

Integrated Crop Management

For Kentucky Cabbage



Scout Manual

INTEGRATED CROP MANAGEMENT FOR KENTUCKY CABBAGE

SCOUT MANUAL

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INTRODUCTION

Agriculture is the world's most important industry because of rapidly expanding populations which demand increased amounts of food and fiber. Crop protection problems associated with this increased production have become more complex. A simplistic approach to pest control leads to serious environmental complications and economic losses. A truly successful pest management program must take a multi-disciplinary approach in order to supply the farmer with reliable pest control information. An approach to crop production based on economic, ecological, technical and social considerations is needed to assist the farmer to achieve the production and quality levels needed to satisfy increasing world demand.

Current economic conditions mandate that farmers be provided with the information needed to manage pests while maximizing profits. This manual describes the information the farmer needs to make important management decisions. Your sound judgment and dedicated effort will directly affect the success of this program. We welcome your participation and look forward to working with you in the coming growing season.

Much of the information in this manual was adapted from other sources, including scouting procedures from the Kentucky Integrated Pest Management program, as well as from other states. Decision guidelines for the cabbageworm complex were adapted from a similar program developed by the New York State Integrated Pest Management Program.

We have found that the most economical methods of controlling pests at the lowest cost and least risk do not involve a regular spray schedule. The most economical approach is Integrated Pest Management (IPM). The cabbage IPM program is based on regular monitoring, correct identification of pests and diseases, estimations of percentage of infected or infested plants, and the use of economic thresholds. To reduce the number of unnecessary sprays, pest infestations and infected plants are only treated when an economic threshold is reached. This is the point at which the pest population is almost high enough to cause economic damage. The economic threshold takes into account the value of the crop, the amount of damage to be expected, the cost of the control, and the amount of damage that can be prevented by using the control.

PRODUCER-SCOUT RELATIONSHIP

In an Integrated Management Program, it is imperative that the scout enjoy a good relationship with the producer-cooperator. The farmer must have confidence that the scout is doing his or her job. In some cases hundreds or even thousands of dollars may rest upon the scout's report. The scout's report will weigh heavily on whether or not control measures for certain insects, diseases or weeds are employed.

The following points will assist scouts in developing a harmonious relationship between IPM scouts, cooperators and supervisory personnel. These points were developed during conversations between cooperators, the Pest Management Supervisor and a County Agent.

1. Let the grower know that you feel this job is important.
2. Be courteous and friendly.
3. Present a good appearance.
 - a. Dress appropriately for the job--short or long sleeve shirt, long pants, cap and shoes. No athletic shirt, cut off pants or sandals.
 - b. Be and look busy.
4. Go about your work in a businesslike manner.
5. Keep a neat legible record.
6. Do not be a "know it all". Be tactful.
7. Answer the grower's questions to the best of your knowledge. Do not be afraid to say "I do not know".
8. NEVER make a recommendation for control measures.
9. Do not discuss other grower's problems or control measures.
10. Do not block drives or lanes with your vehicle.
11. Keep all gates closed or open as the cooperator has left them. Do not ride down

fences.

12. Do not trample or otherwise damage crop.
13. Let cooperator know the type vehicle or vehicles you will be using and approximate time that you will be on farm.
14. Place report in location agreed upon with cooperator.
15. Let the cooperator know where you can be reached by phone.
16. Use tact in dealing with cooperator's dog.
17. ALWAYS follow recommended sanitation practices in regard to diseases, insects and weeds. Clean shoes are a must. Washable boots are preferred.
18. Remarks regarding the pest management program, fellow scouts, cooperators and supervisory personnel should be positive. If you cannot say anything good about the program and/or people involved, do not say anything
19. Always keep in mind that you are scouting his acreage. He expects you to do a good job.
20. Do not spend excessive time talking with the cooperator or others.
21. If asked to have lunch with the cooperator, do so, but make it clear that your time is limited.
22. Carry your own water supply so that you don't have to ask for water.
23. Keep vehicle on solid ground.
24. Be on time to begin work.
25. Do not get involved with jobs on cooperator's farm unless there is some emergency. STAY OFF MACHINERY.
26. You are not to scout crops not in program. Make sure you scout the right field.
27. You are not to take anyone with you while scouting unless instructed to do so by supervisory personnel.
28. You are not to be on farm after dark.
29. Do not go in farm buildings unless invited or caught in rain.
30. Do not scout when you are miring to shoe

tops unless advised to do so by supervisor.

