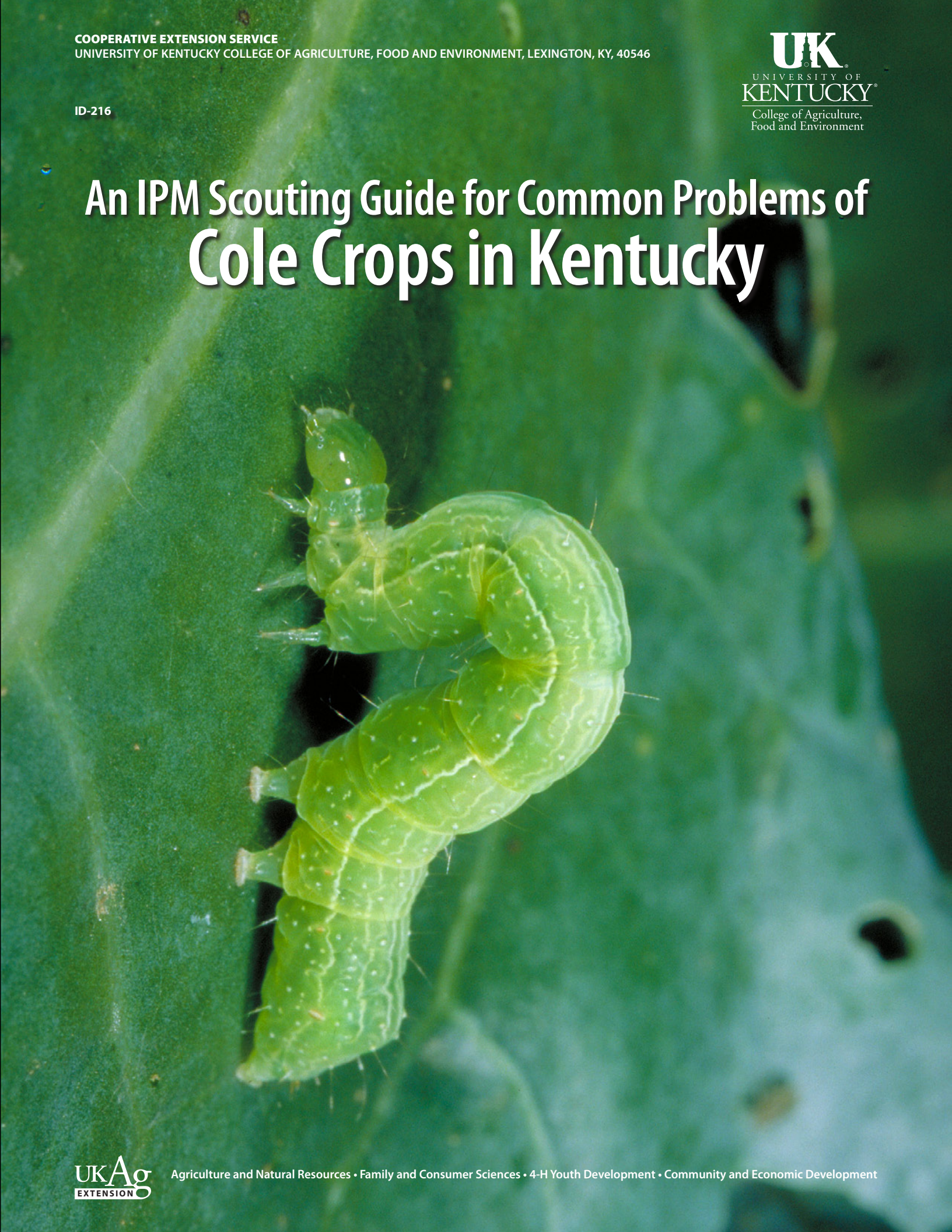
COOPERATIVE EXTENSION SERVICE
UNIVERSITY OF KENTUCKY COLLEGE OF AGRICULTURE, FOOD AND ENVIRONMENT, LEXINGTON, KY, 40546

UK UNIVERSITY OF KENTUCKY College of Agriculture, Food and Environment

ID-216

An IPM Scouting Guide for Common Problems of Cole Crops in Kentucky



UKAg EXTENSION Agriculture and Natural Resources • Family and Consumer Sciences • 4-H Youth Development • Community and Economic Development

An IPM Scouting Guide for Common Problems of Cole Crops in Kentucky

This manual is the result of efforts of the University of Kentucky Vegetable IPM team.
Funding for this publication is from the University of Kentucky Integrated Pest Management Program and the University of Kentucky Cooperative Extension Service.

Cover photo: Cabbage loopers get their name from their inchworm-like movements.

