Mid-Atlantic Region CCA Exam Study Guide

Competency Area 3 – Management of Insects and Other Invertebrates

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Field Corn – True Armyworm

Identification

- Larvae with parallel white, dark, and pinkish stripes on the side of the body
- Larval head capsule with two parallel dark lines
- Adult: straw colored moth with two white spots surrounded by dark area on wing.

Life Cycle

- Moths emerge in April
- Lay eggs on grasses
- Larvae feed on small grains and field corn then pupate in soil or under debris
- 3-4 generations/year
- overwinter as partially grown larvae

Field Corn – True Armyworm

Damage

- Larvae feed in late spring-early summer on early mid-whorl stage corn
- Attack small/seedling stage corn in no-till
- Do not damage growing point

Field Corn – True Armyworm

Alternative Controls

- Avoid planting near small grains
- Avoid planting into no-till small grain cover crop or when terminated less than 2 weeks prior to planting
- Bt Corn – for small larvae only present at planting time/ no-till covers

Field Corn - Slugs

Life Cycle

- Overwinter as egg, immature or adult
- Feed on seedling corn leaves, young sprouts, and seeds
- 2 species: Marsh slugs (*Deroceras leave*) and Grey Garden Slugs (*Deroceras reticulatum*)

Marsh Slug

Grey Garden Slug

eggs

Field Corn - Slugs

Damage

- Feeding occurs in spring when cool and wet on young corn leaves (spike-3 leaf stage), sprouts, seeds
- Leaves have a shredded appearance, slime trails may be seen on leaf surface
- Favored by no-till; surface residue; wet conditions; poor seed furrow closure

Field Corn - Slugs

Alternative Controls

- Cultural practices to enhance and favor early seedling growth and vigor including starter fertilizer, row cleaners
- Tillage, strip tillage, and vertical tillage to reduce surface residue and warm seedling faster

Field Corn - Stink Bugs

Life Cycle

- Egg, nymph (immature), adult
- Overwinters as adult in leaf litter or debris
- Brown stink bugs move to wheat in April and begin reproducing, then to corn in late spring
- Green stink bugs develop first on woody hosts such as black cherry before moving to corn

Brown Stink Bug

Green Stink Bug

Brown Marmorated Stink Bug

Field Corn –Stink Bug

Damage

- Feeds on seedling plants
- Inserts mouthpart into stalk and growing point
- Causes deformed, twisted plants, wilting of new leaves, elongated feeding holes, and tillering
- Most susceptible at spike to 4-leaf stage and corn no-tilled into wheat

Field Corn –Stink Bug

Damage

- Feeding between V14 and VT can cause hooked ears
- Feeding between R1 and R2 can cause shriveled or sunken kernels that may be susceptible to disease

Dominic Reisig, NCSU

Field Corn – Stink Bugs

Alternative Controls

- Plant early
- Tillage to reduce harborage/overwinter sites
- Good seed slot closure – prevent feeding below ground
- Scout corn adjacent to small grains, especially near or just after small grain harvest

Field Corn – European Corn Borer

Life Cycle

- Overwinter as larvae
- Pupate in spring
- Moths lay eggs on corn in whorls
- Peak larval activity in mid-June
- Second Generation: late corn and vegetables

Field Corn – European Corn Borer

Damage

- Feeding by 1st generation peaks in mid-June-affects translocation of nutrients
- Plants 18-24 inches in whorl stage most susceptible

Field Corn – European Corn Borer

Alternative Controls

- Avoid early planting
- Genetically resistant varieties/ Bt corn
- Natural Controls: Nosema; fungal pathogens
- Deep Plowing – must be done on an area-wide basis
- Released Parasites: Lydella thompsoni; Trichogramma

Field Corn – Black Cutworm

Life Cycle

- Overwinter as fully grown larvae or pupae
- Larvae dark with a greasy appearance and black spots in the body sides
- Moths emerge in March; moths with a black dagger shape on forewing
- Lay eggs on weeds
- Larvae hatch and feed on weeds then corn (1 generation/year)

Field Corn – Black Cutworm

Damage

- Damage in late spring on spike to 5 leaf corn
- Leaf feeding/ Shredding
- Cut plants
- Feeds on growing point

