# Organic Pest Management for Row Crops



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# Definition of Organic directly related to Integrated Pest Management (IPM) principles

"An ecological production management system that promotes and enhances biodiversity, biological cycles, and soil biological activity. It is based on minimal use of off-farm inputs and on management practices that restore, maintain and enhance ecological harmony."

National Organic Program (NOP), NOSB

# Principles of ecology/agroecology in organic agriculture rules

Biodiversity: Diversity = Stability

- Multiple species in the system (e.g., crop rotations: “The same crop cannot be grown in the same field every year”; intercropping, buffer strips, companion planting): Rotating can interrupt insect, weed and disease cycles
- Pests less likely to find hosts when hosts are switched

Biotic regulation: Feedback mechanisms between organisms to keep pest population levels in check

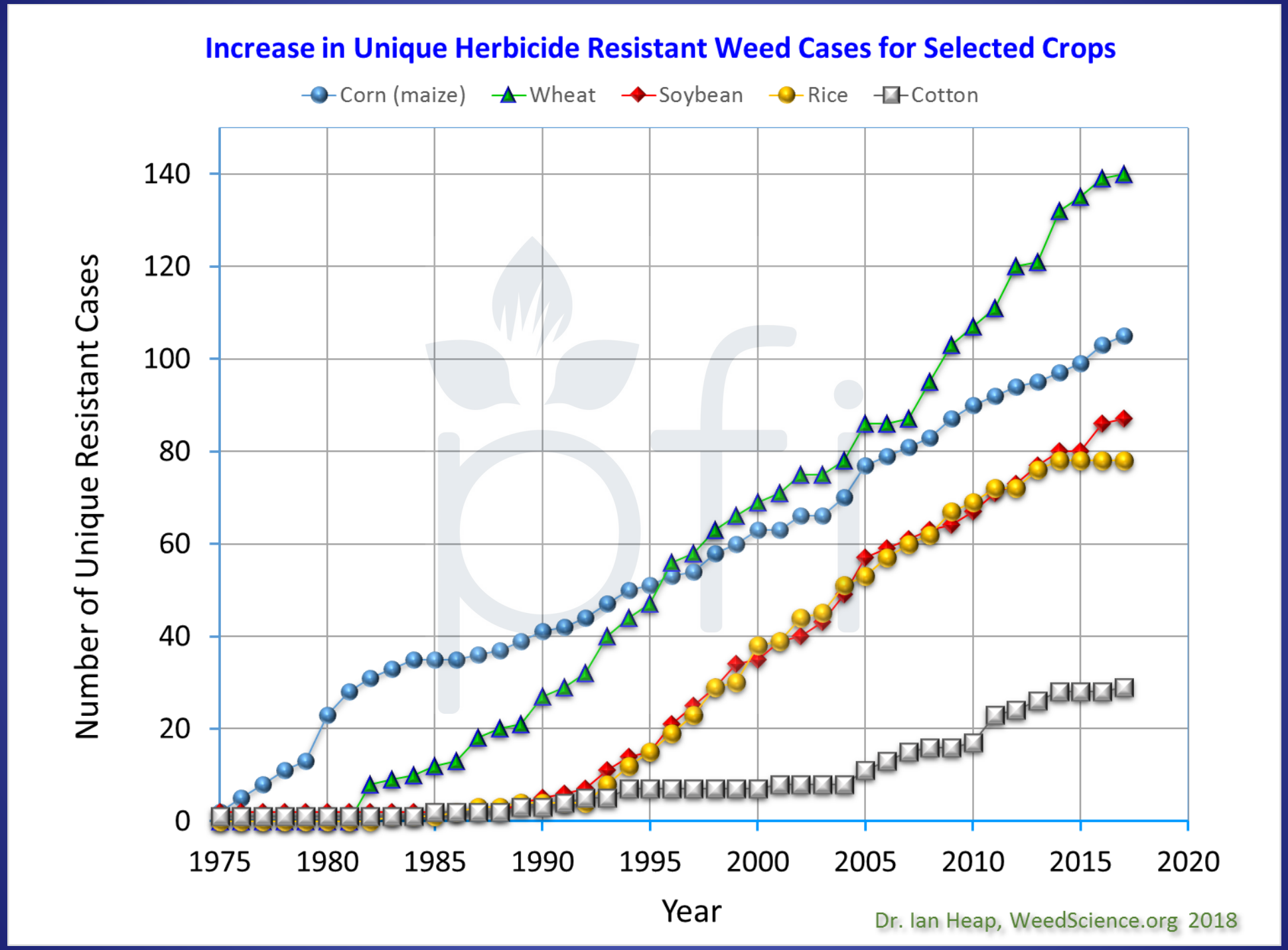
Stability of production: After a disturbance, community returns to equilibrium condition

Red clover and winter wheat add C and N plus interrupt corn rootworm and soybean cyst nematode life cycles

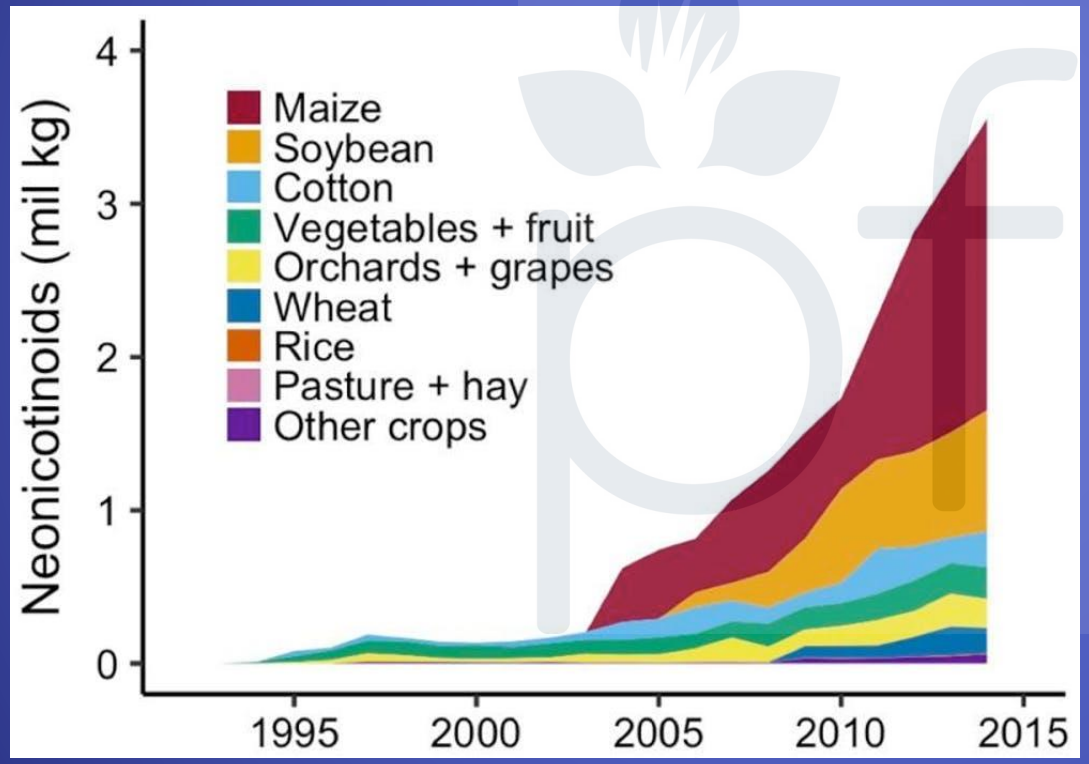
# No. 1 consumer preference is for foods with no/limited pesticide residues


