

## APPENDICES

PA CCA Study Guide – Appendix 1, Disease Identification

APPENDIX 1 - DISEASE IDENTIFICATION

Diseases can be caused by viruses, fungi, bacteria or nematodes.

Fungi lack chlorophyll, and reproduce by microscopic spores.

Viruses become infectious and self-replicating inside plant cells.

Bacteria enter through wounds and natural openings.

Nematodes are non-segmented round worms that feed on roots and occasionally above ground plant parts.

Disease	Crop Infected	Crop Symptoms	Causal Organism
	<b>CORN</b>		
<b>Stalk rots</b>	corn	Deterioration of inner stalk tissue, usually appearing at senescence. Anthracnose; charcoal; diplodia; gibberella; fusarium; pythium Bacterial	fungus  bacteria
<b>Ear rots</b>	corn	mold starting at ear tip - gibberella mold between kernels, starting at base of ear - diplodia	fungus fungus
<b>Northern leaf blight</b>	corn	Long, elliptical grayish green or tan lesions appear on lower leaves first; later turn grayish black due to spore production by fungus, especially on under surface.	fungus
<b>Gray leaf spot</b>	corn	Lesions are pale brown or gray, parallel-sided	fungus
<b>Stewart's leaf blight</b>	corn	Long irregular pale green streaks	bacteria - corn flea beetle is vector
<b>Maize dwarf mosaic, maize chlorotic dwarf</b>	corn	Yellow streaks on corn leaves; mottle or mosaic of light and dark green in young leaves	Viruses transmitted by aphids and mites.
	<b>SMALL GRAIN</b>		
<b>Take-all</b>	wheat; barley; rye	Affected plants are stunted to severely dwarfed in localized areas; may lodge in all directions and develop white heads that are poorly filled and later darkened by sooty molds.	fungus
<b>Powdery-mildew</b>	wheat; barley; rye; soybeans	White to light gray patches form on leaves, sheaths, stems and floral bracts	fungus
<b>Head scab</b>	wheat	One or more spikelets per head turn prematurely straw-colored when glumes on healthy spikelets are still green	fungus
<b>Crown and root diseases of alfalfa</b>	ALFALFA		
<b>Phytophthora</b>	RR (root rot)	Infected plants stunted; early or reddish leaves drop early; taproots, bases or lateral roots and tips of small roots rotted.	fungus
<b>Mycoleptodiscus</b>	C (crown) /RR	Infected crowns have numerous wilted and dead stems due to black rot of tap root and crown; spindle shaped black sclerotia form in decayed crown tissue.	fungus

PA CCA Study Guide – Appendix 1, Disease Identification

Disease	Crop Infected	Crop Symptoms	Causal Organism
<b>Fusarium</b>	C/RR	Reddish brown streaks form in vascular cylinder of taproot; scattered stunted plants in irregular areas wilt rapidly, sometimes starting on one side.	fungus
<b>Sclerotinia (white mold)</b>	C	A white cottony mass of fungus mycelium grows over dead plant parts or the soil surface; crown turns soft and grayish green causing shoots to wilt and turn yellow	fungus
<b>Stagonospora leaf spot and RR</b>	C/RR	Brown to black dry rot of crown and upper portion of taproot develops; circular or irregular leaf spots with infected leaves dropping	fungus
<b>Violet</b>	RR	Plants killed in enlarging circular patches; roots decay and become covered with bright violet mycelium	fungus
<b>Bacterial wilt</b>	C/RR	Yellowish brown discoloration of vascular cylinder is evident when diseased taproot or crown is cut; scattered wilted, dying plants which are stunted bunched and yellow-green to bleached.	bacteria
	<b>ALFALFA &amp; SOYBEAN</b>		
<b>Anthracnose</b>	alfalfa; soybeans	Infected shoots wilt, die, turn straw-colored to white. Newly killed shoot tips often develop a "shepard's crook".	fungus
	<b>SOYBEAN</b>		
<b>Sclerotium stem rot (white mold)</b>	soybeans	Lower stems covered with white cottony mold.	fungus
<b>Purple seed stain</b>	soybeans	Pink or pale to dark purple coloration of seed coat; inconspicuous reddish brown spots form on leaves, stems and pods.	fungus
<b>Septoria brown spot</b>	soybeans	Chocolate to reddish brown spots form on both surfaces of leaves. Lower and older leaves gradually turn yellow and drop early; black specks form in older lesions.	fungus
<b>Virus diseases of soybeans</b>	soybeans		
<b>Soybean mosaic virus</b>	soybeans	Crinkled, mottled leaves; blades puckered.	Virus spread by aphids and other insects
<b>Bean pod mottle virus</b>	soybeans	Yellow to green mottling of young leaves in cool weather.	Virus spread by aphids and other insects
<b>Bud Blight</b>	soybeans	Terminal bud curves downward and dies	Virus spread by insects

**APPENDIX 2 - INSECT IDENTIFICATION  
Corn**

C = Complete Metamorphosis - 4 life forms are present: egg, larvae, pupae and adult  
G = Gradual Metamorphosis - 3 basic life forms: egg, nymph and adult