When in doubt about proper procedures,
consult with supervisory personnel.

SCOUTING PROCEDURES FOR CABBAGE INSECTS

HOW TO SCOUT A FIELD

Specific survey procedures are described for each insect. In general, you will EXAMINE 5 PLANTS PER LOCATION and record the number of insects or percent of damaged plants. Fields will be monitored on a weekly basis. Select locations randomly so that they will be representative of the entire field. Don't survey along field margins unless specifically directed to do so. Don't limit surveys to one side or end of a field. IF YOUR SURVEY IS NOT RANDOM IT IS NOT REPRESENTATIVE OF THE WHOLE FIELD and you may find a lot of problems on your return visit. Do not bias your sample by looking for damaged or undamaged plants. Because IPM for fresh-market cabbage is new for Kentucky, we will use 8 locations per acre.

For most of the season, the primary pests will be the lepidopteran larvae (imported cabbage worm, diamondback larvae, cross-striped cabbage worm, and cabbage looper). These larvae cause similar types of damage and they are combined when using the economic thresholds. On each plant, we use presence/absence sampling to determine the percentage of plants infested and the types of insects found. As soon as the first larva of any lepidopteran species is found, that plant is considered "infested" and the scout moves to the next plant. Thresholds are based on the percentage of plants infested and the growth stage of the plant, so growth stage of the plant must be recorded during each visit.

<u>Plant Stage</u>	<u>Number of leaves</u>
Cotyledon	No true leaves
Precupping	Up to 19 leaves
Cupping	20 to 28 leaves
Head fill	29 to 35 leaves

If the percentage of plants is less than the threshold, then the field does not need to be treated. If the field percentage of affected plants is greater than the threshold, then the field probably needs to be treated. If the percentage of plants is very close to the threshold, treatment may be required soon. Consider the size of the larvae, predicted temperature and current and forecasted spraying conditions before making a decision.

CUTWORMS

Occurrence: From setting of the transplants until the 8 to 10 leaf stage. These are more often a problem with fall cabbage production. Fields having one or more of the following characteristics should be watched very carefully:

- history of cutworm damage
- excess surface litter
- fair to poor drainage or overflow land
- fall production
- excessive annual weeds prior to tillage

When to scout: Cabbage plants should be monitored weekly from emergence until they reach the 10-leaf stage. Watch for missing leaves or plants, or removed leaves at the base of the plant. Infestations are often spotty so check carefully for damage. Make counts only if cutworm damage is noticed in the field. Continue to scout damaged fields once an infestation is found.

Description: Larvae are light gray to nearly black and may have a faint, narrow mid-dorsal

stripe. Larvae vary from 1/4 inch long after hatch to 1-3/4 inches long when full grown.

Damage: Larger worms (about 1/2 inch or longer), cut small plants and may pull parts into their burrow. Symptoms are cut off leaves or cut plants.

Preventive management: Eggs and larvae are frequently in the field prior to planting. Prepare fields and eliminate weeds at least 14 days before planting to destroy eggs, larvae and egg-laying sites.

How to scout: Begin making counts when evidence of cutworm damage is found. 1) Randomly determine a starting point and examine 5 consecutive plants per location and write down the number of cut plants. Determine the percent plants cut by dividing the total plants cut by the total number of plants inspected. Multiply this figure by 100 and record the percent infestation on the report form. 2) Look for live cutworms around freshly damaged plants. They will generally be covered or underground during the day. First check under clods near the base of the plant. Then, dig up an area three inches in diameter and three inches deep around the damaged plant. Record the average number and length (inches) of "live" cutworms per 5 plant sample and whether they were found near the soil surface or deep.

Record: Record the number of cut plants found per 5 plants examined at each site. Record the average length of "live" cutworms found. Note if they were found near the soil surface or deep.

Economic Threshold: 3% or more cut plants and 1 or more cutworms (1 inch or smaller) per 40 plants. **Inform the grower immediately.** If conditions are borderline, check the field again in 24 to 48 hours or until a final decision is made.

FLEA BEETLE

Occurrence: Cotyledon through seedling plant stage. Flea beetles are not usually a problem on larger plants, except that they can reduce the marketability of the cabbage during the early head stage.

When to scout: Check cabbage seedlings carefully. Flea beetle may be numerous on young plants.

Description: Flea beetles are very small, dark insects that jump readily when disturbed. Several species may attack cabbage. They may be black, black with yellow stripes, or metallic blue-green depending on the species.