UK Vegetable IPM Team
Timothy Coolong, Extension Horticulturist
Kenneth Seebold, Extension Plant Pathologist
Ric Bessin, Extension Entomologist

Contents

Photo Credits

Many of the images in this manual came from the personal collections of the UK Vegetable IPM Team. However, in some instances images were used from outside sources. Credits for those images are listed as follows:

Unknown—9a, b, 30a, b

Colorado State University
M.E. Bartolo, Bugwood.org—10a

University of Georgia
David Langston, Bugwood.org—7a, 11, 29, 31b
Hunt Sanders, Bugwood.org—31a

University of Kentucky
Paul Bachi, Bugwood.org—25c
Ty Cato—8ab, 32b
John Hartman—10b
Cheryl Kaiser—7b

Sponsored by Kentucky IPM

Cole crops are important as a group, particularly when all acreage of cabbage, broccoli, cauliflower, and brussel sprouts are combined. Spring planted crops may have very different problems associated with them compared to fall crops. Integrated Pest Management (IPM) programs fill an important role in production of these crops and have enabled growers to improve quality and minimize input costs. IPM uses a combination of biological, cultural, physical, and chemical methods to reduce and/or manage pest populations. **These strategies are employed in such a way as to minimize environmental risks, economic costs, and health hazards.** Pests are "managed," but not necessarily eliminated, in order to reduce their negative impact on the crop.

The first, and possibly most important, step in managing a pest, disease, or other disorder is to properly identify the problem. Once the problem is correctly identified, a world of information becomes available through the Cooperative Extension Service and the internet. Essential to the IPM approach is frequent scouting and monitoring diseases, insects, weeds, and abiotic disorders in order to identify potential problems before they result in serious losses. This guide covers the common abiotic and biotic problems that occur on cole crops corn in Kentucky.

Please contact your local Cooperative Extension agent should you need additional assistance or encounter a problem not included here. Additional information on cole crop production, fertility, and pest management information may also be found in the University of Kentucky publication *Vegetable Production Guide for Commercial Growers* (ID-36) available from your county Extension office or online at http://www.ca.uky.edu/agc/pubs/id/id36/id36.htm.

Diseases

Bacterial soft rot on cabbage (a) and on broccoli florets (b).

Diseases Caused by Bacteria

1. Bacterial soft rot (*Erwinia carotovora* var. *carotovora*) affects many cole crops, including Chinese cabbage, cauliflower, broccoli, and radish. On cabbage, water-soaked spots are the earliest symptoms on outer leaves. The disease progresses quickly, leaving large areas of wet, necrotic tissue. Inside the head, tissues may liquefy and a foul odor is often present. On broccoli and cauliflower, localized areas of the head will have wet appearance at first. These areas become larger as disease progresses, leaving sunken, necrotic patches.
Management—Crop rotation, irrigation management (minimize leaf wetness and soil splash), plant in well-drained soils, and careful harvest (minimize bruising and wounding). Certain varieties of broccoli have head shapes that minimize pooling of moisture and are considered tolerant.

2. Black rot (*Xanthomonas campestris* pv. *campestris*) affects all cole crops. Early symptoms appear as small, yellowed spots on the margins of leaves. These areas will expand inward to form characteristic "v-shaped" lesions with brown centers and yellow margins. Lesions may merge to form large, blighted areas on the margins of leaves.
Management—Pathogen-free seed, hot-water treatment of seed, crop rotation, production of transplants away from production fields, deep-turn soil after crop is finished, fixed-copper, and resistant varieties.

Diseases Caused by Fungi and Fungus-Like Organisms

3. Alternaria leaf spot (alternaria blight, alternaria black spot) (*Alternaria spp.*) affects all cole-crop types. Initial symptoms on foliage are small, dark spots that later enlarge to as much as 25 mm in diameter. Older lesions become tan to brown in color, often exhibiting a concentric (zonate) growth pattern and, in some cases, a yellow margin. Masses of spores may be evident in lesions under humid conditions. The centers of mature lesions may crack as the disease progresses. Symptoms, in the form of darkened lesions or cankers, are found also on stems and heads of crops such as broccoli and cauliflower.
Management—Pathogen-free seed, fungicide seed treatments or hot-water treatment, sanitation (destruction of crop residues), crop rotation, fungicides.

Black rot on leaves of savoy cabbage.

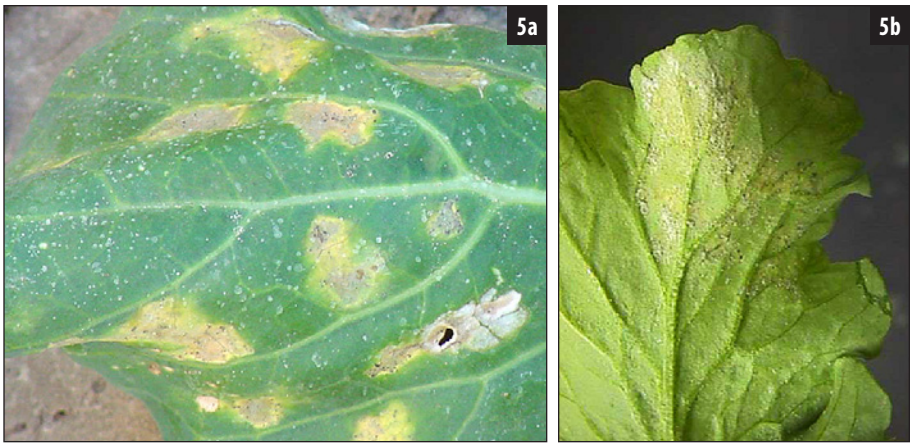
Alternaria blight on wrapper leaves of cabbage.