<b>Insect</b>	<b>ID - life cycle</b>	<b>Feeding habit</b>	<b>Injury Symptoms</b>	<b>Host Range</b>	<b>Damaging stages</b>
<b>Corn leaf aphid</b>	G - 40 to 50 generations. Females produce living young (nymphs). Small, bluish green, soft-bodied insect. Migrate north in spring to colonize whorl stage corn.	Feed by sucking sap from upper leaves and tassels. Tassels become covered with sticky honeydew substance which turns black due to fungus.	Damage is generally of little concern except in seed corn production. Stress usually higher when dry conditions exist.	Corn, sorghum, small grains and other grasses	Adults and nymphs. Populations normally controlled by environmental factors and natural enemies.
<b>Northern corn rootworm</b>	C - Yellowish to pale green beetle, 1/4" long. Newly emerged are cream to light brown. Mature larvae are white and slender, about 1/2" long, have brown heads and dark plate on top side of terminal segment. Beetles emerge between mid-July and mid-August. Female prefers to lay eggs in cornfields over 1 month period. Larvae begin to hatch in June.	Larvae feed on corn roots from early June until late July. Adults are present on corn silks, tassels and foliage until frost. Heavy populations at silking may clip silks at pollination.	Lodging due to root pruning by larvae. Poor pollination due to clipping of silks by beetles. Soil moisture largely determines extent of damage. Severe root pruning of small plants can kill the plant.	Corn	Larval and adult (beetle)
<b>Western corn rootworm</b>	C - Adults are yellow with three black stripes on wing covers. Some beetles may appear to have a completely black back. Stipes are more pronounced on female. Mature larvae are white and slender, about 1/2" long, have brown heads and dark plate on top side of terminal segment. Beetles emerge between mid-July and mid-August. Western larvae emerge 5 to 7 days before northern. Female prefers to lay eggs in cornfields over 1 month period. Larvae begin to hatch in June.	Larvae feed on corn roots from early June until late July. Adults are present on corn silks, tassels and foliage until frost. Heavy populations at silking may clip silks at pollination. Western feed more vigorously and emerge earlier than northern.	Lodging due to root pruning by larvae. Poor pollination due to clipping of silks by beetles. Soil moisture largely determines extent of damage. Severe root pruning of small plants can kill the plant.	Corn	Larval and adult (beetle)

PA CCA Study Guide – Appendix 2, Corn Insects

Insect	ID - life cycle	Feeding habit	Injury Symptoms	Host Range	Damaging stages
<b>Seed corn maggot</b>	C - 2 to 3 generations/yr. In late April adult flies emerge from pupae; flies deposit eggs on or near soil surface; eggs hatch and maggots work way to seeds where they destroy seed germ. Maggots have no head or legs and are dirty white in color.	Maggot feeds on seed germ and attack underground stem of sprouted corn.	Weak seedlings result and often die.	Corn, soybeans and vegetables	Larval (maggot) A planter box seed treatment, commercially treated seed corn or a soil insecticide is recommended to control.
<b>White grub</b>	C - White grub larvae appear in spring. The term white grub refers to several species with variable life cycles.	Feed on roots and below ground stem.	Cause stunted, often purplish, low vigor plants that appear nutrient deficient.	Corn, soybeans, small grains.	Larval
<b>Garden symplylan</b>	G – Not an insect. More closely related to centipedes. Overwinter as adults. About 1/4" long with 12 sets of legs . Immature stages have only six sets of legs. In late April, May and June eggs are deposited in soil. Eggs hatch into white nymphs that resemble adults with fewer legs. Takes about 45 to 60 days to go from egg to adult. Entire life spent in soil.	Symplylan feed on sprouting seeds and underground stems of seedlings.	Plants are weakened or killed.	Corn, alfalfa, soybeans, small grains, vegetables with tubers	Adult symplylan
<b>Slugs</b>	There are four main slug species that attack corn and soybeans in Pennsylvania. Most have 1 and partially 2 generations/yr. Overwinter in either egg or adult stage. Juvenile eggs hatch from eggs in early spring. They reach sexual maturity by mid-to-late summer and start depositing eggs when climatic conditions are favorable. Majority of eggs are deposited in September and October.	Start feeding on leaves immediately after hatching. Prefer high humid and cool temp. Feed mainly at night and hide under debris during day.	Feed by rasping leaf surface, causing leaves to have shredded appearance. Slugs leave trail of slime.	Feed on practically all crops	Immature and adults