British Journal of Nutrition
Issue 05 / September 2014, pp 794-811

- Pesticide residues were four times more likely to be found in conventional crops than organic ones
- Organic crops were up to 60% higher in a number of key antioxidants than conventionally-grown ones
- Antioxidants are associated with plant's natural defenses against insects/diseases


Increase in Unique Herbicide Resistant Weed Cases for Selected Crops
Corn (maize)
Wheat
Soybean
Rice
Cotton
Number of Unique Resistant Cases
0
20
40
60
80
100
120
140
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year
Dr. Ian Heap, WeedScience.org 2018

# Systemic insecticides – highly water soluble (neonics)




Tooker, Douglas, Krupke, 2017, doi:10.2134/ael2017.08.0026,

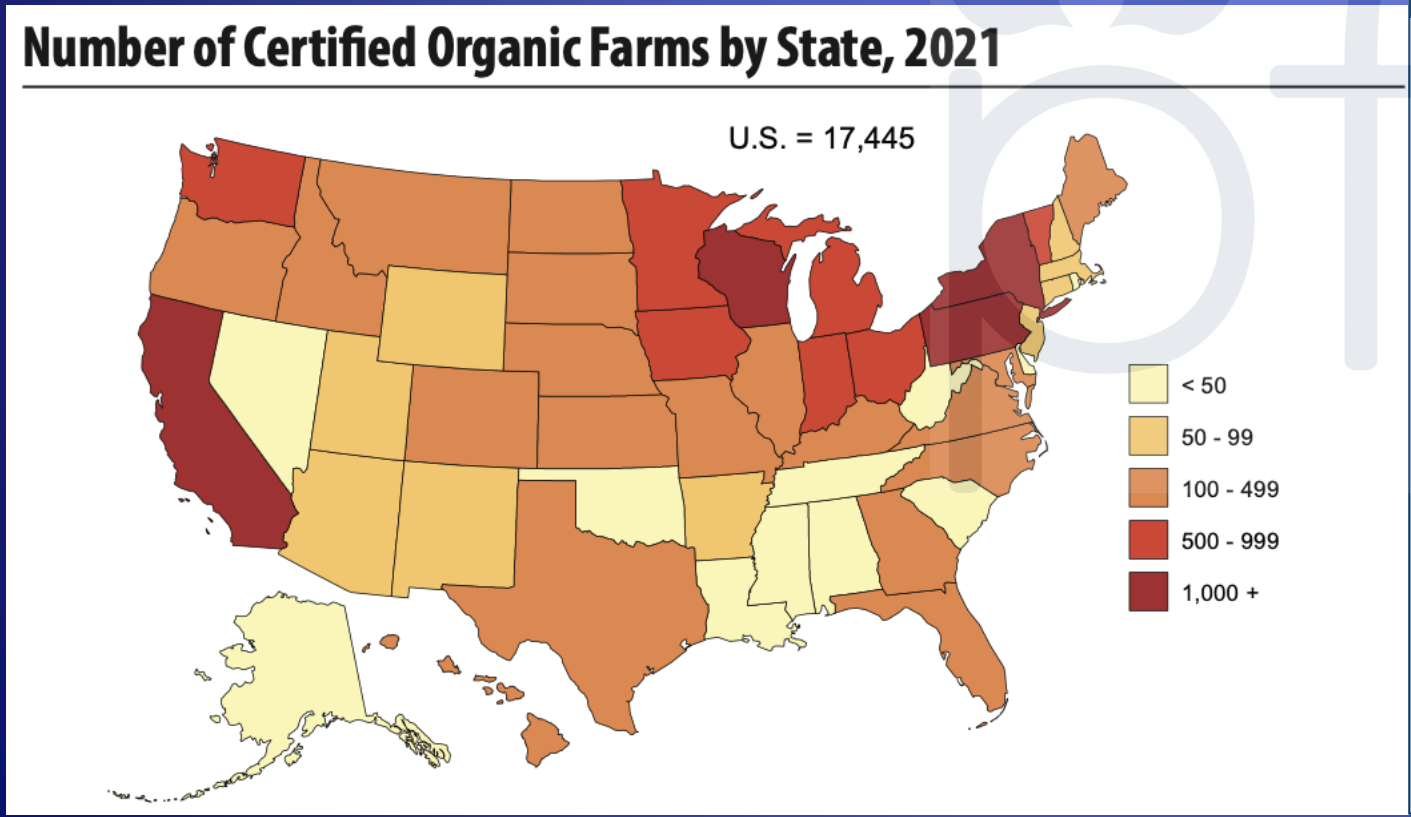
Tooker et al. (2017)