Black leg on cabbage stem.
4

4. Black leg (*Phoma lingam*) will affect most cole crops. On younger plants, infection of cotyledons of seedlings leads to damping-off. On older plants, tan-to-gray lesions may be present; however, the most damaging phase of this disease occurs on stems. Cankers on stems are initially elongated and brown in color. These cankers eventually girdle the stem, and woody tissues turn black. Numerous fruiting bodies (pycnidia) of the pathogen are usually present in older cankers, and appear as small, black specks.
Management—Pathogen-free seed, hot-water treatment of seed, crop rotation, and fungicides.

5. Downy mildew (*Hyaloperonospora parasitica*) affects all types of cole vegetables, and all above-ground parts of the plant are susceptible. Foliage is most commonly affected, and the disease appears as small yellow blotches on seedlings and as angular, yellow spots on the upper surfaces of older foliage. The undersides of lesions may have a sunken appearance, and sporulation of the pathogen will be evident during periods of high humidity. Extensive blighting of foliage is common in severe outbreaks of downy mildew. Cruciferous weeds can serve as a source of the downy mildew pathogen.
Management—Crop rotation, planting in areas with good air drainage, weed control, and fungicides.

6. Phytophthora root rot (*Phytophthora drechsleri*). Cabbage is the main cole vegetable impacted by this disease. Infections occur during periods of high temperatures and when soils are saturated. Wilting and plant collapse are usually the first symptoms observed; a necrotic canker will be present at the soil line of affected plants and root decay is common. Tissues above the canker may have a purplish discoloration. Extensive spread of disease is common in poorly drained soil or during periods of heavy rainfall.
Management—Improve soil drainage, crop rotation, fungicides applied prior to planting.


5a

5b

Downy mildew lesions on upper leaf surface of collard (a). Sporulation of downy mildew on the underside of a mustard leaf (b).


6a


6b

Wilting (a) and stem canker (b) on cabbage caused by *Phytophthora*.

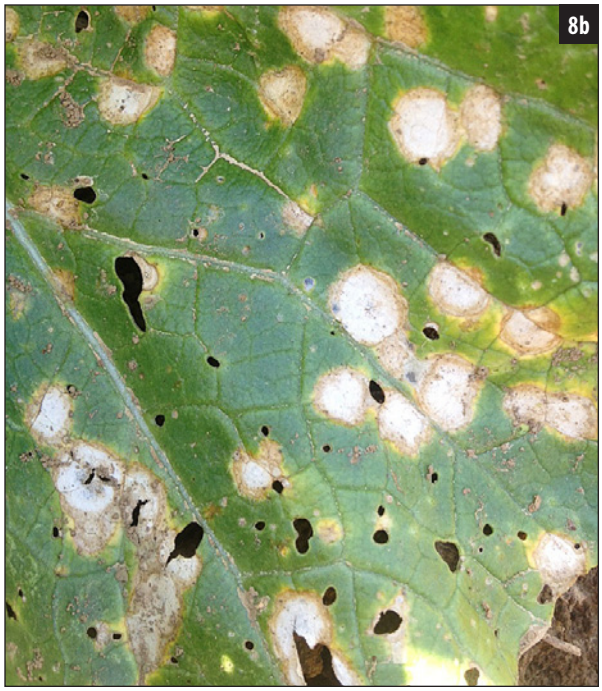
Wet rot and fungal growth (mycelium and sclerotia) caused by *Sclerotinia* on cabbage head (a). White mold on lower stem of cabbage (b).

7. White mold (*Sclerotinia sclerotiorum*) affects the majority of cole vegetables, but is found most often on cabbage in Kentucky. On cabbage, symptoms occur first on tissues near the soil line, and generally appear as a soft, wet rot that is light brown in color. The necrotic area will extend to the head as the fungus invades these tissues, resulting in extensive soft-rotting. Under humid conditions, a profuse white mycelium may be present on infected plant parts, along with numerous black-colored resting structures (sclerotia) that are irregular in shape and size. Transplants of cole crops are occasionally attacked by *S. sclerotiorum*. Infection occurs usually on stems at the soil line, resulting in a soft rot and eventual collapse of seedlings. Fungal growth (mycelium) is often present, along with sclerotia, on infected plant parts.

Management—Crop rotation, deep-turning of cole-crop residues after harvest, weed control, and fungicides.