PA CCA Study Guide – Appendix 2, Corn Insects

Insect	ID - life cycle	Feeding habit	Injury Symptoms	Host Range	Damaging stages
<b>Sod webworm</b>	Several species attack corn in Pennsylvania. 1 to 2 generations/yr., but only the first generation attacks corn. Overwinters as partially grown larvae enclosed in silken cases usually covered by soil. Start feeding in April and complete development in early June. Pupate and emerge as moths by mid-June. Drop eggs in grassy areas and larvae emerge. Gray spotted worms that remain hidden during day and feed at night.	Consumes some of leaves and stem of young plant. Also may chew into plant stems above or below ground level.	Some seedlings die and others may be deformed.	Grasses	Larval
<b>Wireworm</b>	Several species attack corn in Pennsylvania with variable life cycles. 1 generation every 2 to 3 yrs, some as many as five years. Overwinter primarily as partially grown larvae and adult "click" beetle. Eggs deposited by beetles during summer. Larvae feed on underground plant parts for 2 to 3 years before reaching maturation. Mature larvae pupate during late summer and new beetles remain in soil until next summer. Pale yellow in color when small and becomes reddish-brown as it approaches 1" in length. Shiny and slender.	Soon after planting, may eat seed or cut off seedling below ground level. Later - tunnel into underground portion of stem.	Kill seedlings or cause stunting of growth.	Corn, small grain and potatoes. Can attack soybeans.	Larval  Because generations overlap, unless larvae are controlled damage can be expected for 2 to 3 yrs.
<b>Black cutworm</b>	C - Three generations/yr., but only the first generation results from migrating adults attacks corn. These species migrates into the northern U.S. each year from the south where they overwinter. Egg laying by females occurs prior to spring tillage and planting. Takes 2 months to go from egg to adult. One month is in larval stage. Newly hatched larvae are 1/4" and mature to 2". Gray to black in color with pale indistinct stripe down back and convex surface.	Where soil moisture is adequate, larvae hide in soil during day and move to surface at night and cut plants just above soil surface. One larva can cut off 5 plants during its development. If dry, cut plants below soil surface.	Plants cut below growing point die. Those cut above the growing point are set back in their development and may have produce a smaller ear or no ear at all.	Corn and alfalfa	Larval

PA CCA Study Guide – Appendix 2, Corn Insects

Insect	ID - life cycle	Feeding habit	Injury Symptoms	Host Range	Damaging stages
<b>Flea beetle</b>	Adult is very small black beetle that jumps when a plant is disturbed. Although they first appear in spring, they are found all season long. (They may be more numerous after a mild winter). Adults overwinter at the base of grasses near cornfield edges. After mating females lay eggs near corn plants. Larval stages feed on corn roots, but seldom cause damage.	Feed on leaves and can transmit E. steward –Steward's wilt (bacterial wilt).	Damage appears as scratches in upper and lower surfaces of leaf, usually parallel to veins. Although feeding damage is seldom economic, beetles can transmit Stewart's disease. (Most commercial varieties are resistant to disease.)	Corn, other grass species and many broadleaf species.	Adult beetle
<b>Billbug</b>	Several species. 1 generation/yr. Larvae cannot develop in corn, thus, damage is limited to cornfields where nutsedge was a problem. Overwinter as adult weevils in soil or nearby protected sites along field margins. They emerge during May and feed on grass plants. After mating, females deposit eggs in stems of nutsedge. Grubs or larvae develop in stems and nutlets and reach maturity in June and July. They pupate and transform into adult weevils by autumn.	Most feeding damage occurs during May. Upon emergence from soil, adults chew small holes in stems.	Numerous stem punctures can severely retard or even kill small plants. As the plant grows and leaves unfold, damage shows as series of 3 to 4 round holes across leaf.	Nutsedge principle host. Will also feed on corn plants.	Adult billbug

Insect	ID - life cycle	Feeding habit	Injury Symptoms PA CCA Study Guide	Host Range – Appendix 2,	Damaging stages Corn Insects
<b>True Armyworm</b>	C - one to three generations. Partially grown larvae and pupae overwinter in clumps of grass and in soil in southern areas. Adults migrate into the state during April and May. From mid-May to mid-June first generation larvae feed on small corn plants. Adult moths emerge in May and June. They deposit eggs in grasses and larva hatch about a week later. Larva pupate and moths emerge in July. Newly hatched larvae are pale green; when half grown, brown with orange, white-bordered stripes on each side.	Larvae feed on leaves at night. Sometimes the insect may move in mass from a ripening small grain field and complete consume corn along the field margin or the entire field.	Practically all damage is from first generation. Defoliation and in severe infestations the growing point can be consumed.	Corn and other grass species	Larval

Insect	ID - life cycle	Feeding habit	Injury Symptoms	Host Range	Damaging stages
<b>Fall Armyworm</b>	C - a warm weather species that migrates into PA in late July and mid Aug. Upon arrival deposit eggs; Eggs hatch in 5 to 7 days; Small larvae feed on plants near ground. Larval stage last about 15 days. Larvae pupate and pupal stage lasts about 2 weeks. A life cycle requires from 30 to 50 days. New generation of moths emerge and may deposit eggs or move on. Activity stops with freezing temperatures. Can be distinguished from true by a distinct light brown inverted "Y" on the head surrounded by a darker brown.	For first few days feed near ground; after about a week, move up and consume everything but veins and mid-rib.	Defoliation plants during mid-whorl to late whorl stage. Later infestations will feed on the developing ear.	Corn, sweet corn and vegetable crops.	Larval

