Sunflower Entomology: The Challenge of Developing Management Strategies for Native Insect Pests

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Origin of Sunflower

- Native to North America
- ~ 49 species in genus *Helianthus*
  (12 annual & 37 perennial)
- Present in most areas of US, extending into Canada & Mexico
- Important food source to Native Americans in western US
- Domesticated in central US before 3000 BC

Sunflower History

- Introduced to Spain in early 1500s
- Spread across Europe & adopted as crop in Russia in early 1800s
- Reintroduced into US in 1880s
- Sunflower production developed in Canada in 1950s & US in 1970s

Sunflower as a Crop

- 2nd among oilseed crops as edible oil
- Major production areas:
  - > 1M ha

    Former USSR, Argentina, US, India, Spain
  - > 100,000 ha

    France, Romania, Hungary, China, Bulgaria, Turkey, *Yugoslavia*, So Africa, Australia
- Annual impact to US economy = $2.7 Billion [1995]

Native & Cultivated Sunflower

- **Plant architecture**
  - ✓ Multiple vs. single head
  - ✓ Branched vs. single stem
  - ✓ Small vs. large seeds
- **Growth phenology**
  - ✓ Variable vs. discrete emergence
  - ✓ Extended vs. short flowering period
- **Plant community**
  - ✓ Mixed vs. monoculture
  - ✓ Small patches vs. large acreages
  - ✓ Low vs. high density

Reasons for Insect Problems in Sunflower

- ✓ Sunflower native to North America
- ✓ Pests specific to sunflower
- ✓ Change in plant architecture
- ✓ Monocultures
- ✓ Breeding for vigor, yield, uniformity oil content, etc.
- ✓ Ineffective natural enemies