8. White leaf spot (*Mycosphaerella capsellae*) affects all cole crops, but leafy varieties are more susceptible than cabbage or broccoli. The first symptoms are small, light-green to grayish spots on foliage. Older lesions are circular, tan to white in color, and may reach 10-12 mm in size. Whitish sporulation is common on the undersides of lesions during humid conditions. Expanding lesions often merge, creating large areas of blighted tissue.

Management—Crop rotation, weed control, and fungicides.



Lesions (a) and severe blighting (b) of napa cabbage caused by white leaf spot.

Wirestem on cabbage (a). Wilted kale affected by wirestem (b).

9. Wirestem (*Rhizoctonia solani*) occurs on seedlings after transplanting, and all cole vegetables are susceptible. Sunken, necrotic lesions form at the soil line and are often dark-brown in color. Lesions expand until the stem is girdled, resulting in wilting, collapse, and eventual death of seedlings. The pathogen, *R. solani*, can cause damping-off of direct-seeded crops.
Management—Plant healthy seedlings, fungicides (seed treatments or in-furrow drenches/sprays at transplanting), crop rotation, and moisture management in fields.

10. Yellows (*Fusarium oxysporum* f. sp. *conglutinans, F.o.* f. sp. *raphani*). All cole vegetables are susceptible. Leaves of plants affected by yellows have a yellow or greenish yellow appearance initially, and are often stunted. Yellowing may be more prominent on one side of the leaf. Stunting tends to be more pronounced over time in infected plants, and symptomatic foliage will become necrotic. Symptoms may be more severe on one side of the plant, resulting in curvature of stems. Defoliation is common in later stages of disease development. No visible decay is present externally; however, discoloration (brown) is usually visible in xylem tissues.
Management—Resistant varieties, prevention of pathogen spread (movement of infested soil), crop rotation.

Diseases Caused by Viruses

11. Turnip mosaic (*Turnip mosaic virus*). All cole vegetables are susceptible, and the pathogen is aphid-transmitted. Symptoms include variegated color patterns (mosaic), necrotic ringspots, and distortion on foliage. Weeds and cole crops are reservoirs of the virus.
Management—Weed management, destruction of crop residues immediately after harvest, insect control (will not impact initial infections, but will help reduce secondary spread).

Fusarium yellows on cabbage (a). Vascular discoloration caused by *Fusarium* on kale (b).

Turnip mosaic on foliage of turnip.

Insect Pests

Cabbage maggot on stem of transplant.

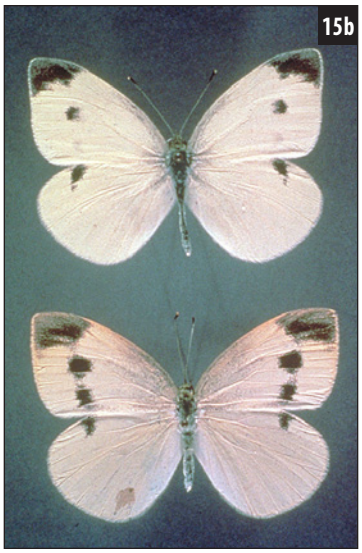
Black cutworm.

12. Cabbage and seedcorn maggots (*Delia spp.*) are in a group of flies that can attack the roots of vegetables. These pests are favored by early planting dates, heavy cover crops, and cool-wet weather. When stand loss or plant injury due to maggots becomes apparent, there are no effective rescue treatments available. These maggots are yellowish white and grow to about 1⁄4 inch in length when mature. The body is legless with a pointed head and a blunt tail. After about 3 to 4 weeks, the larvae pupate in the soil. The brown pupal cases are hard and football-shaped and are found in the soil near the roots. The adult is a dark gray fly with smoky-gray wings, black legs, and three stripes on its back.
Management—Transplanting after the peak of adult emergence and egg laying in the spring will avoid problems. Plow fields at least 3-4 weeks before planting, as freshly plowed fields are attractive for egg laying. Soil drenches with an insecticide at transplanting is helpful if these flies are active.

13. Black cutworms (*Agrotis ipsilon*) are occasional pests of many vegetables and can cause considerable stand loss. Black cutworms are active on many vegetable crops from transplanting until stems toughen or reach more than ½ inch in diameter. They are more likely to be found in fields with a history of cutworm damage, those planted under reduced or no-tillage practices, or those with poor drainage. Excessive fall or spring weed growth and the amount of surface residue influence the potential for cutworm infestations. The cutworms are light gray to nearly black with a faint, narrow, stripe down the middle of the back. The skin appears "greasy" and to contain tiny granules. Larvae can reach 1¾ inches in length when full grown. They will be coiled in a compact "C" when uncovered. Cutworms are active at night, feeding first on leaves when small and later cutting plants as they grow. Infestations usually begin on early season weed growth prior to field preparation.
Management—Early land preparation two or more weeks before transplanting and good weed control will help to reduce cutworm problems. It is important to watch the field closely for seedlings with small holes in the leaves or cut plants. Early detection means an insecticide application can be made before serious damage occurs.