<b>Common stalk borer</b>	One generation/yr. Eggs deposited on corn plants, orchard grass and rye in Sept. and Oct. overwinter and hatch from mid-May to mid-June. Larval stage last from 9 to 12 weeks. Starting in late July larvae pupate. Moths start emerging in late August. Larvae is light brown with a narrow white stripe running from head to tail, a similar white stripe on each side and a purplish-brown band that circles the front third of the body.	Larvae burrow into stalks near ground level and then eat their way upward through the stalk. They also crawl to near tops and eat their way through rolled leaves down into stalks, leaving a few ragged holes and small amounts of sawdust-like frass.	Small plants seldom survive infestation. Wilting in top half of plant is an early symptom. If plants survive they may be barren or produce only small ears.	Field and garden crops. This pest has a very wide host range.	Larval Plowing under trash provides control. A foliar insecticide applied with the burndown herbicide.
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PA CCA Study Guide – Appendix 2, Corn Insects

Insect	ID - life cycle	Feeding habit	Injury Symptoms	Host Range	Damaging stages
<b>European corn borer</b>	C - One to 3 generations/yr; (based on # of generations - northern, central or southern borers) Diapause suspends larval development. Flesh colored worm with a reddish or blackish head and two distinct light brown spots on the top of each abdominal segment. Overwinters as larvae dug into cornstalks, corn cobs and other cornfield debris. Spring development begins when temp. exceeds 55 degrees F. In May and June they pupate, in June and July adult moth is present, eggs are laid in June and larvae are present in July. A second generation begins in July with larvae pupating. Egg masses are deposited near mid-rib and on underside of leaves. In northern and cooler areas of the state a single generation type of European corn borer is dominant that attacks during the late whorl and early reproductive stages.	Female moths in spring flight are attracted to tallest cornfields. If corn is less than 16" when eggs hatch, most larvae fail to become established. Younger plants have increased plant aglucone that causes borer to wander off. Moisture stress and evaporation will also kill borer. Those that live move to the whorl where they feed and develop. Eventually they burrow into the stalk, pupate and emerge as moths in mid summer.	Yield losses are primarily because of physiological losses rather than ear droppage. Damage results from leaf feeding (first generation), stalk tunneling (first and second), leaf sheath and collar feeding (second and third) and ear damage (second and third). Secondary invasion of stalk rots into susceptible varieties also occurs.	Corn and vegetable crops	Larval
<b>Japanese beetle</b>	Adult brightly colored beetle. Only adult grub which damages corn. However, in recent years the larval stage (white grub species) has caused stand reductions in some areas through root feeding.	Adults feed on silks reducing pollination efficiency and causing poorly filled ears. Larval stage – feeds on corn roots and can cause stand reductions.	Silk clipping. Reduced pollination resulting in reduced kernels/plant.	Corn and other grasses, but will also feed on many other plant species.	Adult beetle and larval stage

Resources:

Handbook of Corn Insects published by the Entomological Society of America

Numerous websites have outstanding information. See the Penn State Department of Entomology Site ([www.ento.psu.edu](http://www.ento.psu.edu))

PA CCA Study Guide – Appendix 3, Soybean Insects

APPENDIX 3 - INSECT IDENTIFICATION  
Soybeans

Complete Metamorphosis - 4 life forms are present: egg, larvae, pupae and adult

Gradual Metamorphosis - 3 basic life forms: egg, nymph and adult

<b>Insect</b>	<b>ID - life cycle</b>	<b>Feeding habit</b>	<b>Injury Symptoms</b>	<b>Host Range</b>	<b>Damaging stages</b>
<b>Green Cloverworm</b>	Adult moth usually migrates into state. Larvae is pale green with 2 thin white stripes along each side of body. It first appears in soybeans in July. Peak in mid-August. Parasites, predators and particularly fungus disease play major role in controlling pest.	Young worms feed on leaves by scraping leaf surface. Older eat irregular holes between main veins.	Plants take on ragged appearance. Worms normally do not attack the pod.	Soybeans	Larvae Rarely occurs in numbers enough to cause economic damage.
<b>Mexican bean beetle</b>	Overwintered adults invade soybean fields shortly after plant emergence. Round orange-brown beetle with 16 black spots on its back. The larva is bright yellow bristly grub which is found on underside of leaves.	Larvae and adults feed on underside of leaves, between veins.	Can kill seedlings by damaging cotyledons before first leaves develop. Leave a lacelike network of the tougher leaf tissue.	Soybeans and garden beans	Larvae and adult
<b>Two-spotted spider mites</b>	Many generations/yr. Not an insect - thus lacks wings. Oval and pale yellow to green. Passively dispersed into fields by wind from vegetation along field borders (or actively crawl). Problems are worst in years of low rainfall and moisture stress. Overwinter as adult females in sheltered areas including roadsides.	Mites use needlelike mouthparts to pierce individual tissue cells on undersides of leaves. They extract entire contents of cells.	Yellow or white stipples first noticed at base of leaf. Feeding by 300 to 600/leaf cause leaf to turn brown or yellow on margin and die.	Soybeans	Mite Check fields in early July and August. Borders affected first.