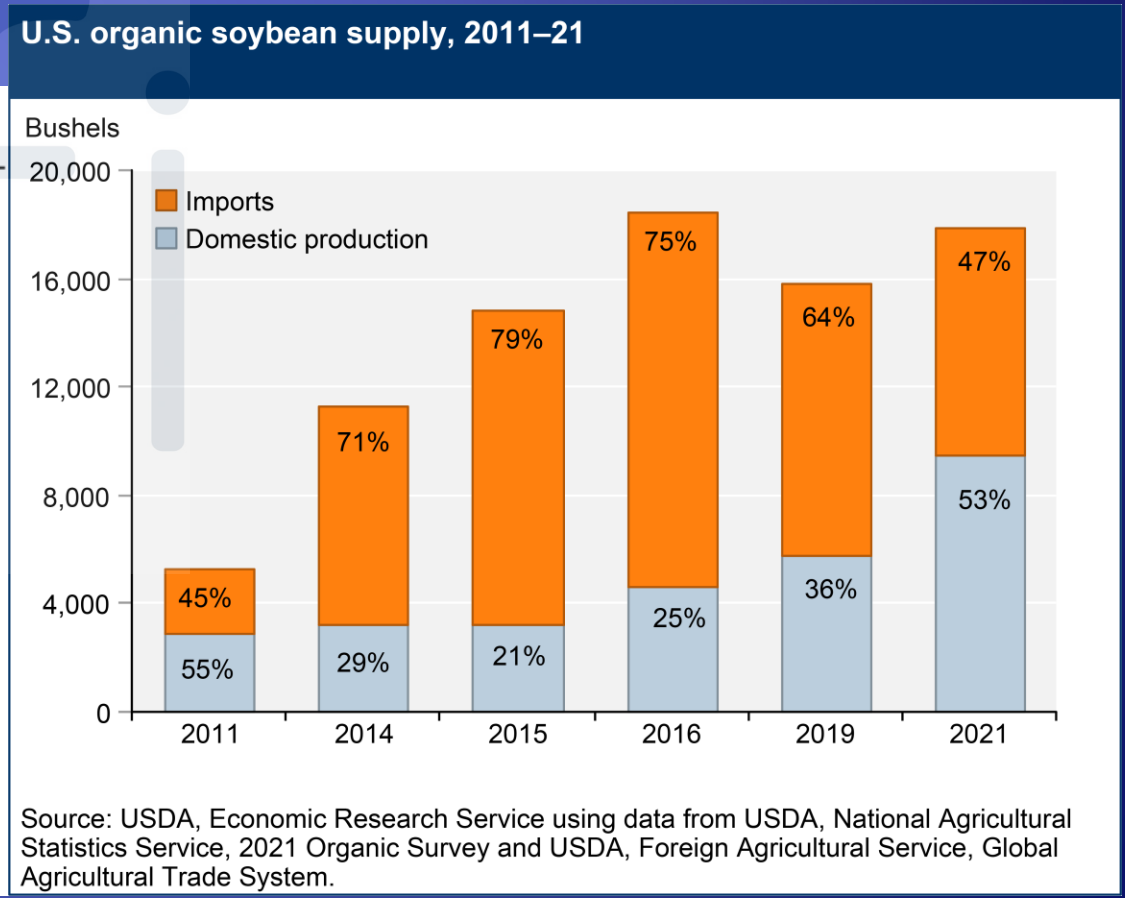
– In Pennsylvania soybean seed treatments disrupted natural enemies, increased slugs, and reduced yields.

- No economic benefit, substantial environmental detriment and health risk from seed treatments

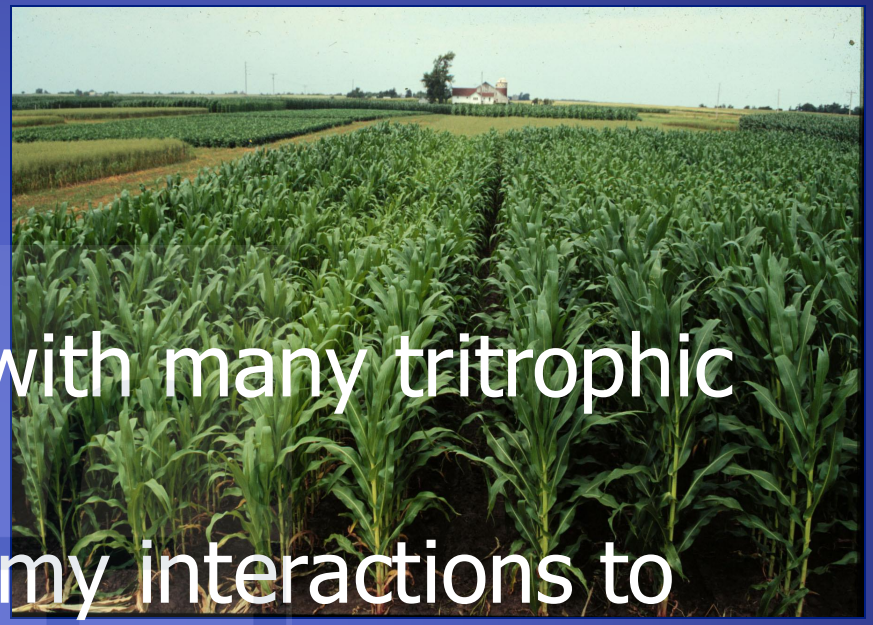
# Iowa: A Leader in U.S. Organic Grain Production

- Largest organic grain producers: Iowa, Minnesota, Wisconsin, Illinois, Nebraska
- Challenge: To improve domestic production/supply and reduce imports



# Organic Approaches



- *The farm is a system* with many tritrophic interactions: multiple plant-pest-natural enemy interactions to help create a balance
- USDA-NOP requires soil quality maintenance to ensure healthy plants
- Prevention of problems
- When controls are warranted, the least toxic materials should be utilized to avoid harm to beneficials/pollinators

# Organic pest management resembles Integrated Pest Management (IPM)

- Multiple, proactive tactics – Suppress pest pressure
- Minimize economic, health, and environmental risks
- Improve profit margin
- Monitor/survey/observe
- Treat when thresholds are reached

Ladybeetle larva

Syrphid larva


-E. Hodgson, ISU

# Organic Pest Management

***Pandora* on aphid**

- Biological
  - Parasites, predators, pathogens (entomopathogen)
  - Host plant resistance (resistant varieties)
  - Conservation of beneficial insects and insectivorous birds (Bio-diversity on farm, biological control)
  - Augmentation (primarily in greenhouses)


- Cultural: Preventative practices (crop rotations)
- -Mechanical/physical barriers (row covers, sanitation, timely harvests; tillage)
- Chemical: naturally-occurring chemicals: garlic, sulfur, neem (azadirachtin). Least toxic organic-compliant pesticides used.