14. Cabbage and green peach/tobacco aphids (*Brevicoryne brassicae* and *Myzus spp.*). Cabbage aphids are grayish-green with a waxy covering that makes them appear dusty. They have short cornicles on their abdomen. The green peach and tobacco aphids range in color from pink to light green and have longer cornicles. The cabbage aphid will attack cole crops while the green peach aphid feeds on most vegetables. Aphids can build rapidly to large number when weather conditions are favorable due to their asexual reproduction. They also produce honeydew which can result in sooty mold on heads. Aphids can stunt plants and contaminate heads for sale. Dead aphids can be as much of a problem as live ones.
Management—Timely destruction of crop remnants after harvest helps to reduce overwintering aphids. Many predators and parasitic wasps can help to mange aphid numbers, so avoiding the use of broad-spectrum insecticides will encourage biological control. Insecticidal soaps as well as selective aphicides are available.

Cabbage aphids on a cabbage leaf (a). Tobacco aphids (b).



Imported cabbage worm larvae (a) and moth (b). Wasp cocoons from an imported cabbage worm (c).

15. Imported cabbageworm *(Pieris rapae)* larvae are velvety green with a narrow, light yellow stripe down the middle of the back and have four pairs of prolegs in addition to the three pairs of true legs behind the head. The larvae reach 1¼ inches in length. The pupae is greenish in color and attached to the undersides of cabbage leaves (without a silk case). The adult is a white butterfly with a few simple black markings. The bullet-shaped eggs are laid singly, have distinct ridges, and are initially white when laid but turn dark yellow as they mature. Imported cabbageworm cause similar damage as loopers, but feed closer to the center of the plant. Larvae are often concealed next to veins or the midrib on the underside of the leaves. Scouting for eggs and larvae should begin as soon as the white butterflies are seen flying about during the day. Late in the season, may of the larvae may become parasitized and wasp cocoons noticeable, do not include these in scouting counts.
Management—Watch fields for white butterflies on warm days in the spring, this is an indication to begin scouting for eggs on leaves. Watch for larvae on the youngest leaves near the bud of the plant. Bt sprays can be very effective against this caterpillar.

16. Diamondback moth *(Plutella xylostella)* larvae, despite their small size, can be very destructive to cole crops. Eggs are laid singly or in small groups on the undersides of lower leaves. Eggs are small, yellowish-white and somewhat football-shaped. Larvae are small, yellowish-green, spindle shaped (widest in the center), and have a forked tail. When mature, larvae are 5⁄16 inch in length. The pupae are found in a gauze-like cocoon attached to leaves or stems of the cabbage plant. The wings of the male form three yellow diamond-shaped spots where they meet. The young larvae mine between the upper and lower leaf surfaces. Look for young larvae emerging from small holes in the underside of the leaf. Older larvae create "window-pane" holes while leaving the upper surface intact. Larvae often drop from the plant on silk threads when disturbed.
Management—Monitoring should begin when the plants are young. During cupping, larvae that feed on heart leaves are difficult to find unless the outer leaves are pulled back. This pest has developed resistance to many classes of insecticides and repeated use of pyrethroids (IRAC group 3) can increase problems by interfering with natural biological control.

Diamondback moth caterpillar (a), pupae (b), and adult (c).

Cabbage looper caterpillar (a) and moth.

Cross striped cabbageworm on a cabbage leaf.

17. Cabbage looper *(Trichoplusia ni)* larvae are light green in color with a pale white stripe along each side and two thin white stripes down the back. The body is wide in the rear and tapers toward the head. There are three pairs of slender legs near the head and two pair of club-shaped prolegs toward the other end. Because the larvae have no legs in the middle area of their body, this area arches when the insect moves. When mature, the larvae reach 1½ inches in length. The ridged, white, round eggs are usually laid singly on the underside of the outer leaves. The pupae are brown, about ¾ inch long and wrapped in a delicate cocoon of white tangled threads. The adult moth is a mottled, grayish-brown moth with a 1½ inch wing span and a small silvery spot resembling a sock in the middle of each front wing.

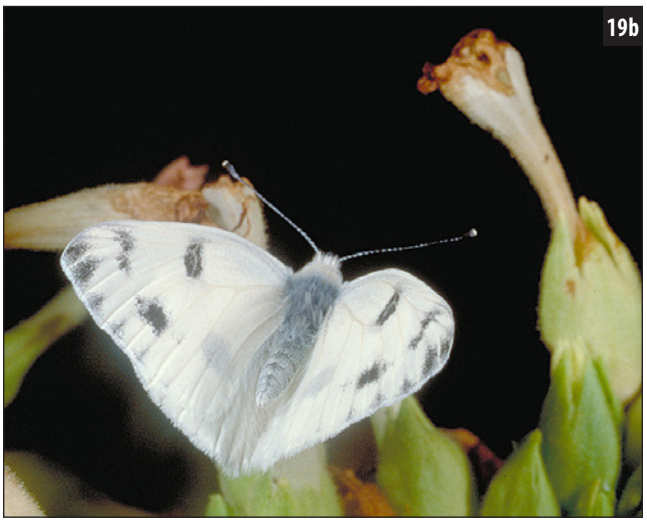
Management—When scouting, examine the undersides of the lower leaves for newly hatched larvae. Pull back loose wrapper leaves and examine around the base of the head for larger larvae. Evidence of frass (excrement) at the base of the head aids in the detection of larvae. Because larger loopers are more difficult to control, it helps to time applications for younger larvae. Pheromone traps are available to detect adult cabbage looper presence and initiate field sampling.