PA CCA Study Guide – Appendix 3, Soybean Insects

Insect	ID - life cycle	Feeding habit	Injury Symptoms	Host Range	Damaging stages
<b>Bean leaf beetle</b>	Overwintered adults invade soybean fields shortly after plant emergence. Either green, yellow, tan or red with a distinct black band around outer edge of wing covers. Usually 2 black spots on each wing cover. A black triangle is always found behind the head on the wing covers.	Damage is usually caused by adult, although larvae feed on bean roots.	Can kill seedlings by damaging cotyledons before first leaves develop. Leave a lacelike network of the tougher leaf tissue. Larvae feed on roots. The first generation may feed directly on the seed pod causing injury.	Soybeans and garden beans	Adult primarily, larvae
<b>Soybean Aphid</b>	Overwinter as eggs on Buckthorn shrubs along forest and field edges. Eggs hatch in the spring and complete two to four generations before migrating into soybean fields. In the soybean field, all individuals are females that bare live young (nymphs). At optimal temperatures a newly born nymph will reach the reproducing adult stage within six days and then produce 50 offspring over a 21 day period. Population buildup can be extremely rapid.	Both nymphs and adults feed by inserting piercing-sucking mouthparts into the stem to withdraw sap. Early in the season when populations are low, most individuals will be found feeding on the newly emerging leaves. As the season progresses, aphids can be found anywhere on the plant.	Plant turn yellow, the leave may become leathery, and the plants will be stunted. In severe infestation, the plants can be killed.	Soybean and a few additional legumes.	Adult and nymph

Resources:

Numerous websites have excellent information

Handbook of Soybean Insects published by the Entomological Society of America

PA CCA Study Guide – Appendix 4, Cereal Grain Insects

APPENDIX 4 - INSECT IDENTIFICATION  
Cereal Grains

Complete Metamorphosis - 4 life forms are present: egg, larvae, pupae and adult

Gradual Metamorphosis - 3 basic life forms: egg, nymph and adult

Insect	ID - life cycle	Feeding habit	Injury Symptoms	Host Range	Damaging stages
<b>English grain aphid</b>	Small bluish-green, pear-shaped bodies with black legs and antennae, less than 1/8"; have pair of black tail pipe like appendages on abdomen. Over winter in small grains as either eggs or females that give birth during spring. During May and June, as wheat, oats and barley mature and lose flavor, winged aphids develop and move to grasses to spend summer. In fall they go back to newly planted winter grains to overwinter.	Needlelike mouth parts remove plant sap. In late spring aphids feed on boot and flag leaf. As grain heads, clusters of aphids move to heads.	Feeding by large numbers causes head to shrivel. Also a vector for barley yellow dwarf virus.  Aphids usually held in check by parasites, predators and fungal diseases.	Small grains	Aphid
<b>Cereal leaf beetle</b>	1 generation/yr. Overwinters in sheltered places in old corn fields. Beetles emerge from late March through April and feed on wild grasses and winter grains. After 2 to 3 weeks adults mate and females lay eggs on young spring-planted oats and late planted wheat. Eggs hatch and feed voraciously during May and June.	Both larvae and adults feed on upper leaf surface of young oats or new growth of winter wheat, particularly the flag leaf. Adults chew completely through leaf. Larvae feed superficially on mesophyll, leaving only translucent lower leaf cuticle in tact.	Tips of damaged leaves turn white, giving infested field an overall frosted appearance.	Small grains	Larvae and adults Usually controlled by 4 or 5 parasite species.
<b>Hessian fly</b>	In late Sept. flies hatch and live for 1 week. During that week they lay their eggs on leaves of young wheat plants, if available. If no wheat lay eggs on barley and rye. Maggots hatch and extract juices from base of plant. Pass winter as puparium (flaxseed). In spring adult flies emerge and lay eggs on leaves. Hatched maggots feed on leaf sheath near node.	Maggots extract plant juices.	Stalks break over before harvest.	Wheat	Maggot (larvae)  Important to plant wheat after Hessian fly free date.

PA CCA Study Guide – Appendix 5, Alfalfa Insects

APPENDIX 5 - INSECT IDENTIFICATION

Alfalfa

C = Complete Metamorphosis - 4 life forms are present: egg, larvae, pupae and adult