Field Corn – Black Cutworm

Alternative Controls

- Avoid late planting and poorly drained soils
- Early heavy growth of broadleaf weeds favors moth egg laying – early burn down with herbicides
- Limited activity with Bt corn – small larvae only; Cry1F varieties

Field Corn – Seed Corn Maggot

Life Cycle

- Overwinters in soil as pupae
- Flies emerge as early as February, but peak activity often in late March/early April with warm days
- Prefer to lay eggs in moist, freshly plowed soil with decaying organic matter or manure
- Eggs hatch in 1-9 days
- Larvae active- as low as 40 degrees F

Field Corn – Seed Corn Maggot

Damage

- Feed on seed content
- Death of seed or poor germination
- Occurs with cool, wet seasons and in soils with high organic matter

Field Corn – Seed Corn Maggot

Alternative Controls

- Shallow planting in well-prepared seedbed to encourage quick germination
- Fall plowing of manure
- Early plowing of cover crops
- Complete plowing of cover crops 3 weeks prior to planting.
- Note: seed treatments generally quite effective, but sometimes can be overwhelmed

Field Corn - Wireworms

Life Cycle

- Overwinter as larvae
- Five-year larval life cycle
- Adults emerge in summer – click beetles
- Very responsive to moisture gradients in soil

Field Corn - Wireworms

Damage

- Feed on seeds as well as the growing point of young plants
- Appears as missing plants in field/ wilting or death of terminal shoots
- Later feeding injury below ground appears as a yellow streak down the leaf margin
- Problem in cool, wet springs; fields that were grassy or weedy the previous year

Field Corn - Wireworms

Alternative Controls

- Summer plowing of fallow fields
- Crop rotation away from small grains
- Most corn seed has an effective insecticidal seed treatment on it (ex: Poncho)

Field Corn – Fall Armyworm

Life Cycle

- Migratory pest, moths found in our area in June, peak in August
- Moths lay eggs on later planted corn
- Larvae feed in the whorl of pre-tassel stage corn in July and August
- Larvae most active early morning and late evening

Male

Female

Field Corn – Fall Armyworm

Damage

- Numerous ragged holes
- May prevent formation of normal ears
- Generally a problem in silage corn

Field Corn – Northern and Western Corn Rootworm

Life Cycle

- Overwinter as egg
- Larvae hatch mid-late May
- Feed on roots 3-4 weeks
- Pupate and males emerge first as early as late June
- Adults emerge late summer and lay eggs at base of corn plants

Field Corn – Northern and Western Corn Rootworm

Damage

- Damage by larvae feeding on roots in late May-early June
- Root pruning results in goosenecking and lodging
- Favored by continuous corn
- Favored by heavy soils
- Uncommon in our region, but areas of Delmarva with significant populations

Field Corn – Northern and Western Corn Rootworm

Alternative Controls

- Crop rotation still works
- No variants (beetles laying eggs in soybeans) documented in our area
- No extended diapausing beetles (eggs stay in soil 2 years) documented in our area
- Bt varieties

Soybeans - Grasshoppers

Life Cycle

- Egg, nymph, adult
- Overwinter as eggs/nymphs
- 3-4 generations per year
- Move out of ditch banks into fields

Soybeans - Grasshoppers

Damage

- Defoliates plants as seedlings or later in season
- Can feed on pods
- Dry weather favors grasshoppers
- High populations: field edges; no-till plantings behind small grains

Soybeans – Green Cloverworm

Life Cycle

- Egg, larvae, pupae, adult
- Moths lay eggs on underside of leaves starting in late June
- Larvae first detected in July and peak mid-Aug

Soybean – Green Cloverworm

Damage

- Window Boxes – for small larvae
- Irregular holes between main veins – larger larvae

Soybeans – Green Cloverworm

Alternative Controls

- Fungal pathogens play major role in control
- Natural Enemies
- Sometimes considered beneficial because of the diversity of natural enemies that feed on them and conserved for later in the season.
- Defoliation thresholds are pretty high
- Susceptible to pyrethroids

Soybeans – Soybean Looper

Life Cycle

- Egg, larva, pupa, adult
- Migrate from the south
- Pupate on the underside of leaves
- Females lay 600-700 eggs
- It takes about 25 to 30 days for development from egg to adult.
- Very similar in appearance to cabbage looper. Loopers generally appear near the beginning to mid-August

Soybeans – Soybean Looper

Damage

- Late season pests
- Feed from the lower, inside canopy and then move up and outwards
- Mainly defoliators but will occasionally feed on pods
- Very resistant to pyrethroids, somewhat resistant to diamides.