Major Sunflower Insect Pests

Sunflower beetle

Sunflower stem weevil

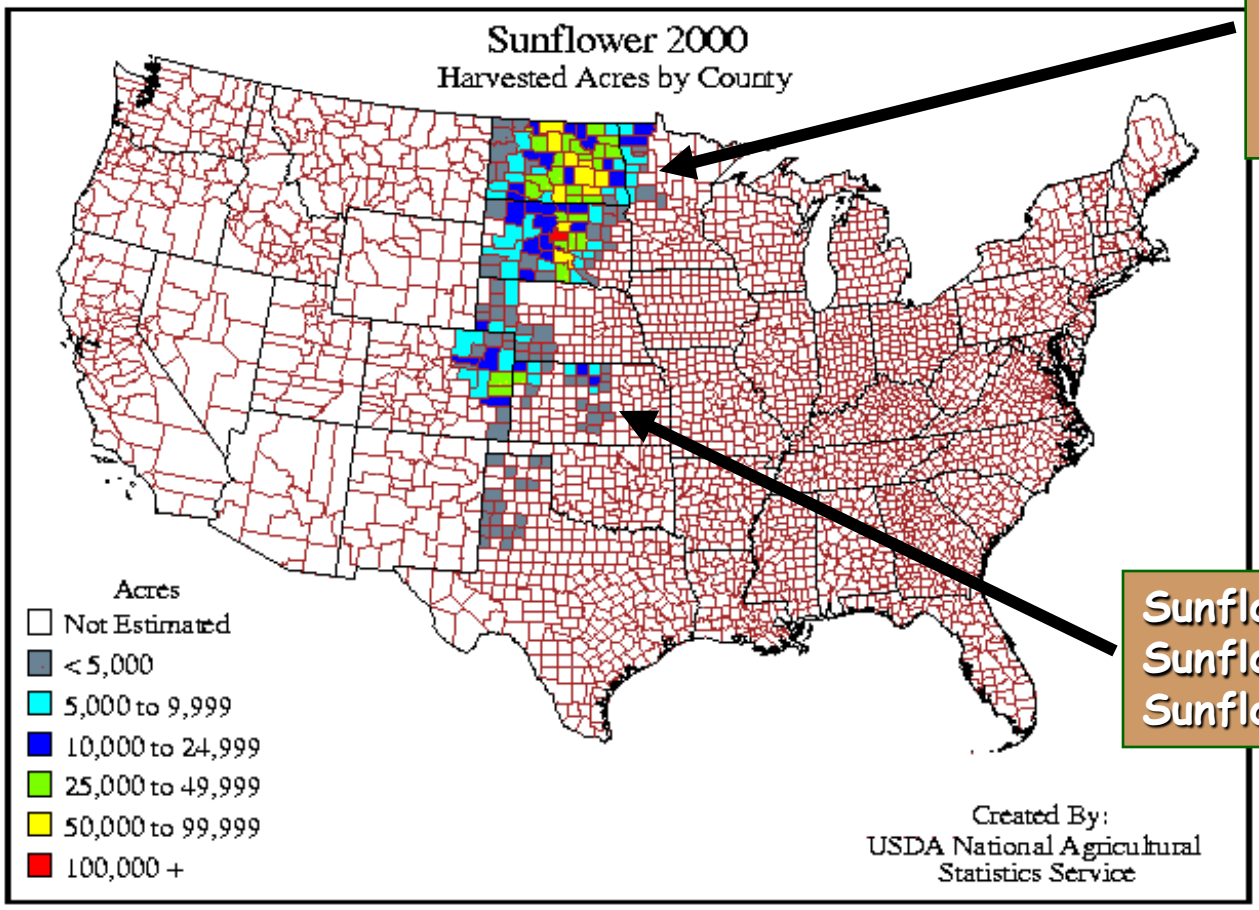
Sunflower midge

Sunflower moth

Red sunflower seed weevil

Banded sunflower moth

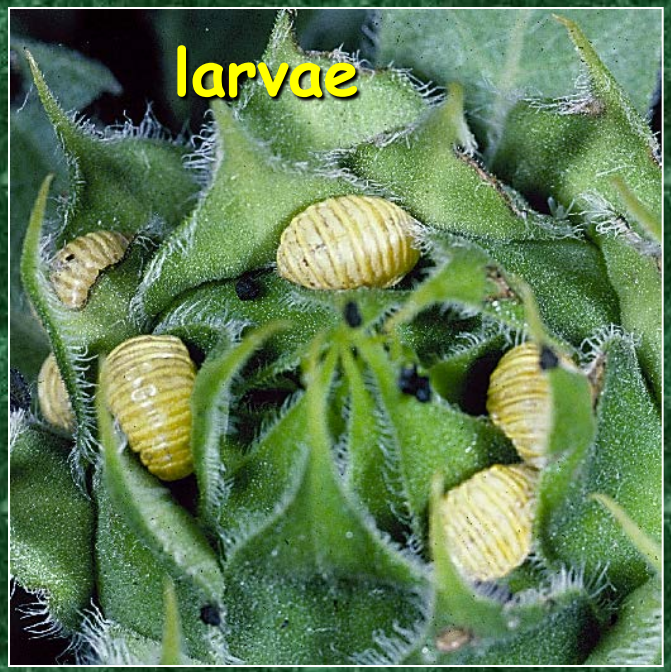
Sunflower Insect Pests



Sunflower beetle
Red sunflower seed weevil
Sunflower midge
Banded sunflower moth

Sunflower moth
Sunflower stem weevil
Sunflower longhorned beetle

Sunflower Beetle



Sunflower Beetle

Biology & Life History

- Overwinter as adults in soil
- Emerge in May & mate
- Eggs deposited on stem & underside of leaves
- Adults - feed on leaf margins during day
- Larvae - feed at night over entire leaf surface
- New generation adults appear late July & move into soil in August to overwinter

Sunflower Beetle Damage

1999 Souris, Bottineau Co.

Sunflower Stem weevil

Sunflower Stem Weevil

Biology

- Overwinter as mature larvae in stalk emerging mid-late June
- Eggs deposited under stem epidermis near cotyledon
- Larvae feed apically in stem vascular tissue & pith
- Larvae move to stalk base in August & construct chambers in stem cortex
- One generation per year

Sunflower Stem Weevil

Damage

- Adult feeding on leaves & stems causes minor damage
- Larval feeding reduces yield only if populations ~ 80 / stalk
- Lodging prior to harvest caused by larval overwintering chambers (30-40 per stalk) & various stalk characteristics
- Implicated in transmission of 2 sunflower fungal pathogens (phoma & charcoal rot)