Damage: These beetles are leaf feeders. They make small, circular, feeding scars on the leaves. Damage can be serious on small plants. While the larvae feed on the roots, they are not usually harmful.

How to scout: On small plants (less than 4 leaves), examine 5 plants at each location and record the number of flea beetles. This must be done carefully because the beetles will jump at the slightest disturbance.

Record: Record the average number of beetles on each 5 plant sample in your comments.

Economic Threshold: An average of 2 flea beetles per plant.

APHIDS

Occurrence: Can be found on cabbage at anytime, but are more common with fall production. These aphids can become numerous during prolonged cool wet periods. Infestations often begin in localized areas of the field.

When to scout: Cabbage should be scouted for aphids during the precupping stage.

Description: Two aphid species are common on cabbage, the cabbage aphid and the tobacco aphid. The pale-green cabbage aphid looks like other aphids but with a grayish waxy coat similar to cigarette ash. Tobacco aphids are pale green to red insects. Aphids occur in groups or colonies on the undersides of leaves. Both winged and wingless aphids may be present.

Damage: These aphids infest the undersides of leaves and suck sap. Infested plants may show signs of curling, wrinkling, or cupping of the leaves. Some plants may be stunted and produce unmarketable heads. Aphids may get under the leaves of older plants and become a contaminant. They may also carry viruses to the cabbage from nearby weeds.

How to scout: Look at the undersides of the leaves for wingless aphids. Do not count the number of aphids.

Record: Of the 5 plants observed at each sample site, record the number of aphid infested plants observed at each site. Calculate and note the percent infestation. Note the type of aphid found.

Economic Threshold: With fall production, cabbage aphid infestations can spread rapidly during prolonged periods of cool, wet weather. Treat if cabbage aphids are found.

Comments: Parasitism of aphids can be high. If aphids appear gold, silver or black they have been parasitized. Ignore these aphids during your scouting.

BEET ARMYWORM

Occurrence: The beet armyworm is a major pest in the southwestern and southern US and an occasional invader of vegetable crops in Kentucky. It is only a potential problem for fall production. Peppers, tomatoes and sweet corn are more susceptible to beet armyworm than cabbage.

When to scout: Late July, August and September.

Description: The beet armyworm is a light-green to 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 usually a distinctive dark spot on each side just above the second pair of true legs. Females lay masses of up to 80 eggs underneath a covering of cottony-white scales.

Damage: Beet armyworm damage is similar to that of the other cabbageworms. Feeding on young tender growth can be very damaging to small transplants. Often a fine webbing is produced by smaller larvae near these feeding sites. Plants can become rapidly defoliated.

How to scout: Examine 5 plants in each of 8 locations per acre for the presence of beet armyworm *only* when beet armyworm moths are found in pheromone traps. Inspect pheromone traps for beet armyworm once a week.

Trapping: Pheromone traps are available for beet armyworm. These traps are very sensitive

and moths may be captured long before larvae are found in the field. Decision to treat for beet armyworm should be made solely on larval counts.

Record: The percentage of plants infested with beet armyworm. **Keep the beet armyworm percentage separate from that of the other larvae.**

Economic Threshold: Timing of insecticide applications is very important. Once larvae are ½ inch or longer, they become very difficult to kill with insecticides. So treatment must be targeted against young larvae. Use the following threshold table to make decisions:

<u>Plant Stage</u>	<u>Percentage of infested plants</u>
Cotyledon	10 %
Precupping	15 %
Cupping	10 %
Head fill	5 %

IMPORTED CABBAGEWORM

Occurrence: Entire season.

When to scout: Begin checking for eggs and larvae as soon as the white butterflies are seen flying about during the day.

Description: The bullet-shaped eggs have distinct ridges and are initially white when laid but turn dark yellow as they mature. The 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 legs toward the head. When mature the larvae reach 1-1/4 inches in length. The pupae is greenish-brown in color and attached to the undersides of cabbage leaves. The adult is a white butterfly about 1-3/4 inches long tinged with yellow on the undersides of the wings and black spots on the

front wing.

Damage: Imported cabbageworms cause damage similar to that of 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. Feeding is not restricted to between leaf veins. Large larvae can be particularly damaging to young plants and can cause significant yield reductions.

Preventive Management: After spring harvest is complete, plants and field debris should be disced under to reduce problems for fall production.