Virginia Tech University

Soybeans – Soybean Loopers

Alternative Controls

- Beneficial Insects - In our area, a large number are destroyed by parasitoids.
- Once get into late R6, defoliation thresholds rise to +50%
- Fungal pathogens – loopers do best in hot dry weather.
- Nematodes

Soybeans – Two-spotted Spider Mites

Life Cycle

- Egg, larvae, nymph, adult
- Adults overwinter in weedy and non-crop areas
- Move into crops as temperatures increase
- Development favored by hot and dry weather
- Populations generally explode during bloom

Soybeans – Two-spotted Spider Mite

Damage

- Yellow discoloration
- Stunted Plants
- Feed on cell contents
- First detected on field edges but can balloon into fields
- 20-30 mites per leaflet, R-stage soybean, yellow discoloration noted.

Soybeans – Two-spotted Spider Mites

Alternative Controls

- Natural Predators – Phytoseiid mites, Orius, Stethorus lady beetles
- Weather Conditions favoring pathogenic fungi - 36+ hours high humidity, cool conditions. Typically populations decline around August 10.

A twospotted spider mite infected with *Neozygites floridanus* fungus. Note the fungal spores that emerged from the unfortunate mite.

Photo by David Smitley, Michigan State University

Soybeans – Mexican Bean Beetle

Life Cycle

- Overwinters as adult
- Adults lay eggs in early planted fields
- Larvae feed, then pupate on plants (3 generations/year)

Soybeans – Mexican Bean Beetle

Damage

- Larvae defoliate early planted full season and double crop beans
- Hot dry weather reduces populations
- Historically a major defoliator, current populations extremely low.

Soybeans – Mexican Bean Beetle

Alternative Controls

- Trap crops – early snap beans
- Parasitic wasps
- Predaceous stink bugs

Soybeans – Corn Earworm

Life Cycle

- Egg, larva, pupa, adult
- Overwinters as pupae (in soil)
- Larvae can be green, pink, orange, yellow or very dark. Usually with an orange head capsule
- Overwintering and migrating moths from the south lay eggs on corn
- Next generation peak flight in August, move to soybean, hemp, and vegetables

Soybeans – Corn Earworm

Damage

- Young larvae feed on terminal leaves, flowers, pods
- Older larvae feed on pods and developing seeds
- Mainly a pod feeder
- NCSU CEW threshold calculator

Soybeans – Corn Earworm

Alternative Controls

- Mostly a problem in late-planted, droughty, open canopy fields
- Natural fungal pathogens – wet and humid conditions
- Natural Enemies- no released parasites

Soybeans - Stink Bugs

Life Cycle

- Overwinter as adults and become active in spring on wild hosts
- Lay eggs in fields in late June but generally a problem late in the season

Brown Stink Bug

Green Stink Bug

Brown Marmorated Stink Bug

Soybeans – Stink Bugs

Damage

- Mechanical injury to seed, shriveled seed, flat pods
- Can transmit a disease organism
- Seed damage = greater yield loss; R5 most susceptible stage; late season infestations reduce oil content and germination of seeds

Soybeans – Bean Leaf Beetle

Life Cycle

- Overwinters as an adult beetle
- Active in April-early May
- Larvae feed at base of stem or on roots
- Adults present again in late July-August

Soybeans - Bean Leaf Beetle

Damage

- Prefer young plant tissue, prefer feeding on leaves. Feeding holes tend to be circular
- Cause windowpaning on pods which can allow for pathogen entry
- Generally problem on early planted beans; defoliation and reduced stands