Sunflower Moth

adults

Adult moths migrate from So. states in early-mid July

seed damage

larva

Each larva consumes 3-12 seeds

Red Sunflower Seed Weevil

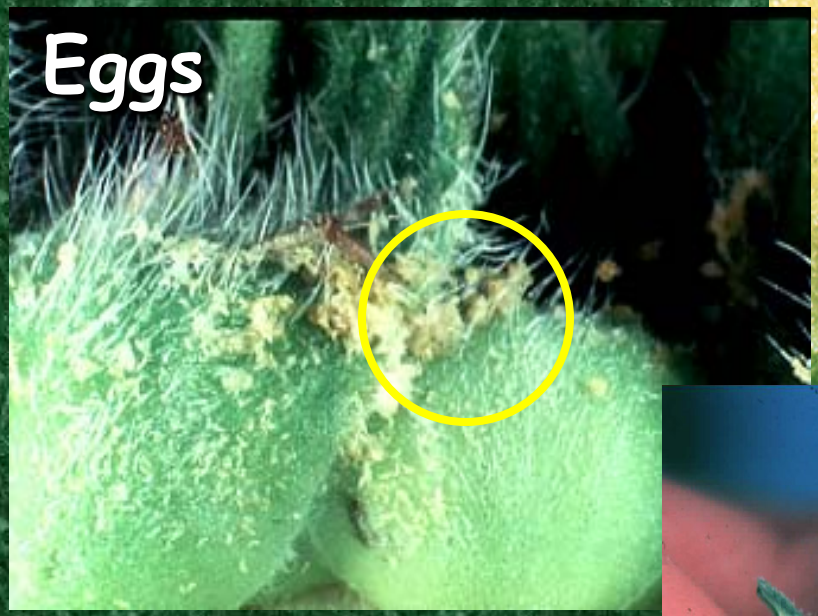
Drop into soil to overwinter

- Females require pollen to mature eggs
- Oviposit during flowering
- Heads with 50% flowering preferred
- Eggs laid inside seed
- Larvae in outer seed rows
- Kernel 1/3 consumed

Sunflower Midge

Adults

Sunflower Midge



Sunflower Midge

Damage

- Necrotic larval feeding depressions between bracts
- Loss of ray flowers
- Altered head growth
- Heavily damaged heads:
  gnarled & cupped with few seeds produced

Banded Sunflower Moth

- Moths lays egg on bracts in the late bud stage
- Larval feeding results in webbing on surface of head

Banded Sunflower Moth

Biology & Life History

- Overwinter as larvae in silken cocoon
- Emerge in early July, mate, & deposit eggs on bracts of sunflower head
- Adults congregate in field margins
- Larvae feed on pollen, disk flowers, immature & mature seeds