How to scout: Examine 5 plants in each of 8 locations per acre for the presence or absence of imported cabbageworms, diamondback larvae, cabbage loopers, or cross-striped cabbageworms.

Record: Of the 5 plants examined at each site record the number of plants infested with any of these four larvae. Note the species of the larvae found.

Economic Threshold: The threshold is based on the percentage of plants infested with any of these four species of larvae. Use the following table to make treatment decisions.

<u>Plant Stage</u>	<u>Percentage of infested plants</u>
Cotyledon	20 %
Precupping	30 %
Cupping	15 %
Head fill	5 %

DIAMONDBACK MOTH LARVA

Occurrence: Entire season.

When to scout: 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. Heart leaves of preheading plants should be examined, if feeding damage is present. Moths found in pheromone traps indicate that egg laying is occurring.

Description: 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, 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 moth has a small, slender, grayish-brown body with folded wings. The wings of the male form three yellow diamond-shaped spots where they meet.

Damage: Diamondback moth larvae, despite their small size, can be very destructive to cole crops. Their feeding on the bud may cause malformation of the cabbage head.

Preventive Management: After spring harvest is complete, plants and field debris should be disced under to reduce problems for fall production.

How to scout: Examine 5 plants in each of 8 locations per acre for the presence or absence of imported cabbageworms, diamondback larvae, cabbage loopers, or cross-striped cabbageworms.

Record: Of the 5 plants examined at each site record the number of plants infested with any

of these four larvae. Note the species of the larvae found.

Economic Threshold: The threshold is based on the percentage of plants infested with any of these four species of larvae. Use the following table to make treatment decisions.

<u>Plant Stage</u>	<u>Percentage of infested plants</u>
Cotyledon	20 %
Precupping	30 %
Cupping	15 %
Head fill	5 %

CABBAGE LOOPER

Occurrence: From May through September

Description: The larvae are light green in color with a pale white stripe along each side and two thin white stripes down the back. The body 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. When mature, the larvae reach 1-1/2 inches in length. Because the larvae have no legs in the middle area of their body, this area arches when the insect moves. All larval stages of the insect move with this looping motion. The ridged, white, round eggs are usually laid singly on the underside of the outer leaves. The pupae are brown, about 3/4 inch long and wrapped in a delicate cocoon of white tangled threads. The adult moth is a mottled, grayish-brown moth with a 1-1/2 inch wing span and a small silvery spot resembling a sock in the middle of each front wing.

Damage: They can cause serious damage to young transplants as well as causing serious leaf feeding damage to older plants. Damage to the head or wrapper leaves often reduces marketability.

Preventive Management: After spring harvest is complete, plants and field debris should be disced under to reduce problems for fall production.

How to Scout: Watch for cabbage loopers particularly on the undersides of leaves along leaf margins, but they can be found anywhere on the plant. Examine 5 plants in each of 8 locations per acre for the presence or absence of imported cabbageworms, diamondback larvae, cabbage loopers, or cross-striped cabbageworms.

Record: Of the 5 plants examined at each site record the number of plants infested with any of these four larvae. Note the species of the larvae found.

Economic Threshold: The threshold is based on the percentage of plants infested with any of these four species of larvae. Use the following table to make treatment decisions.

<u>Plant Stage</u>	<u>Percentage of infested plants</u>
Cotyledon	20 %
Precupping	30 %
Cupping	15 %
Head fill	5 %

CROSS-STRIPED CABBAGEWORM

Occurrence: Entire season. This insect is more common in the mountainous region of eastern Kentucky. Because eggs are laid in clusters, individual plants scattered over a field may be infested with large numbers of

cross-striped cabbage worms.

Description: The 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. When mature, the larvae reach 3/4 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.

Damage: Larvae feed on all tender parts of the plant, but prefer terminal buds. Young leaves and buds are often riddled with holes.

Preventive Management: After spring harvest is complete, plants and field debris should be disced under to reduce problems for fall production.

How to Scout: Examine 5 plants in each of 8 locations per acre for the presence or absence of imported cabbageworms, diamondback larvae, cabbage loopers, or cross-striped cabbageworms.

Record: Of the 5 plants examined at each site record the number of plants infested with any of these four larvae. Note the species of the larvae found.

Economic Threshold: The threshold is based on the percentage of plants infested with any of these four species of larvae. Use the following table to make treatment decisions.