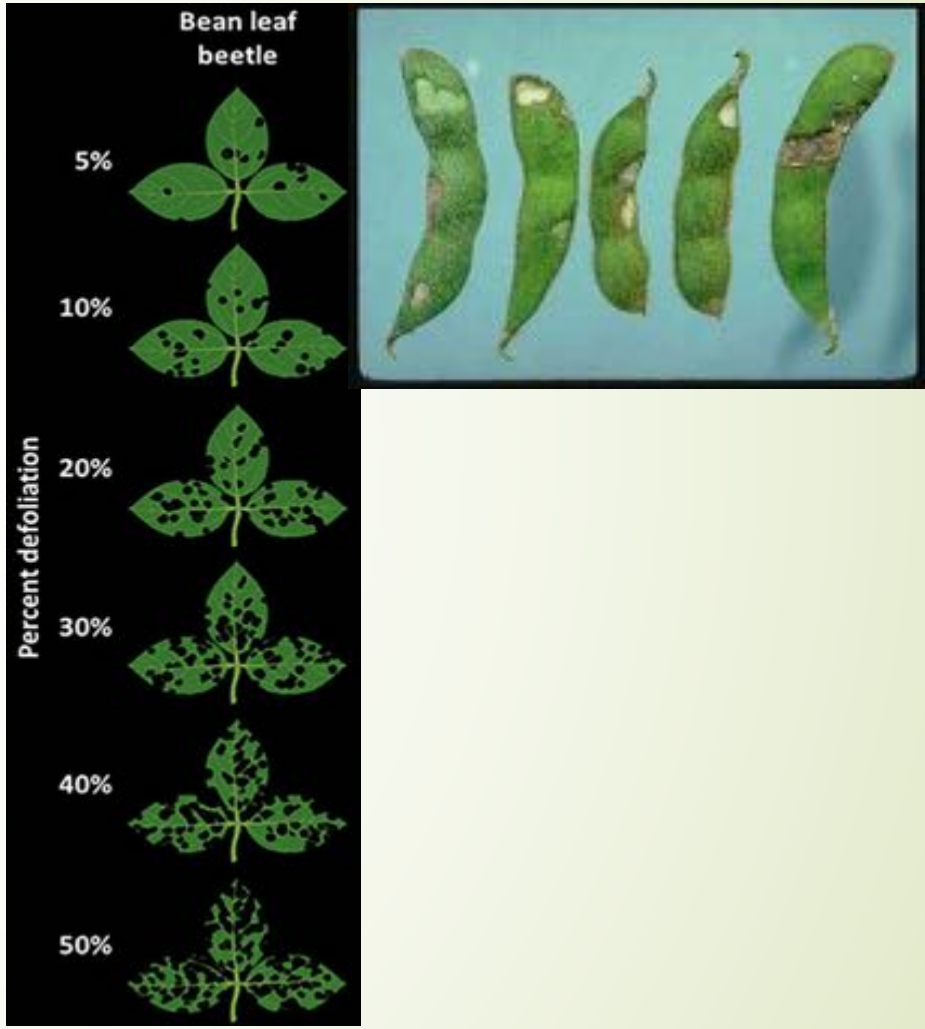


Photo by Robert Koch

Soybeans - Slugs

- Slugs are molluscs, not insects
- Egg, juveniles, adults
- Marsh slugs are dark brown/black, all life stages present in spring
- Gray garden slugs are a light brown/tan color. May overwinter as adults or as eggs, eggs hatch beginning of April
- Potential pests of no-till, high residue crops

Soybean - Slugs

- Damage: slugs feed on cotyledons, destroying stand
- Sample using shingle/shelter traps, 1 slug/sq ft puts a field at risk

Controls

- Promote rapid germination and growth
- Push residue out of way
- Vertical tillage
- Closed seed slot
- Metaldehyde or iron phosphate baits

- Open seed slot with corn, showing corn fed on at or under soil surface. Soybean seed fed upon before unifoliates appear will often be completely destroyed

Soybean – Kudzu bugs

- Life cycle: egg nymph adult
- Introduced in 2009 in Georgia
- Adult overwinters in plant debris and buildings
- A sucking insect, feeds on phloem sap
- Threshold 5/plant or 1 nymph/sweep
- Although present, no significant populations in Delaware

Photo by Alejandro Del Pozo-Valdivia, NCSU

Alfalfa – Alfalfa Weevil

Life Cycle

- Overwinters as adult and egg
- Larvae feed on leaves 3-4 weeks
- Pupate on plant or on ground (1 generation/ year)

Alfalfa – Alfalfa Weevil

Damage

- Larvae feed on leaves in late March-early April
- Defoliated fields take on a ‘frosted’ or ‘silvery’ appearance
- Pest of 1st cutting and sometimes regrowth for second cutting