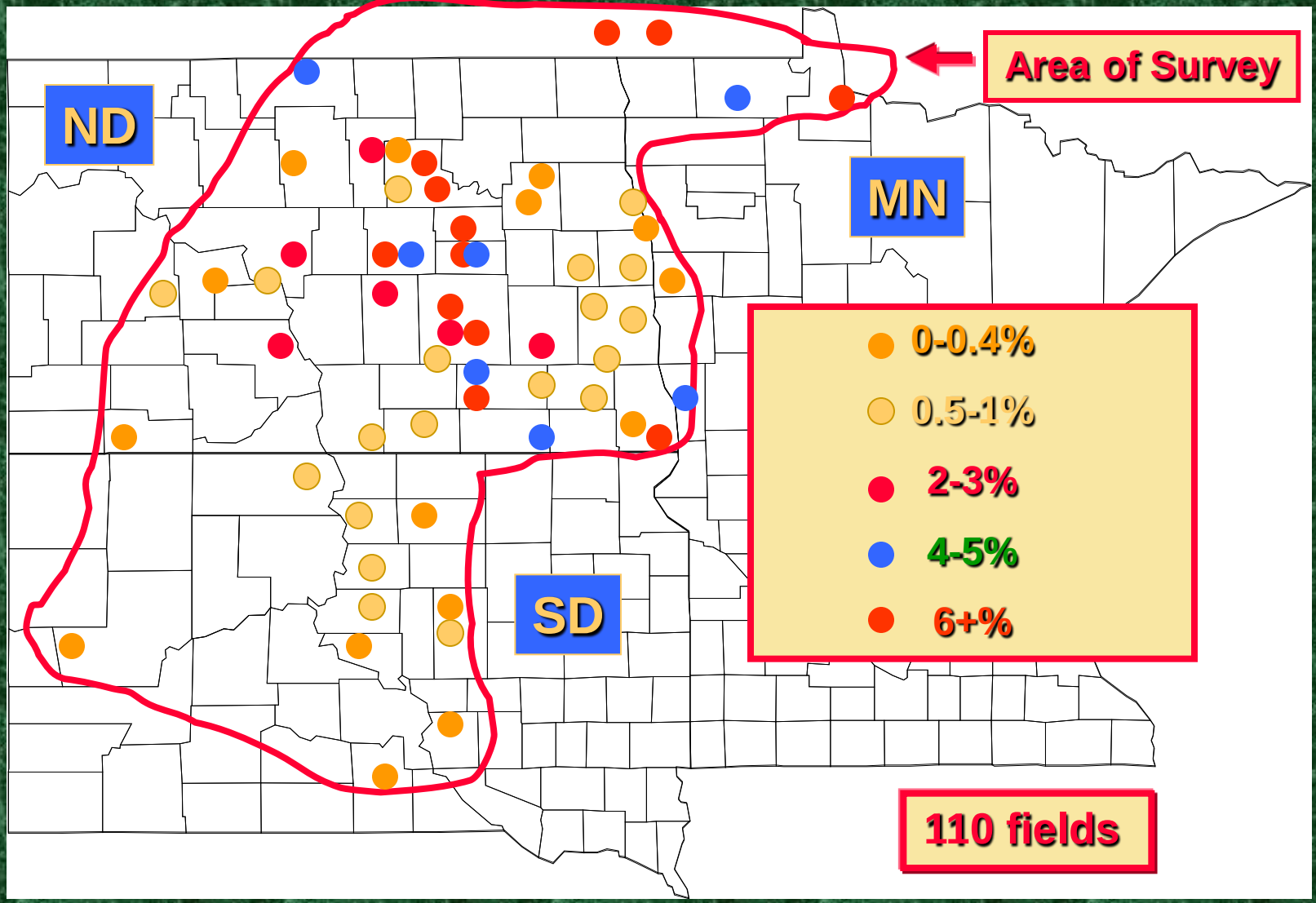
New Sunflower Pest Problem

- 1998 several U.S. & Canadian processors notice seed lots with brown spots on kernel
- Although seed damage is minimal, some end users reject seed lots & processors either dock or reject lots
- Disease or insect causing damage?