Insectary plants in tree middles

Whitney Cranshaw, Colorado State University

Bugwood.org

*Cotesia* on *Pieris rapae*

British Ecological Society

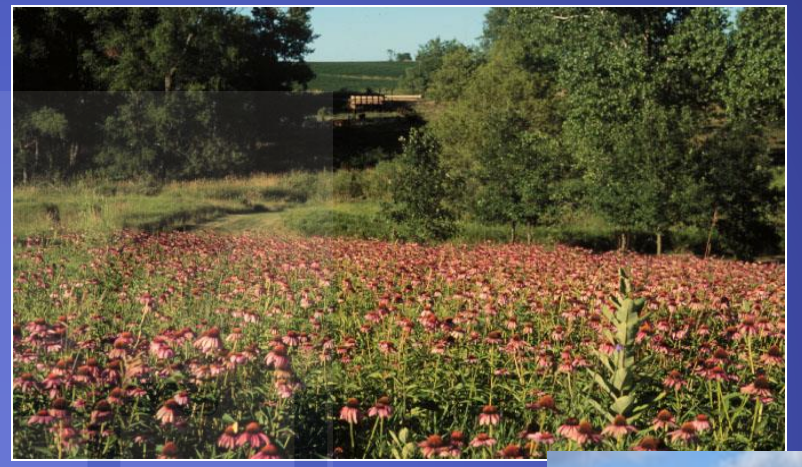
Parasitoids

Row covers

# Biological Control

- The basis of sound organic farming
- Natural enemies (predators, parasites and pathogens) exist for nearly every pest
- Conservation of beneficials is key
- Augmentation (purchased beneficials) can work in certain cases (e.g. greenhouses) but generally, conservation is more effective

# Multi-species crop/farm borders to enhance biological control and pollination



- The landscape surrounding crops affects the amount and timing of ecosystem services such as pest suppression and pollination
- **Flowering perennials can increase insect predators** and reduce herbivores in field crop production systems


Landis, D.A., S.D. Wratten & G.M. Gurr. 2000. Habitat Management to Conserve Natural Enemies of Arthropod Pest in Agriculture. Annual Review Entomology 45:173-201.

https://www.gwct.org.uk/farming/advice/sustainable-farming/beetle-banks/

# Biological IPM options

- Conserved areas
- Trap crops (okra, sunflowers)
- Beneficial insect releases
- Entomopathogens: *Bacillus thuringiensis; Steinernema*

https://www.organiccotton.org

# Bean Leaf Beetle

*Cerotoma trifurcata*

Damage:

- Larvae feed on soybean roots
- Adults feed on soybean pods, more economically significant than the larval damage
- Some leaf damage
- Transmits Bean Pod Mottle Virus
- Opens infection sites for *Cercospora, Fusarium* (other staining fungi)


An adult bean leaf beetle (ISU IPM).

Bean leaf beetle larvae (ISU IPM).

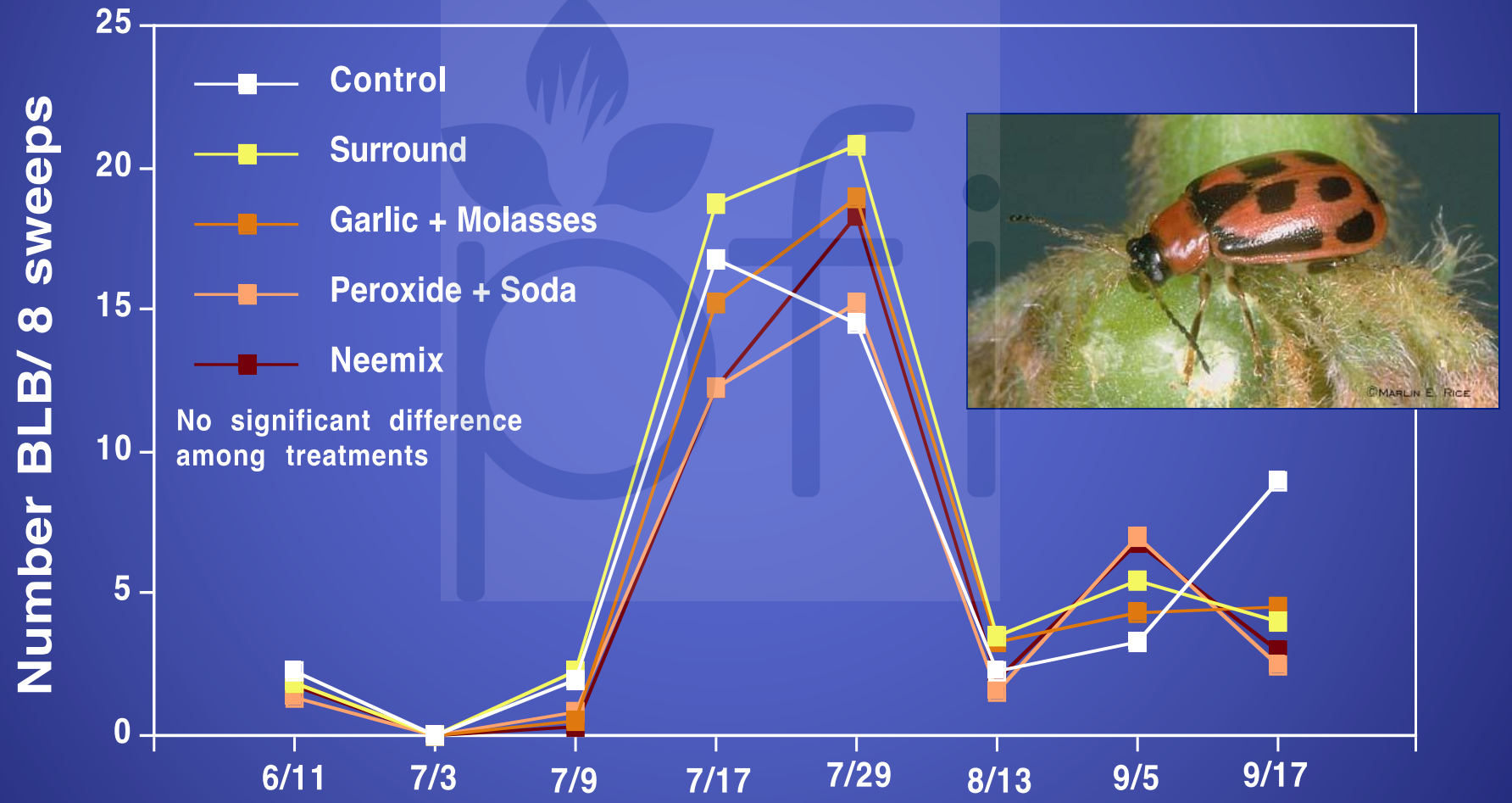
# Bean Leaf Beetle


- Rejection of stained organic tofu beans
- More aesthetic than food quality distinction