18. Cross-striped cabbageworm (*Evergestis rimosalis*) larva is bluish-gray in color with numerous black stripes running cross-wise on its back. Below the transverse stripes on each side is a black and yellow stripe along the length of the body. The larva reaches ¾ inch in length. The larvae drop to the soil to pupate in a tight cocoon just below the soil surface. The scale-like eggs are light yellow and laid in masses of 20 to 30 on the undersides of the leaves. The moth is yellowish-brown to brown with dark zigzag markings and has a wingspan of about 1 inch. Larvae feed on all tender parts of the plant, but prefer terminal buds. Young leaves and buds are often riddled with holes.

Management—Because eggs are laid in clusters, infested plants are often found close together. Sprays used to control other caterpillars on these crops are usually effective against cross-striped cabbageworm. Bt insecticide sprays early can be very effective against this pest.

19. Southern cabbageworm (*Pontia protodice*) tends to be more of a late-season pest in Kentucky. The head of the larva is gray with yellow patches and the body is gray with yellow stripes. Numerous black spots and numerous short hairs adorn the body. The larvae reach 1¼ inches in length. The adult is the checkered white butterfly.

Management—This caterpillar is closely related to the imported cabbageworm and can be managed in the same manner. However, eggs are laid in groups so infestations may be clustered in the field.



Southern cabbageworm caterpillar (a) and adult moth (b).

Yellow-striped armyworm on cabbage leaf.

Cabbage webworm caterpillar (a) and moth.

20. Yellowstriped armyworm *(Spodoptera ornithogalli)* is a common pest of many vegetable crops including greens, tomatoes, peppers, and cole crops. The larva varies from dark grey to black in color with two prominent yellow stripes along each side. Below this yellow stripe there are other less distinct stripes including a pink stripe above the prolegs. Two dark triangles may be apparent on the top of each segment. There may be a noticeable dark spot above and behind the hind legs, but this can be difficult to see on darker larvae. The dark head capsule has a net-like pattern. The larva can reach 1¾ inches in length.

Management—As with other armyworm species, it is much easier to control small larvae as larger stages are more tolerant of some insecticides. Therefore, transplanted crops and young plants should be monitored regularly for early detection of yellowstriped armyworm. Insecticides listed for corn earworm are generally effective against small larvae while those listed for beet armyworm may be more effective against larger stages.

21. Cabbage webworms *(Hellula rogatalis)* are easily recognized. Unlike other caterpillar larvae that attack cole crops in Kentucky, this larva has a black head capsule. Larvae are tan colored with four brown stripes running the length of the body. Larvae are often found inside webbed pockets formed along the leaf margins. Initially damage appears as small (quarter sized) brown, dried areas along the leaf margins. The moth has brownish-yellow forewings mottled with darker brown and pale gray hind wings. Resting on the ground where it is well camouflaged, the moth takes short, erratic flights when disturbed.

Management—This pest is more destructive than the other caterpillar pests of cabbage, particular when attacking the bud of small plants. This is a fall pest so later planting should be monitored. Sprays should be applied while the larvae are small before they construct their protective silken webs. Once inside the folded leaves the larva are protected from insecticide sprays. Sprays need to be directed underneath the leaves and down into the bud.

22. Beet armyworm (*Spodoptera exigua*) is a light-green and black larva with four pairs of abdominal prolegs and a dark head. There are many fine, white wavy lines along the back and a broader stripe along each side. There is a distinctive dark spot on each side just above the second pair of true legs. Females lay masses of up to 80 eggs under a covering of cottony-white scales. These eggs hatch in 2 to 3 days and the larvae first feed together in a group near the bud if the plant. As they grow, they disperse. After they complete their feeding, the 1¼ inch larvae pupate in the soil. Beet armyworm feeding on young tender growth can be very damaging to small transplants. Often fine webbing is produced by smaller larvae near these feeding sites. Older plants can become rapidly defoliated.

Management—Beet armyworm is not as sensitive to the common types of Bt sprays, but those containing *Bacillus thuringiensis* var *aizawai* (Bta) are more effective. This pest is highly resistant to pyrethroid sprays (IRAC group 3), so insecticides from others groups need to be selected.

Beet armyworm on cabbage leaf.

