prejudice
  - Understanding of the concept of cause-and-effect relationships
  - Habit of basing judgment on fact
  - Power or ability to distinguish fact from theory
  - Freedom from superstitious beliefs

I've heard that …

And they say …

How many "hits" come up for a Google search of "safety GMO crops"?

3,510,000

Cartoon from "Beware of false balance …" at http://undsci.berkeley.edu/article/sciencetoolkit_04. Are there similar concerns with reporting on … ?

- Pesticides
- Climate change
- Clean Water Act