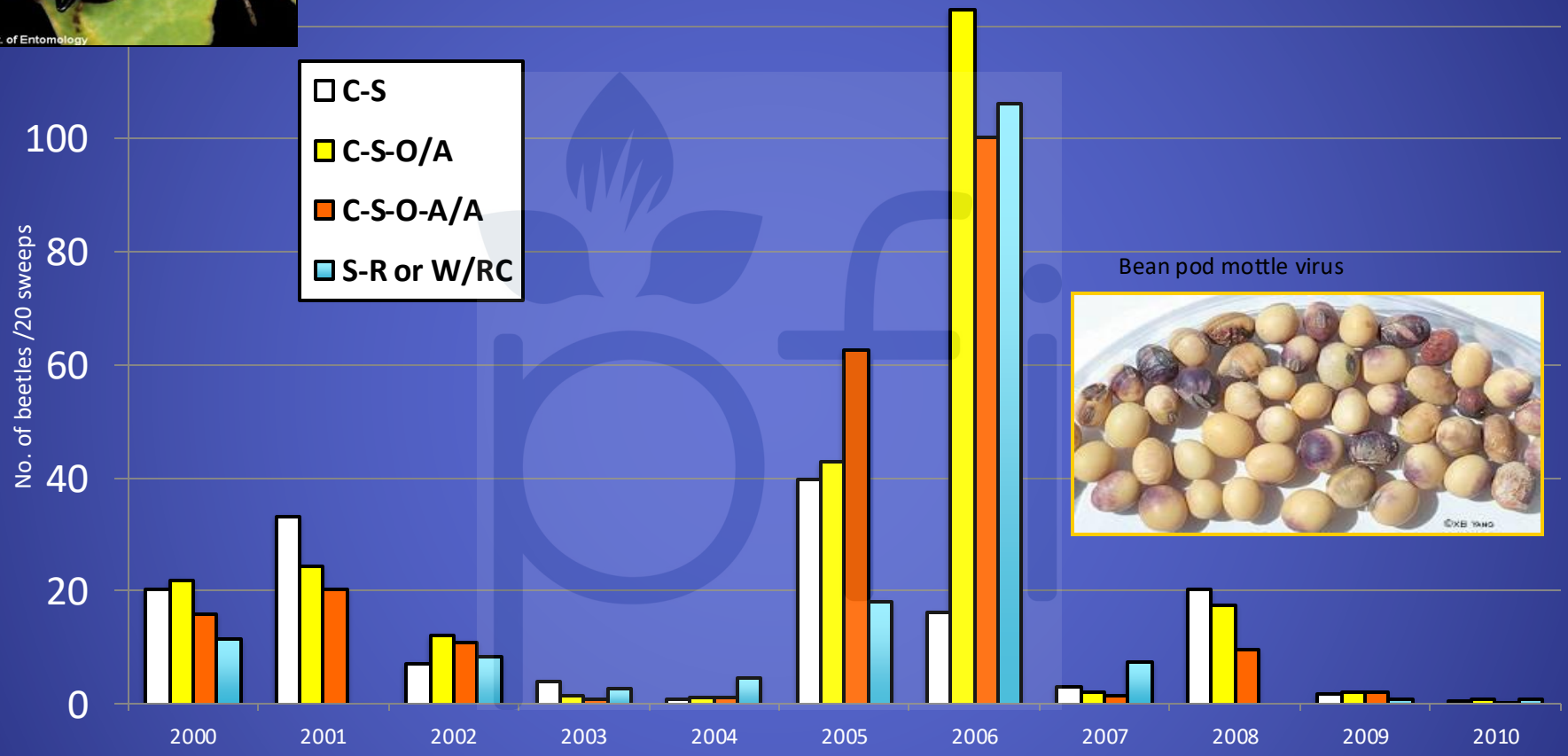
Management:

- Hard winters reduce emergence rates
- Late planting can protect pods from damage