G = Gradual Metamorphosis - 3 basic life forms: egg, nymph and adult

Insect	ID - life cycle	Feeding habit	Injury Symptoms	Host Range	Damaging stages
alfalfa weevil Eggs-Fall/Spr	C - 1 generation/yr. Yellow oval egg; small legless, yellowish green larva with white stripe along middle of back (fainter white stripe on each side) and black head (3/8" mature); pea size loosely woven cocoon; Medium brown snout beetles with distinctive light brown strip down back. Overwinters in adult and egg stages. 90% of eggs are deposited in spring before mid-May.	In early spring, larvae that hatch from eggs deposited by overwintering adults in plant stems begin feeding within folded leaves at growing tips. Feed for 3 to 4 weeks.	Early - tiny pinholes on inside of terminal leaves. Later move to foliage on lower leaves - can skeletonize plants. Crop has grayish white cast to it (frosted appearance). Reduces yield and quality. Injury first cutting and sometimes new growth of second cutting. Damage complete by mid June.	Alfalfa	Larval Early spray application s harm certain parasites. Early spray and sprays with long residual action should be avoided.
clover root curculio (sitona) Eggs-Fall/Spr	C - 1 generation/yr. Eggs are deposited on ground adjacent to crowns in clover and alfalfa fields in spring and late summer (fall). During winter, they survive as adult weevils, eggs and larvae. Pupation occurs in June. Adult emergence occurs in late June. Adults are small grayish brown weevils < 1/4" long.	Newly hatched white larvae feed upon root nodules. Larger larvae feed on lateral roots and main tap roots. Adult weevils cause minor damage by notching edges of clover leaflets.	Early season injury is primarily to nodules and lateral roots of alfalfa and red clover. More mature larvae may cause significant damage to taproot later in spring. Damage complete by end of June. If very dry or wet conditions, plants may die.	Red clover and alfalfa	Larval No control practiced.
spittlebug Eggs-Fall	G - 1 generation/yr. Eggs are laid in fall in clover and alfalfa fields. Hatch in April; Nymphs are very small (1/32") and are yellow to orange. Nymphs are damaging phase and live in moist frothy spittle-like secretions. They are found from April through early June. Adults do not produce spittle and are very mobile and jump readily when disturbed. Adults resemble leafhoppers but are much larger - 1/4 - 3/8" and are pale to dark brown.	Nymphs suck plant fluids from within spittle mass.	If severe infestation, plant growth may be stunted due to plant sap removal. Yield losses are often greatest in new stands of alfalfa that have been established in small grain stubble. Damage complete by early June.	Alfalfa, but can be found in other legumes	Nymphs Spittle masses with > 1 nymph/ste m control may be necessary.

PA CCA Study Guide – Appendix 5, Alfalfa Insects

Insect	ID - life cycle	Feeding habit	Injury Symptoms	Host Range	Damaging stages
<b>tarnish plant bug</b>	G - 3 to 5 generations/yr. Adults overwinter in debris in legume fields, fence rows, woods and ditches. With warm temperatures in spring, begin to feed on wide variety of plants. Adults insert eggs into plant stems, leaf midribs, etc. Adults are brown with mottling of white, yellow and black colors; 1/4" long. Nymphs are green with similar shape.	With piercing sucking mouthparts, remove plant fluids.	Feed on many portions of plant including leaves, stems, flowers and seed pods of alfalfa.	Alfalfa	Adults Usually only controlled in seed production.
<b>Potato Leafhopper</b>  Eggs layed when alfalfa is 2 to 4 inches tall	G - 3 or 4 generations/yr. From egg to adult takes 3 weeks. Life cycle takes about 1 month. PLH moves into state in late May and early June from southern states. No damage to first cutting harvested before middle of June. Eggs deposited in stems and leaf veins. Nymphs have no wings and take two weeks to become adults. Adults have long hind legs, are wedge shaped and 1/8" long and are pale green. Adults have wings.	Adults and nymphs feed on plants. Insert mouthparts into plant tissue to extract plant juices. Process blocks tiny tubes that distribute nutrients within plant.	Injury most likely on spring seedings and regrowth of second and third cuttings. Blockage results in triangular shaped yellowing of leaves and stunting of plants. Reduces protein and vitamin A content.	Alfalfa and other legumes	Adults and nymphs Cutting management and chemical control management.

PA CCA Study Guide – Appendix 5, Alfalfa Insects

Insect	ID - life cycle	Feeding habit	Injury Symptoms	Host Range	Damaging stages
<p><b>pea aphid</b></p>	<p>G - Complete life cycle requires 12 days, allowing 7 to 20 generations/yr. Adult overwinters in crown of plant or under crop residue. Eggs may also overwinter in plant stems. Mild winters improve adult survival. During harsh winters only eggs survive. Black eggs are small and are glued to stems and foliage. Hatch occurs in early spring. Pea-green or pink in color; roughly 1/16"; adults may be winged or wingless; immatures or nymphs are smaller and wingless.</p>	<p>adults and nymphs remove fluids from alfalfa plants with piercing and sucking mouthparts. Often feed on new growth.</p>	<p>If feeding is heavy, plants will yellow and display wilting. Prolonged feeding may produce stunted plants. Beneficial insects and fungal diseases can reduce populations.</p>	<p>Alfalfa and other legumes</p>	<p>Adults and nymphs If pea aphids average more than 100/sweep and no beneficial insects, economic damage may occur. Fungus usually keeps in check.</p>
<p><b>grasshoppers</b>  Eggs-Fall Hatch-June/July</p>	<p>G - 1 generation/yr. Eggs laid in clusters in late summer and fall in soil at various depths; uncultivated preferred; hatch in spring; Adults are 3/4 to 2". Newly hatched nymphs have no wings and are about 1/4". Usually brown or gray. Nymphs are most sensitive life stage to disease development. Dry warm weather promote populations. If wet and humid, diseases are likely to kill many nymphs.</p>	<p>Nymphs and adults feed on same host plant.</p>	<p>Alfalfa and corn - Leaves are chewed from the margins inward. Corn - also shucks and ear tips. Soybeans and sorghum - pods or heads.</p>	<p>alfalfa, corn, soybeans, sorghum, small grains</p>	<p>Adults and nymphs Weather may control. Monitoring in late summer will help estimate potential for problems next year.</p>