Alfalfa – Alfalfa Weevil

Alternative Controls

- Resistant varieties
- **Early cutting**
- Biocontrol: natural enemies/diseases
- Winter grazing

Alfalfa – Potato Leafhopper

Life Cycle

- Egg, nymph, adult
- Adults migrate by wind arriving in late April
- Develop from egg to adult in 3 weeks when conditions favorable

Alfalfa – Potato Leafhopper

Damage

- Nymphs and adult feed on 2nd and 3rd cutting alfalfa
- Severe damage also done to spring seeded alfalfa
- Pest during hot,dry seasons

Alfalfa – Potato Leafhopper

Alternative Controls

- Early cutting
- Fungal Pathogens
- Resistant Varieties – Hoppergard

Alfalfa – Blue Alfalfa Aphid

Life Cycle

- Egg, nymph, adult
- Occur in March-April – same time as pea aphid

Alfalfa – Blue Alfalfa Aphid

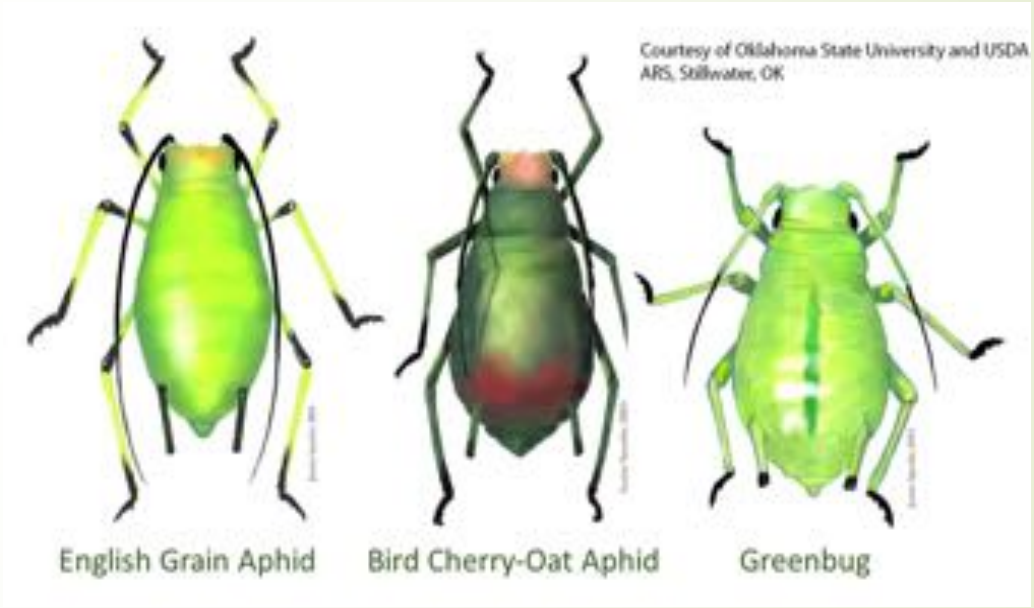
Damage

- Damage to 1st cutting alfalfa
- Plants stunted
- Associated with spring black stem disease

Wheat - Aphids

Life Cycle

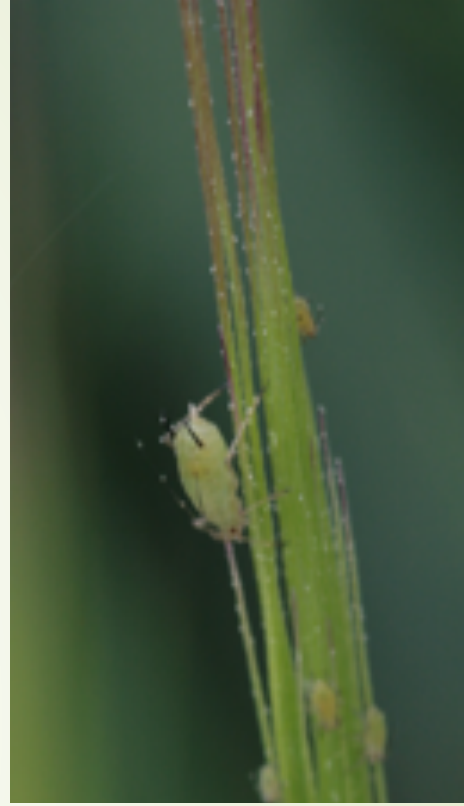
- Egg, nymph, adult
- Overwinter in the crop as nymphs and females, depending on weather and species
- More of a problem in early plantings
- Favored by mild winter and cool, dry spring