# Bean Leaf Beetle Population Cycles
# Two generations/yr




# LTAR Peak Bean Leaf Beetle Populations




Bean pod mottle virus

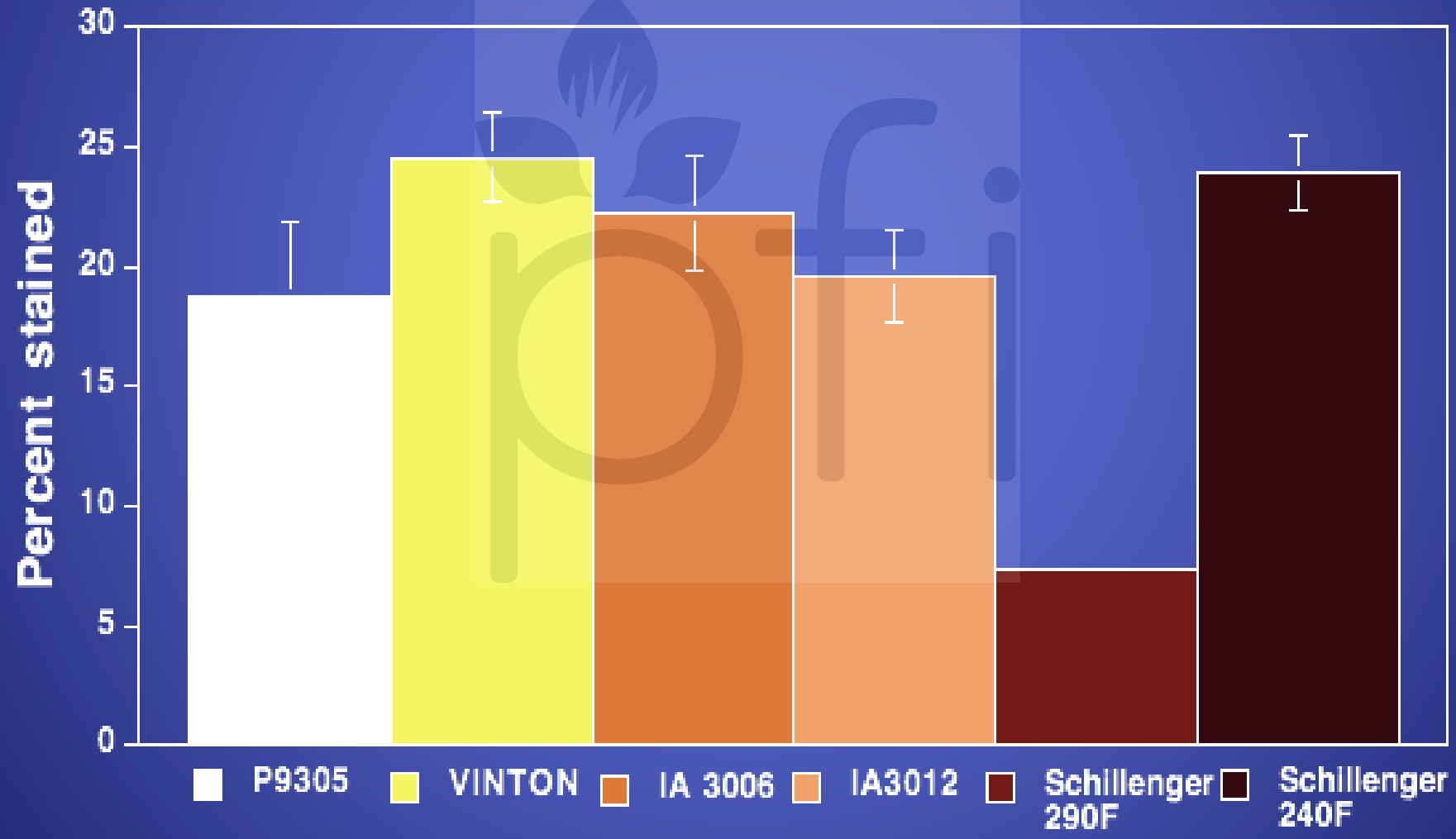


**Conventional average: 13.4  Organic average: 19.2**

**No significant difference**

**Winter weather: big impact on following summer populations**

# Soybean varieties show some differences in staining; potential for Host Plant Resistance



# Soybean Aphid
## *Aphis glycines*

Damage:

- Aphids feed on sap by using their needle-like mouths to pierce leaves
- Sooty mold due to honeydew left by aphids, resulting in yield loss
- Distorted leaves, stunted plants

Management:

- Resistant varieties
- Tracking development: using Growing Degree Days to predict aphid hatching (between 147-154 GDD): ISU Pest Forecasting
- Support biologicals: lady beetles, parasitic wasps, and lacewings.
- Later planting to reduce infestations on young plants

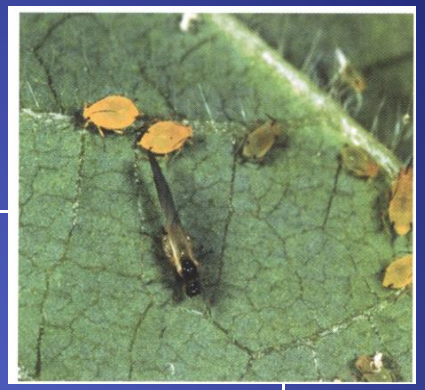
An adult soybean aphid (ISU IPM).

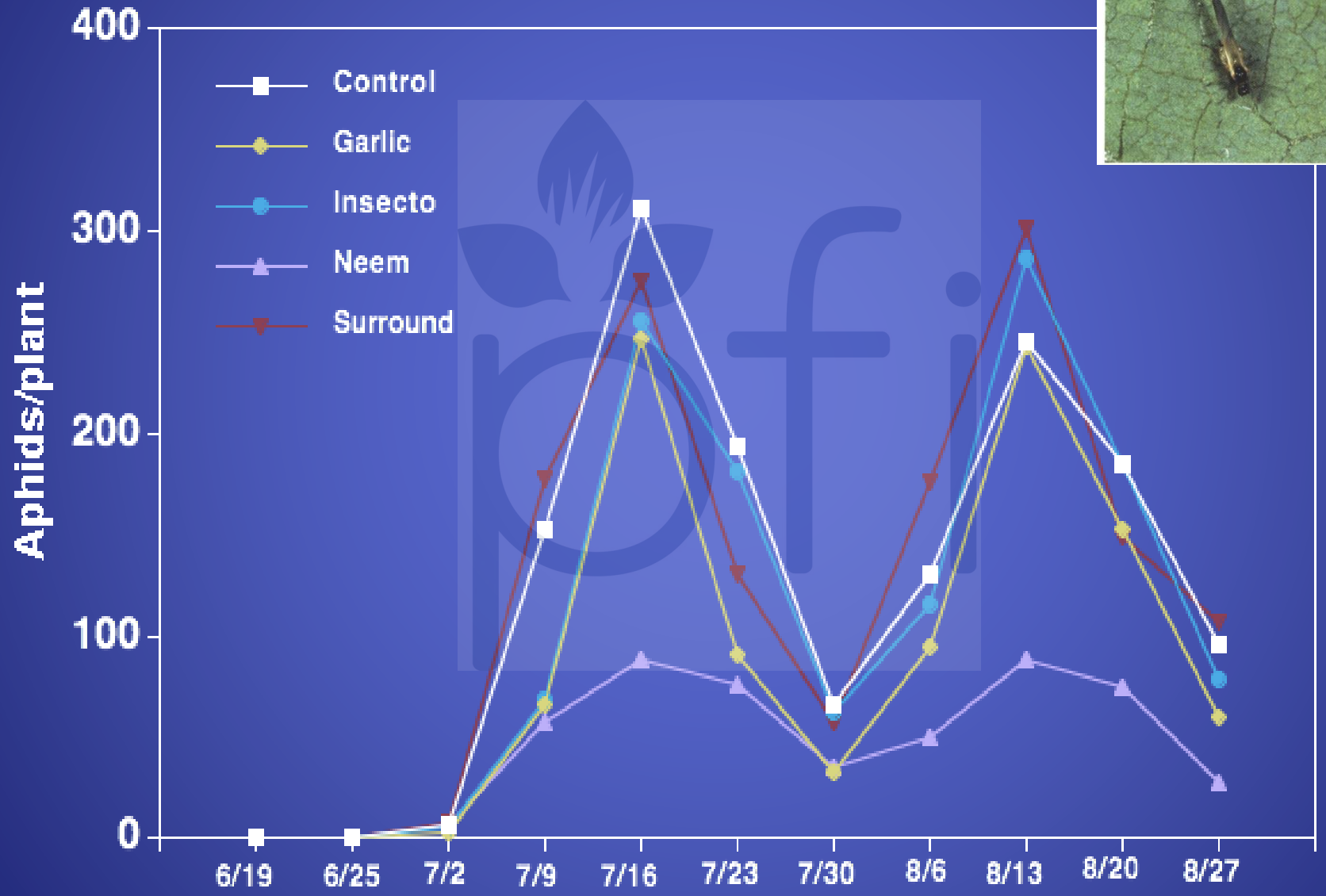

An infestation of soybean aphids being farmed by ants (ISU IPM).