PA CCA Study Guide – Appendix 5, Alfalfa Insects

Insect	ID - life cycle	Feeding habit	Injury Symptoms	Host Range	Damaging stages
<p><b>alfalfa leaf miner</b></p> <p>Eggs layed in early April by overwintering adults</p>	<p>G. 2 to 5 generations/yr. One generation is about 30 days.</p>	<p>Larvae (maggots) feed between the epidermal layers of the leaf removing chlorophyll, thereby reducing the plants ability to photosynthesis sugars (energy).</p>	<p>Typically a comma shaped whitish blotch (mine) on alfalfa leaves. The small end of the comma is where the egg was laid under the leaf surface. The increasing size of the comma reflects the sequential growth and feeding of the maggot.</p>	<p>Alfalfa</p>	<p>Larval stage, although the adults will cause a pinhole in leaf while laying eggs.</p>

For additional information on timing of each pest, pest biology, scouting methods, and economic thresholds visit the following webpages ([http://www.ento.psu.edu/extension/field\\_crops/alfalfa.htm](http://www.ento.psu.edu/extension/field_crops/alfalfa.htm) and <http://www.ento.psu.edu/extension/factsheets/cloverRootCurculio.htm>).

Another good resource is "Destructive and Useful Insects", by Metcalf, Flint and Metcalf published by McGraw-Hill Book Company, Inc.

PA CCA Study Guide – Appendix 6, Beneficial Organisms

APPENDIX 6 – BENEFICIAL ORGANISMS

Insect	Classification	Pest Target	ID - life cycle
<b>Syphrids</b>	Predator	Aphids	Fly maggots have light green to brown slug like body with tapered head end and blunt hind end.
<b>Lady bird Beetle</b>	Predator	Aphids	Several generations/yr. Beetles are moderately small hemispherical, black, orange, or red beetles with black, brown or yellow spots on their wing covers. Larva is alligator-shaped; bluish-black with orange markings and legs stretched out on sides. Adults and larvae feed on many kinds of scale insects, mites, aphids and insect eggs. During aphid outbreaks, tremendous lady bird beetle populations can develop. Unfortunately crop may be damaged before beetle control occurs.
<b>Lacewing</b>	Predator	Aphids	Adults are green or brown, "lacy-winged insects about 1/2 to 3/4" long with long, slender bodies. Their larvae, called aphid lions are light brown, mottled with brownish-red markings about 1/4" and also resembles small alligator in general appearance. It has a pair of long, sickle-like jaws, used to spear and suck body juices from aphids, causing them to die and turn brown.
<b>nabids (Damsel bug)</b>	Predator	General	Attack aphids and other pests.
<b>Parasitic wasps</b>	Parasites	Aphids	Insert eggs into aphids, causing them to die and turn brown.
<b>Spiders</b>	Predator	General	Don't need to know
<b>Minute pirate bug</b>	Predator	General	Don't need to know
<b>Predatory mites</b>	Predator	Other mites	Don't need to know
<b>Stinkbugs</b>	Predator	General	Don't need to know
<b>Lacewings</b>	Predator	General	Eggs are oblong whitish found on the end of a long stalk or leaves. Young nymphs hatch out and feed on anything they are find including each other. The nymphs look like small alligators with long sickles in front. The adults look totally different. They can be green or brown and have lacy wings held in a roof-like fashion over their abdomen.
<b>Parasitic flies</b>	Parasites	Typically specific to a single pest species or to a small set of other insects. In field crops they most attack larva of lepidoptera	They look like a large house fly, but with a hairier abdomen.
<b>Ground beetles</b>	Predators	General	Don't need to know. There are many species.
<b>Preying mantis</b>	Predators	General	Don't need to know. Overwinter in an egg mass
<b>Big-eyed bug</b>	Predator	General	Don't need to know
<b>Nematodes</b>	Predators	Can be generalist or specialist	Don't need to know
<b>Bauvaria bassiana</b>	Disease	Numerous insects	Don't need to know

**Importance of beneficial insects in pest population regulation:** All beneficial organisms help reduce pest populations by using the pest as a food resource. In most cases, these naturally occurring beneficial will cause from 50 to 99% mortality of a pest's population. Even when a pest outbreak occurs, we must keep in mind that without the efforts of beneficial organisms the numbers of pests could have been 10 or more fold higher. These organisms are always working for us and we should not take

## PA CCA Study Guide – Appendix 6, Beneficial Organisms

their efforts lightly, because without their help we would be spraying every field multiple times each year just to protect the crop. This in turn would likely lead to the pest rapidly developing resistance to all of our control efforts. For these reason, it is important in a sound IPM program to make sure it is absolutely necessary to apply a pesticide before doing so.