Wheat - Aphids

Damage

- Damage in fall (first 60 days after planting): vector BYDV, greenbug aphid injects toxin
- Damage in spring: grain fill, dead plants, blasted heads

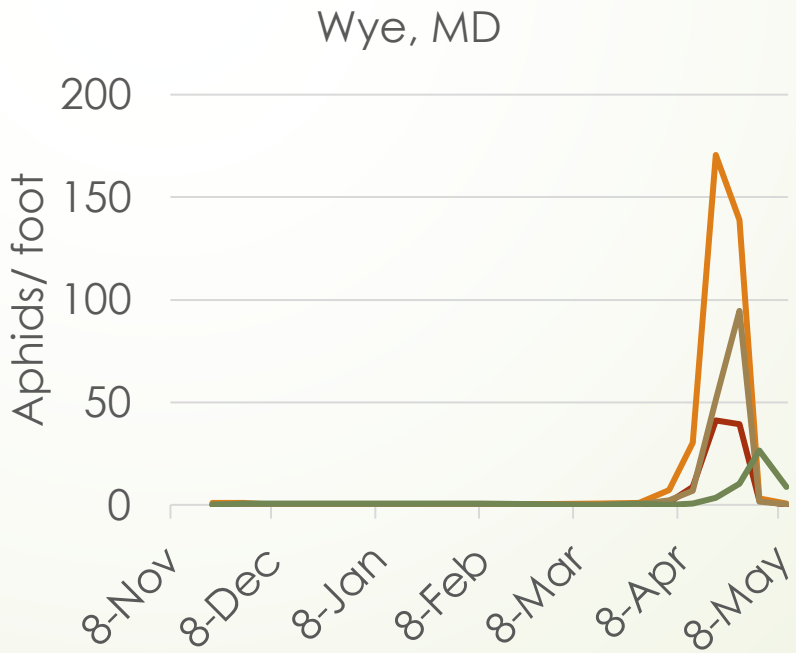


Greenbug damage to orchardgrass

Wheat - Aphids

Alternative Controls

- Natural parasites and predators; ratios of 1 natural enemy per 100 aphids should result in sufficient biological control
- Fungal Pathogens can quickly wipe out aphids.



Wheat – True Armyworm

Life Cycle

- Egg, larva, pupa, adult
- Moths emerge in April
- Lay eggs on grasses
- Larvae feed then pupate in soil or under debris
- 3-4 generations/year
- Overwinter as partially grown larvae

Wheat – True Armyworm

Damage

- Larvae feed on leaves in early May
- Young larvae on upper leaf surface
- Older larvae- leaf blades
- Last instar does most of the feeding
- Heads clipped when all leaves consumed

Wheat – Cereal Leaf Beetle

Life Cycle

- Overwinter as adult
- Emerge March, lay eggs for 2-3 weeks
- Larvae feed for 3 weeks, pupate
- Adults emerge and feed on corn

Wheat – Cereal Leaf Beetle

Damage

- Larvae first feed on stem leaves
- Reduce Photosynthesis
- Move to flag leaf in late April-early May
- Most important defoliator, elongate windowpanes
- Populations cycle long term due to parasitoids; currently low

J. Knodel

Wheat – Cereal Leaf Beetle

Alternative Controls

- Early planting
- Introduced parasites
- Weather factors – late winter warm up followed by cool early spring

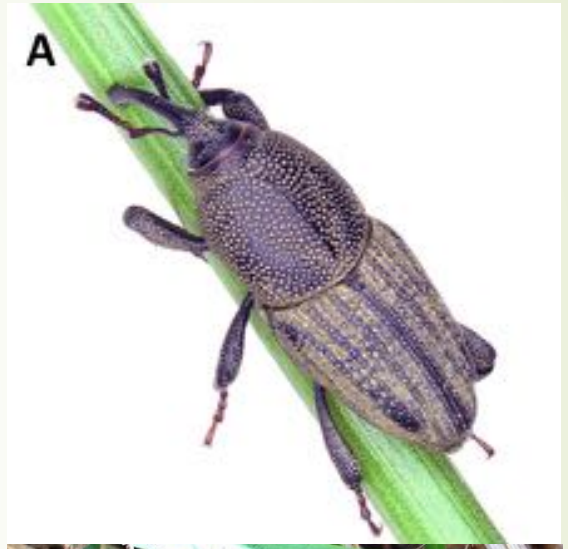
Wheat – Grass Sawfly

Life Cycle

- Adults emerge in April
- Lay eggs on leaf margins until early May
- Larvae enter soil in mid-June for summer diapause (prepupal) stage
- Larvae have 7 pairs of prolegs. Caterpillars have 2-5.