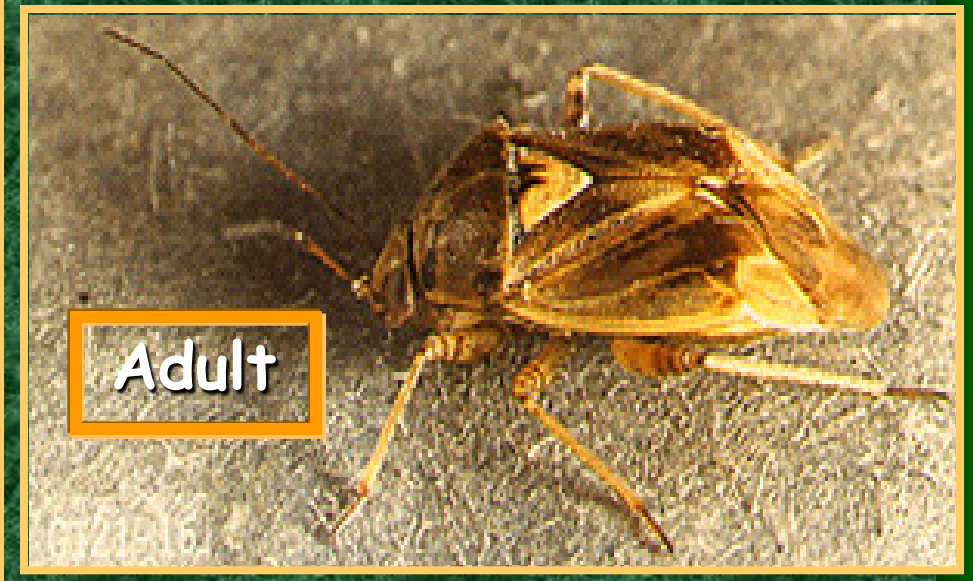
Damage Appearance

Brown spot on confection kernels

Kernel Brown Spot Incidence Damage Survey 2000



Lygus Plant Bugs



Lygus Plant Bugs

- Taxonomy
  - ✓ Includes number of indigenous species (family = Miridae, genus = Lygus)
  - ✓ Tarnished plant bug - *Lygus lineolaris* most common species
- Host plants
  - ✓ Recorded from 385+ crop plants & weeds
- Biology
  - ✓ Inject enzymes into plant & extract nutrients
  - ✓ Development not always on plants in which adults feed
- Life history
  - ✓ Overwinter as adults in leaf litter
  - ✓ 2 generations/year in southern Canada

Sunflower Insect Management

- Identification of pest
- Knowledge of pest biology
- Economic/treatment thresholds
- Field monitoring/sampling
- Management tactics include:
  - ✓ Cultural control
  - ✓ Plant resistance
  - ✓ Biological control
  - ✓ Chemical control

Current IPM Practices for Sunflower Insect Pests

- Economic thresholds developed for all except – sunflower midge
- Scouting methods inadequate for some species & need to be refined
- Management strategies:
  - Chemical control most frequently used
    - Pyrethroids & methyl parathion
  - Cultural control
    - Planting date effective for:
      - banded sunflower moth, sunflower stem weevil, sunflower moth, sunflower beetle & red sunflower seed weevil

Host Plant Resistance

- Genus *Helianthus* has 49 species
- Coevolutionary history with insects
- Majority of major pests specific to *Helianthus* or related composites
- Levels of resistance in native sunflowers reported for:
  - sunflower beetle, banded sunflower moth, sunflower stem weevil & sunflower moth
- Differences in susceptibility in lines to:
  - red sunflower seed weevil, banded sunflower moth, sunflower stem weevil, sunflower midge & sunflower moth

Biological Control of sunflower pests

- Many natural enemies have made the transition along with their hosts from native to cultivated sunflower
- Potential pests held in check by beneficials
- Natural enemies known for major pest species
  - ✓ predators & parasitoids have been studied
  - ✓ little known about pathogens
- Research has revealed regional differences in parasitoid species richness
- Studies also show parasitoids attacking pest species in native sunflowers not present in agroecosystem

Sunflower Insect Natural Enemies

Banded sunflower moth parasitoid

Sunflower midge parasitoid

Sunflower stem weevil parasitoid

Sunflower Beetle predators

Biological Control: Problems & Potential

- Reasons for inadequate natural control:
  - ✓ Changes in plant architecture
  - ✓ Plant growth phenology
  - ✓ Monocultures
  - ✓ Increased acreage
  - ✓ Expansion of crop into new area
  - ✓ Delay in following host into cultivated setting
- Research needed to study natural enemy biology & population dynamics to improve impact
  - ✓ Conservation & augmentation

Biological Control: Problems & Potential

- Search for new natural enemies in native sunflowers & throughout range of pest
  - Most complete complex of beneficials present in proximity to center of origin of native hosts

Future for Sunflower IPM

- Compared to most row crops sunflower is relatively new
  - ✓ Research dates only to late 1960s (Texas & North Dakota)
- Potential sources of germplasm for resistance:
  - ✓ 49 native species of sunflower
  - ✓ USDA Plant Introduction Station
    - ➢ 1660 cultivated accessions
    - ➢ 2150 wild accessions

- Improve biological control through conservation, augmentation, or search for new beneficials
- Refine EIL, monitoring, cultural control strategies (trap cropping), reduce pesticide use, & integrate methods to lower production costs