For this section, the main issue is that you can identify the above beneficials, their general classification, and the range of pests they attack. It is not important to know the life cycle, because each individual species has a unique life cycle. **You should also know, in general, how they regulate arthropod pest populations.**

### **Resource:**

Use the web to search for each one. There are many good sources on the web including commercial suppliers. Handbook of Corn Insects and the Handbook of Soybean Insects published by the Entomological Society of America.

## PA CCA Study Guide – Appendix 7, Publication Resources

### PUBLICATION RESOURCES

Manure Management for Environmental Protection – Department of Environmental Protection;  
[http://panutrientmgmt.cas.psu.edu/pdf/rp\\_manure\\_mgmt.pdf](http://panutrientmgmt.cas.psu.edu/pdf/rp_manure_mgmt.pdf); Document # 361-0300-001

Soil Fertility Manual – Potash & Phosphate Institute; [www.ppi-ppic.org](http://www.ppi-ppic.org)

Nitrogen Fertilization of Corn – Agronomy Facts # 12 - Penn State Extension Publication;  
<http://pubs.cas.psu.edu/FreePubs/pdfs/uc049.pdf>

Managing Phosphorus for Crop Production – Agronomy Facts #13 - Penn State Extension  
Publication; <http://pubs.cas.psu.edu/FreePubs/pdfs/uc055.pdf>

Managing Phosphorus for Agriculture and the Environment - Penn State Extension Publication;  
<http://pubs.cas.psu.edu/FreePubs/pdfs/uc162.pdf>

Soil Acidity and AgLime – Agronomy Facts #2 - Penn State Extension Publication;  
<http://pubs.cas.psu.edu/FreePubs/pdfs/uc038.pdf>

Agronomy Guide - Penn State Extension Publication; <http://agguide.agronomy.psu.edu/>

How a Corn Plant Develops - Iowa State Publication; <http://maize.agron.iastate.edu/corngrows.html>

Inoculation of Forage and grain Legumes – Agronomy Facts #11 - Penn State Extension Publication;  
<http://pubs.cas.psu.edu/FreePubs/pdfs/uc048.pdf>

Managing Potassium for Crop Production – Agronomy Facts #14 - Penn State Extension Publication;  
<http://pubs.cas.psu.edu/freepubs/pdfs/uc060.pdf>

Presidedress Soil Nitrate Test for Corn in Pennsylvania – Agronomy Facts #17 - Penn State Extension  
Publication; <http://pubs.cas.psu.edu/FreePubs/pdfs/uc067.pdf>

A nutrient management approach for PA: Nutrient stocks and flows - Agronomy Facts #38B- Penn State  
Extension Publication; <http://pubs.cas.psu.edu/FreePubs/pdfs/UC108.pdf>

Nutrient Management Legislation in Pennsylvania: A Summary of the Regulations - Agronomy Facts #40 -  
Penn State Extension Publication; <http://pubs.cas.psu.edu/FreePubs/pdfs/uc111.pdf>

Nutrient Management Planning: An Overview, Agronomy Facts #60 - Penn State Extension Publication;  
<http://pubs.cas.psu.edu/FreePubs/pdfs/uc156.pdf>

Pennsylvania Farm-A-Syst Worksheet 4: Barnyard Conditions and Management - Penn State Extension  
Publication; <http://pubs.cas.psu.edu/FreePubs/pdfs/uc138.pdf>

Avoiding Soil Compaction - Penn State Extension Publication; <http://soilmanagement.psu.edu/>

Weeds of the Northeast, Uva, Neal and Ditomaso, Cornell University Press

Introduction to Weeds and Herbicides - Penn State Extension Publication;  
<http://pubs.cas.psu.edu/freepubs/pdfs/uc175.pdf>

Cutting Management of Alfalfa Red Clover and Birdsfoot Trefoil - Agronomy Facts #7 - Penn State  
Extension Publication; <http://pubs.cas.psu.edu/FreePubs/pdfs/uc044.pdf>

## PA CCA Study Guide – Appendix 7, Publication Resources

Four Steps to Rotational Grazing - Agronomy Facts 43- Penn State Extension Publication;  
<http://pubs.cas.psu.edu/FreePubs/pdfs/uc114.pdf>

### Sources of Insect and Arthropod Pest Identification

The Entomological Society of America  
9301 Annapolis Rd, Suite 300  
Lanham, MD 20706-3115  
(301) 731-4535  
FAX (301) 731-4538  
Handbook of Corn Insects  
Handbook of Soybean Insects  
Handbook of Alfalfa Insects (under development)

### Sources for Specifics of IPM

Agronomy Guide – pages 149-155 (2005-2006)

“Entomology and Pest Management” by Larry Pedigo, MacMillan Publishing Co. – Chapters 6 – 8.

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