Forage Grasses - Billbugs

- Life Cycle: Complete metamorphosis, egg-larva-pupa-adult
- Several weevil species in the billbug complex.
- Larvae are legless ‘white grubs;’ Adults have snouts
- Adults overwinter, become active when soil warms to 67 degrees. Larvae are present from the end of May to July and pupate during the summer. Adults reappear in late summer. One generation per year.



Photos from https://extension.entm.purdue.edu/publications/E-266/E-266.html

Forage Grasses - Billbugs

Damage

- Larvae feed on crowns and roots
- Adults feed on young leaves leaving paired holes.
- Easily overlooked or mistaken for other causes of stand decline. Feeding damage appears as irregular brown grass patches.

Control

- Few control measures; lambda cyhalothrin can ‘suppress’ egg laying adults

Photo by William Kuhn

Forage Grasses – Cereal Rust Mite

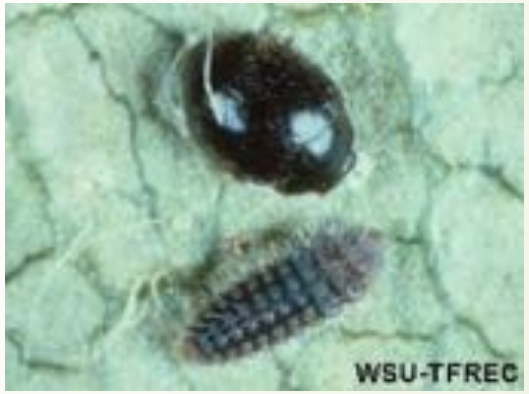
- Life Cycle: egg – nymph- adult
- Adults and eggs overwinter near crown. Eggs hatch in March, adult population peaks in late March to early April
- Prefer cool weather
- Most severe in Timothy grass
- Damage: plants appear drought stressed with rolled leaves
- High volume application of Sevin; close mowing in late fall or early winter may reduce mite population in spring but can reduce early vigor.

Beneficial Insects - Ladybug

- Aphid predators; multiple species
- Orange cylindrical eggs laid in clusters
- Larvae are 'alligator' shaped
- Adults orange, red, or pink with black spots

Photo by Jack Kelly Clark

- Stethorus = spider mite predators
- Small, black



Beneficial Insects - Lacewings

- Adults are green, wings with numerous crossveins; feed on pollen
- Eggs laid at the end of a long threadlike stalk to protect from being preyed upon by other hatching lacewings
- Larvae have sickle jaws and feed on soft bodied insects including aphids and small worms
- Sometimes hide under a shield of debris

Photos by Rick Bessin, UKY

Beneficial Insects - Syrphids

- Also called hover flies, drone flies, and sweat flies
- Many are very good bee mimics, but with two wings and a short threadlike antenna
- Larvae are free living maggots that feed on aphids. No headcapsule, just paired mouth hooks. No legs.

Beneficial Insects – Pirate Bugs

- Small insects, voracious predators of thrips, aphids, mites, and Lepidopteran eggs
- Adults with white and black markings on wing, nymphs yellow/orange
- Often give a probing bite that feels like a needle prick

Beneficial Insects - Nabids

- Also called damsel bugs
- Small, mottled-brown triangular shaped true bugs with enlarged forelegs.
- Feed on small insects including worms, aphids, leafhoppers, plant bugs
- Handle carefully, bite is painful

Photo by W. Sterling

Beneficial Insects - Parasitoids

- Most Hymenopterans (tiny wasps), Tachinid flies, some beetles
- Lay eggs inside or on the host, larvae consume the prey and destroy it.
- Adults free living and most feed on nectar and pollen from flowering plants
- Important regulators of worms, stink bugs, and others

Beneficial Insects

- Provide valuable, free pest control
- "When you kill the natural enemy, you inherit their work"
- Destruction of natural enemies by broad spectrum insecticides often results in 'flaring' pest species or setting a field up for a subsequent pest outbreak
- Sometimes incorporated into threhsolds, especially for aphids (in wheat, 1 natural enemy per 100 aphids sufficient for effective biological control)
- Fungal pathogens of insects can also wipe out pest populations – require cool, high humidity conditions.