# Soybean Aphid

- Can reduce yields in years of high populations
- ISU research: up to 1,000 aphids/ plant: yields still 53 bu/acre
- Non-GMO aphid resistant variety (Blue River/Albert Lea): 2244A, 2188A12N
- IA State varieties: IA 3045 RA12; IA 3027 RA12
- Beneficial insects: highly regulatory effect

# Soybean aphids reduced by neem





# Soybean Aphid
## *Natural Enemies*

**Adult and nymphal Orius***

**Adult ladybird beetle**

**Adult and larval lacewing**

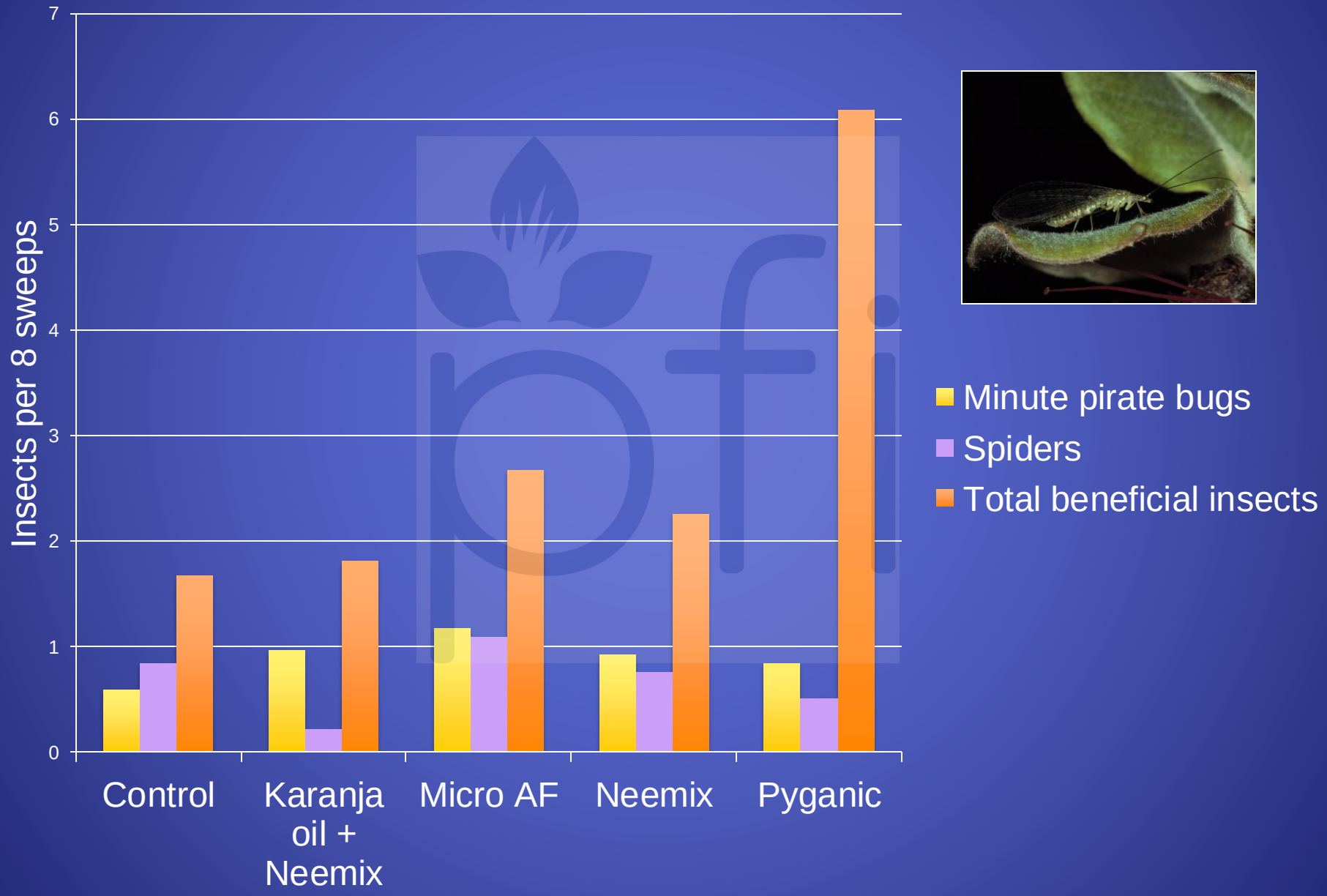
**Parasitoid wasps**

Pathogens: *Pandora neoaphidis*

**Adult and larval Syrphid fly (hover fly)**

* http://www.ento.vt.edu/Fruitfiles/orius.html, Douglas Pfieffer and http://www.lea.esalq.usp.br/patologia/img_site/gallery/p_neoaphidis.jpg

# Organic Soybean Pest Management Natural Enemies: No effect on beneficials compared to control



# Soybean Cyst Nematode (SCN)

Damage:

- Stunting and yellowing, early senescence above ground
- Root stunting and fewer root nodules below ground
- Adult female nematode cysts can be seen on the roots

Management:

- Fall sampling before planting the next soybean crop
- Resistant varieties
- Use a rotation that helps minimize the resurgence of SCN, keep in mind vetch, cowpea, and dry beans are also hosts of SCN
  - Poor hosts include: Alfalfa, barley, corn, oats, wheat, brassicas, and red clover

Soybean stunting as a result of SCN (ISU IPM)

Nematode cysts on soybean roots (ISU IPM)

# Other pests

- Whiteflies and leafhoppers: many natural enemies
- Diversity = stability

https://www.istockphoto.com/photos/lacewing

# Soybean Gall Midge

*Resseliella maxima*

Damage:

- Larvae feed on tissue within the soybean stem, causing the stem to become dark and discolored
- Infested plants wilt and break at the stem
- Scout edges of field

Management:

- Potential resistance
- No other research-based strategies; multiple universities are working on evaluations

An adult soybean gall midge (ISU IPM).


Soybean gall midge larvae in a stem (ISU IPM).

# Seedcorn Maggot

*Delia platura*

Damage:

- Larvae feed on germinating seedlings of corn and soybean
- Reduced stand or gaps in row caused by maggots feeding on the embryo

Management:

- Terminate cover crops early
- Use high seeding rates
- Plant later when warm soils encourage rapid emergence
- Track development: peak adult emergence at 360, 1,116, and 1,876 GDD

Seedcorn maggot on a soybean seedling (ISU IPM).


Adult seedcorn maggot (ISU IPM).

# Seedcorn maggot

Photo by J. Obermeyer

Photo by B. Christine

- Usually affects early planting when cool and wet with high plant residue and manure/compost addition
- Delay planting, allow biomass to decay, wait 360 growing degree days after plowing

-Drew Smith, Rodale Institute

# Black Cutworm

Damage:

- Young larvae feed on leaves, creating irregular holes
- Older larvae cut stalks at or below ground level, leading yield loss

Management:

- Tracking development: Cutworms are large enough to cut plants at the 4th instar, about 300 GDD. ICM News predicts cutting dates each year.
- Early-season weed control and timely termination of cover crops removes food sources.