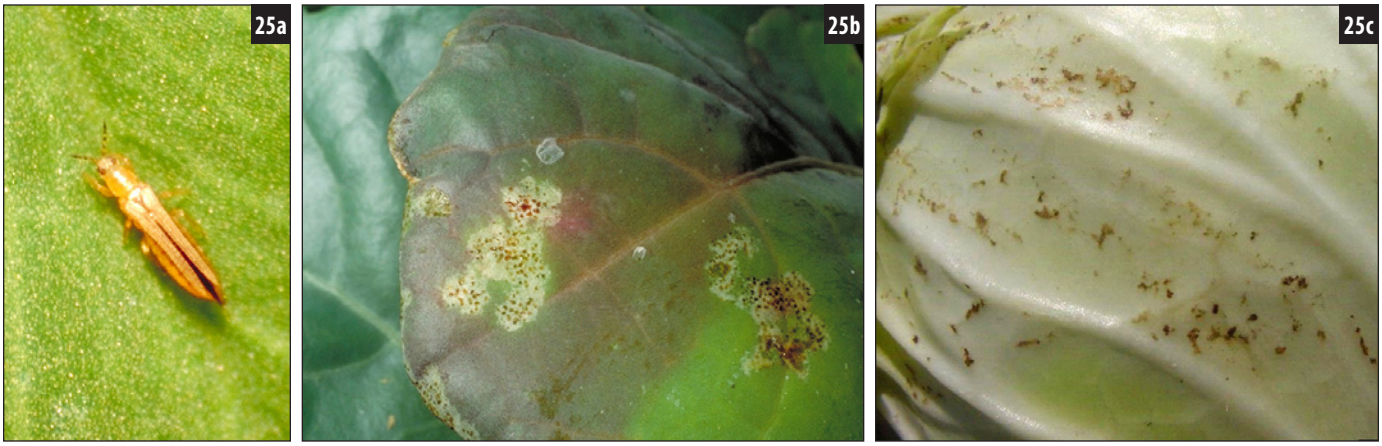
Striped flea beetle.

Harlequin bug nymph (a) and adult (b).

23. Striped flea beetle (*Phyllotreta striolata*). Several species of flea beetles attack cole crops in Kentucky. They are very small brown to black beetles that may have some yellow markings on their wing covers. The striped flea beetle has a broken pale stripe on each wing cover. Flea beetle lay their eggs at the base of the plants and the larvae feed on the roots. Flea beetles over winter as adults in plant debris in and around the field and may be much more common following mild winters.
Management—Small transplants may need to be protected from excessive feeding by flea beetles. Row covers, insecticide sprays, or transplant drenches can provide effective control of flea beetles.

24. Harlequin bug *(Murgantia histronica)* nymphs are black, orange, and white, have a rounded convex appearance, and only short wing buds. The adults are orange and black stink bugs that are about ⅜ inch in size. The eggs are laid in clusters and resemble tiny white barrels with black bands with a black crescent on top. Adults overwinter in debris around the field. Harlequin bugs feed with piercing-sucking mouthparts giving leaves a tattered appearance.
Management—Timely destruction of plant residues at harvest can help to reduce their numbers. Row covers can be used to exclude them from young transplants. Generally stink bugs are more difficult to control with insecticides than other pest and types of sprays should be chosen carefully (See efficacy chart in back of ID-36).

25. Thrips *(Frankliniella occidentalis* and *Thrips tabaci)* are minute insect pests that often feed in hidden locations. Thrips reach a length of 1⁄20 of an inch at maturity and are often found between leaves or in the bud of the plant. In cabbage their feeding can causing small brown scars similar to edema of the cabbage leaves. On other brassicas they feed on open leaves causing discolored patches. During head formation, they can be infest inner sections between layers of leaves sometimes causing leaf discoloration.
Management—Thrips can move between crops, be careful planting cole crops near Alliums (onion family), alfalfa, or clover, that can harbor large populations of thrips. Thrips can migrate into Brassicas when forage crops are cut. Where thrips have been a problem consider using thrips tolerant varieties.



Thrips on a leaf (a), damage to greenhouse seedlings (b), and to mature cabbage head (c).

Nutritional and Physiologic Disorders and Herbicide Injury

Clomazone (Command) injury on cabbage transplants.

Broccoli head past maturity.

26. Clomazone (Command) is a commonly used herbicide for cabbage production. A pre-emergent herbicide, Command typically bleaches crops where it is applied.
Management—Although heavily bleached these plants will grow out of this injury resulting in a normal appearing mature cabbage plant. Always follow labels for proper rates and application periods for all chemicals.

27. Bolting is the emergence of flowers from a vegetable crop. Cole crops are subject to bolting in Kentucky, particularly those planted during spring. Exposure to cold temperatures in early spring followed by rapid warming will often initiate bolting in several cole crops. In many cases, planting crops late in the spring on black plastic can exacerbate bolting. Bolting will make crops unmarketable and result in a strong bitter flavor if consumed by home gardeners.
Management—Avoid planting late in the spring. In Kentucky, many fall-planted cole crops produce higher quality crops than those planted in spring. This is particularly true with broccoli and cauliflower.