Factors Influencing Insect Population Growth

Cultural Practices

- No-Till Favors: slugs, stinkbugs, cutworms, seed corn maggot and cutworms in corn; grasshoppers in soybeans
- Planting Date: late planting favors stinkbugs, cutworms and fall armyworm in corn; late planted wheat more susceptible to cereal leaf beetle; late planted, open canopy soybeans more susceptible to corn earworm

Factors Influencing Insect Population Growth

Environmental Factors

- Hot, Dry Weather: increases spider mites and grasshoppers in soybeans; decreases Mexican bean beetle in soybeans
- Cool wet weather: increase slug and seed corn maggot in corn
- High Humidity and Moisture: fungal pathogens of alfalfa weevil, aphids, green cloverworm and corn earworm

Factors Influencing Insect Population Growth

Crop Growth

- Alfalfa less than 12 inches tall= more susceptible to weevil and leafhopper damage
- Blooming Soybeans: spider mites, beginning of worm migration
- Open Canopy Soybeans: corn earworm
- Early reproductive stage soybean: stink bug

Factors Influencing Insect Population Growth

Importance of Beneficial Organisms

- Predators: Feed directly on pest, consume prey
- Parasites: lay eggs in pest, larvae develop in pest
- Pathogens: fungi, bacteria and viruses
- Alfalfa weevil: released parasites, fungal pathogens
- Aphids in Wheat and Alfalfa: predators, parasites and fungal pathogens
- Green Cloverworm and Corn Earworm: natural enemies and fungal pathogens
- Mexican Bean Beetle: parasitic wasps and predacious stinkbugs

Chemical Control

Mode of Action of Insecticides

- Contact – enters body wall by direct treatment of insect or treated surfaces
- Stomach – ingested and acts on digestive system
- Fumigant – absorbed through tracheal system as a gas
- Systemic – translocated through vascular system of plant, killing insect after feeding on host

Chemical Control

Insecticides classified by Mode of Action Group.

- Organophosphates (MOA group 1B) – chlorpyrifos (Lorsban), dimethoate
- Carbamates (MOA 1A)– methomyl (Lannate), carbaryl
- Pyrethroids (MOA 3) – cyflu**thrin** (Tombstone), cyhalo**thrin** (Warrior), bifen**thrin** (Brigade) broad spectrum but resistance a concern with several. Harsh on natural enemies, can lead to secondary pest flare ups.
- Chloronicotinyls or Neonicotinoid (MOA 4A) – imidacloprid, thiamethoxam (Poncho) – good on sucking bugs, early seedling pests. plant systemic; bee warnings on labels except for acetamiprid
  - MOA 4C – sulfoxaflor (Transform) – kills aphids, tarnished plant bug
  - MOA 4D – flupyradifurone (Sivanto) – aphids, much safer on bees than any other MOA 4
- Spinosyns: Spinosad (Blackhawk), spinetoram (Radiant) – good on worms, thrips
- Insect Growth Regulators – methoxyfenozide (Intrepid), need to target small larvae
- Diamides – chlorantraniliprole (Prevathon) – systemic, stomach poisons, excellent on worms
- Biopesticides: Bts, insecticidal soaps, Neem tree extracts

Insecticide Resistance

- Definition of Resistance: population no longer controlled with insecticides used at previously efficacious rates
- Resistance is inheritable, genetically linked trait
- Requires a lot of selection pressure
- It is not induced by low dosage habituation during life of an insect

Insecticide Resistance

Factors Favoring Development of Resistance

- Over dependence on insecticide
- Continued use of a single insecticide
- Continued use of insecticides with the same mode of action

Mitigation/Prevention of Resistance

- Apply pesticides only when threshold is reached
- Apply narrow-spectrum insecticides that preserve beneficials, if available
- Use recommended dose
- Rotate mode of action groups if a follow up treatment is necessary
- Use insecticides as a 'last resort'