Black cutworm larva (left) and adult moth (right) (ISU IPM).


Cutworm next to a cut corn plant (ISU IPM).

# European Corn Borer

*Ostrinia nubilalis*

Damage:

- Larvae feed on all above- ground parts of the plant
- Young larvae create “shotholes” in the leaves

Management:

- Resistant varieties: High DIMBOA content important
- Tillage to combat eggs in the soil
- Late planting can avoid first generation
- Biologicals such as parasitic wasps (*Trichogramma*), lady beetles, lacewings, and spiders
- *Bacillus thuringiensis (Bt)* sprays


European corn borer larva.


“Shotholes” in a corn leaf (ISU IPM).


*Trichogramma* on a corn borer egg.

# Corn Rootworm

Damage:

- Larvae feed on root hairs and tissue, causing root pruning
- Adults feed on silks or green tissues of the leaves

Management:

- Crop rotation
- Adjust planting dates to avoid stress and allow silking before peak adult rootworm emergence
- Weed management to avoid providing additional pollen sources for adults

Adult southern (left), western (middle), and northern (right) corn rootworm (ISU IPM).

Severe root pruning (ISU IPM).

# Corn Pests

Corn rootworm – Western: *Diabrotica virgifera virgifera;* Northern: *Diabrotica barberi*
Southern: *Diabrotica undecimpunctata howardi*

Photo by B. Christine

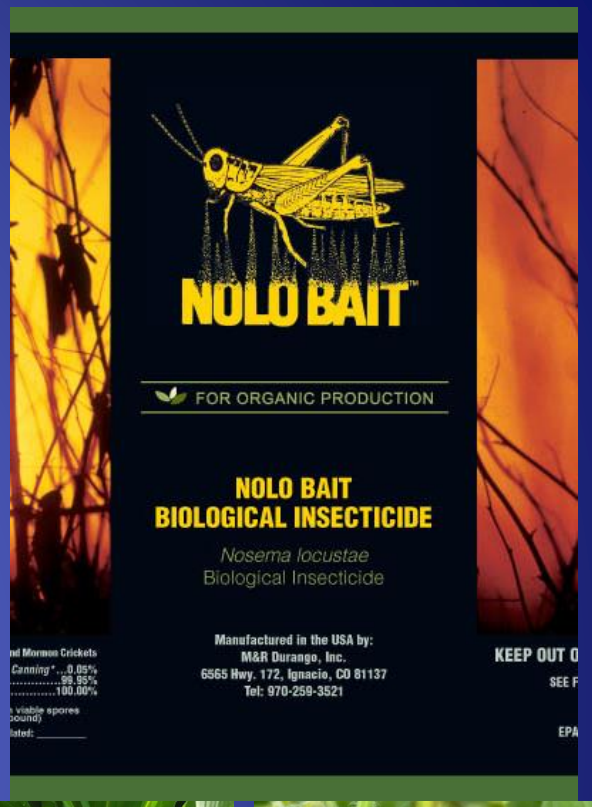
Photo by J. Obermeyer


- Rotation – change hosts
- PA farmer had success with nematodes in side-dresser *Heterorhabditis bacteriophora*

-Drew Smith, Rodale Institute

# Grasshoppers

Adult differential grasshopper (ISU IPM).




Damage:

- Chewing ragged holes in corn leaves and bean pods
- Do not usually need to be managed, but large numbers of nymphs can become an issue

Management:

- Creating habitat for natural predators (birds, robber flies)
- Crop rotation and a greenbelt/border discourages adults from moving to field crops
- Tillage discourages female egg laying
- Natural enemy: *Nosema locustae* (protozoan)

Grasshopper damage on a corn leaf (left) and bean pod (right) (ISU IPM).

# Soybean Diseases

*Phytophthora spp*.

- Fungus that causes root rot and damping off in seedlings and yellowing of mature plants
- Common in damp/wet soils
- Resistant cultivars with high field tolerance should be planted, varieties with *Rps* genes

*Pythium spp*. –

- Similar to Phytophthora, but more common in **cold** wet soils
- No resistant varieties, but some cultivars are more susceptible than others

Field with Phytophthora (Dr. Alison E Robertson)

Field with Pythium (Dr. Alison E Robertson)

# Soybean Diseases

*Phyllosticta* leaf spot

- Fungus that causes uniform rounded brown lesions
- Crop rotation and tillage reduces the survival rate of fungal spores

*Cercospoa* leaf blight

- Fungus that causes leaf discoloration with dark spots/patches
- Disease-free seed, crop rotation, and residue management reduce leaf blight spread

Soybean plant with Phyllosticta leaf spot (U of M Extension, Angie Peltier)

Soybean plant with Cercospoa leaf blight (C. Grau)

# Corn Diseases

*Gibberella zeae*

- Ear rot caused by fungus
- White or pink mold that infects the silks/tip of the ear
- Infected fields should be harvested as early as possible
- Some corn varieties have silk resistance or kernel resistance

Corn with Gibberella ear rot (left) (Bayer Crop Science).

Bacterial leaf streak (*Xanthamonas vasicola*)

- Yellow to brown lesions with wavy edges between leaf veins
- Clean debris from combines and equipment to reduce spread
- Crop rotation and tillage to help minimize debris can reduce spread

Corn with bacterial leaf streak (right) (UNL Crop Watch).

# Corn Diseases

Common rust (*Puccinia sorghi*)

- Rust to dark brown pustules on leaf surfaces, can cause leaf chlorosis
- Most common management is using disease free cultivars


Tar spot (*Phyllochora maydis*)

- Small raised black spots on the leaf surface caused by fungus
- Mild chlorosis
- No varieties with full resistance, but partial resistance can reduce severity
- Crop rotation and tillage help minimize tar spot

Corn leaf with a tar spot infection (Dan Quinn).

# Summary

- Maintaining a systems approach required for optimal pest (insect, weed and disease) management in organic systems
- Biodiversity aids natural enemy populations
- Prevention with resistant/tolerant varieties
  - Soybean aphid, SCN and corn borer resistant/tolerant varieties
- Allowable spray treatments can be used–more so for horticultural crops (greater per acre returns)
- When natural control is insufficient, organic companies often develop alternate solutions
  - Stained soybean hulls removed in cleaning process
  - Check with certifier before using new product

# Webpage/Contact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# Extension Publications