Bolting (flower emergence) in pak choi.

28. Over-mature broccoli head. Broccoli grown for the wholesale market has a fairly narrow window for harvest. Florets will begin to yellow in broccoli that is allowed to stay in the field too long. The broccoli head in this picture is unmarketable and is showing too much yellowing in the head.
Management—Broccoli must be harvested when florets are tight and blue-green in color.

29. Calcium deficiency. Many cole crops are subject to calcium deficiency. Calcium and boron are the only two elements that primarily move through the plant via the transpirational stream. Calcium is immobile in the plant as well. Although soils may be calcium deficient, any conditions which disrupt the transpirational stream may result in calcium deficiency. Periods of drought or irregular watering can result in calcium deficiency in cole crops. In cabbage, calcium deficiency will appear as a burn on the leaf edges.
Management—Foliar applications have been largely unsuccessful to correct calcium deficiencies in crops. To prevent calcium deficiencies ensure that adequate calcium is available and ensure that plants are irrigated on a regular basis and avoid large fluctuations in soil water content.

Calcium deficiency of cabbage.

Boron deficiency in cauliflower (a) and in n broccoli (b).

30. Boron deficiency is rare in most vegetables in Kentucky, but does appear in broccoli and cauliflower. In both vegetables symptoms will be a hollowed appearance couple with internal browning of the stem. Minor deficiencies will be noted by a few small brown areas in the stem, with severe cases appearing as a completely hollow stem. Boron is deficient on some soils in Kentucky.

Management—Growers can make applications of solubor or other boron-based fertilizer products. Excessive boron applications can result in toxicity symptoms, which are marked by burning on the leaf edges.

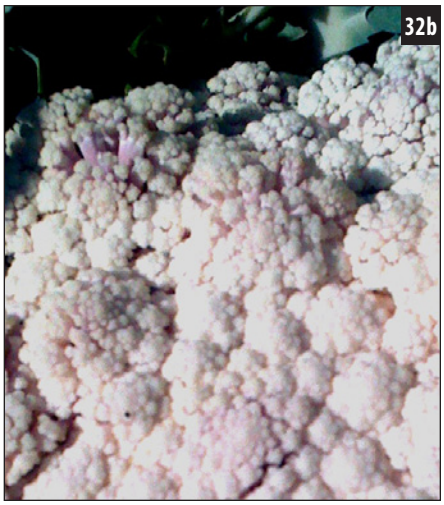
31. Edema (Oedema) is caused by the uptake of excessive water by the plant which cannot be transpired by the leaves. It will show up as small blister-like areas, which eventually can turn into sunken corky lesions. Edema is characteristic of plants which are overwatered, but also occurs in plants grown under conditions of normal water status but low transpiration (low light, low temperatures). Because many cole crops are planted during periods of cool temperatures they may be subject to edema.

Management—Edema can be limited by growing transplants under low humidity and high-light conditions and not watering excessively. In the field growers can attempt to reduce excessive irrigations though humidity, temperature, and light levels are impossible to control.

Edema on cabbage leaves (a). Closeup of edema on cabbage leaves (b).

32. Cold injury. Cole crops are fairly cold tolerant. Nearly all cole crops can tolerate temperatures below freezing, though vary in what temperatures will result in cold injury. Symptoms of cold injury can appear as a purpling of leaves. This results from the production of additional anthocyanins at low temperatures. In cauliflower, low temperatures can result in a browning or reddening of the curd. Cauliflower tends to be more sensitive to cold temperatures than other cole crops.

Management—Growers should plant broccoli and cauliflower by early August in central Kentucky to avoid cold damage for fall-grown plants.



General cold injury on broccoli leaves (a) and on cauliflower (b).

For More Information

Specific pest management and crop production information can be found in the following University of Kentucky publications, available at county extension offices as well as on the Internet.

Entomology fact sheets

Cabbage Insects (ENTFACT 300)
http://www2.ca.uky.edu/entomology/entfacts/ef300.asp7

Beet armyworm (ENTFACT 308)
http://www2.ca.uky.edu/entomology/entfacts/ef308.asp

Cabbage webworm (ENTFACT 315)
http://www2.ca.uky.edu/entomology/entfacts/ef315.asp

Yellowstriped armyworm (ENTFACT 321)
http://www2.ca.uky.edu/entomology/entfacts/ef321.asp

Integrated crop management for Kentucky cabbage (IPM 11)
http://www.uky.edu/Ag/IPM/manuals/ipm11cab.pdf

Black rot of crucifers (PPFS-VG-1)
http://www2.ca.uky.edu/agcollege/plantpathology/ext_files/PPFShtml/PPFS-VG-1.pdf

Issued 7-2013