<u>Plant Stage</u>	<u>Percentage of infested plants</u>
Cotyledon	20 %
Precupping	30 %
Cupping	15 %
Head fill	5 %

THRIPS

Occurrence: these are sporadic pests that may migrate to cabbage when surrounding fields of small grains ripen or when alfalfa is cut. Injury from thrips is most severe during hot dry weather.

Description: Thrips are slender, tiny insects about 1/25" long and range in color from light yellow to brown. They have 4 long, fringed wings that are held flat over the back.

Damage: Thrips feed by rasping the plant surface and sucking up the exuding sap. Thrips cause whitish scratches on the leaves.

Heavily infested leaves may have brown, leathery patches. Thrips often get inside the head and damage layers in the outer third of the head.

Preventive Management: Some varieties are more susceptible to thrip damage. In general, thrips prefer varieties with tight heads over those with loose heads. Unfortunately, the market demands varieties that have tight heads.

How to Scout: examine the bud area of young plants and underneath the leaves of older plants for the presence or absence of thrips.

Record: The percentage of plants infested with thrips.

Economic Threshold: treatment is advised if more than 20% of the plants are infested with thrips.

Effectiveness of Cole Crop Insecticides

Insecticide	Imported Cabbageworm	Diamondback Moth	Cabbage Looper
Ambush	G*	G	G
Ammo	G	G	G
Asana	G	F	G
Bacillus thuringiensis	G	G	F
Guthion	G	G	F
Lannate	G	G	F
Larvin	G	G	-
Lorsban	G	G	-
Mustang	G	G	G
Orthene	G	G	G
Pounce	G	G	G
Thiodan	G	G	G
Warrior	G	G	G

*G= Good control, F=Fair, - = Insufficient information

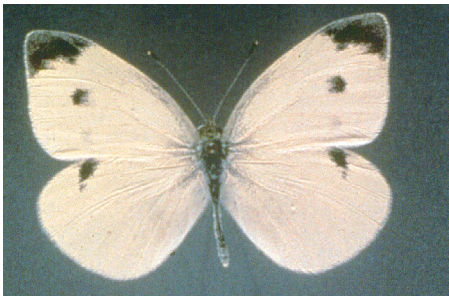
CABBAGE INSECTS PICTURE SHEET



DIAMONDBACK MOTH



BEET ARMYWORM MOTH



**IMPORTED CABBAGEWORM
BUTTERFLY**



CABBAGE LOOPER MOTH



CABBAGE APHID



CABBAGE LOOPER



CROSS-STRIPED CABBAGEWORM



DIAMONDBACK LARVA



IMPORTED CABBAGEWORM



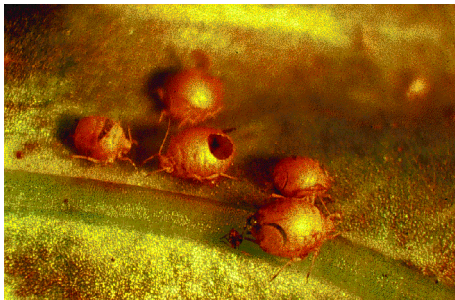
BEET ARMYWORM



CUTWORM



THRIPS



PARASITIZED APHIDS



THRIPS DAMAGE



DISEASED CABBAGE LOOPER

SAMPLING TECHNIQUES AND SIGHT I.D. CHARACTERISTICS FOR CABBAGE DISEASES

CABBAGE DISEASES

In commercial plantings of cole crops, it is strongly recommended that growers have all initial diagnosis of diseases confirmed through the Plant Disease Diagnostic Laboratories. Few "new" growers have sufficient experience to scout and identify diseases properly. Therefore, it is more important for growers to be walking their fields and looking for any of the symptoms described here, then submitting typical samples of whole plants for diagnosis; while they wait, they can shorten the interval on their spray schedule or if no sprays have been made start with a broad spectrum fungicide such as Bravo.

Black Rot: Look for V-shaped yellow lesions at the margins of the leaves, particularly the upper leaves. Inside the yellow lesions look for black veins. Cut through a vein at least 3/8" from the bottom edge of the yellow "V", if it's black rot the vein will be as black as ink.

Club Root: Look for stunted, wilted plants with swollen, deformed roots. Some plant death.

Alternaria: Look for round, dark lesions with concentric rings inside on the leaves or head. Alternaria leaf spot can be a problem during wet periods, it is especially favored by high temperatures and becomes more prevalent as cabbage heads age.

Downy Mildew: Look for yellowed leaf lesions, especially on lower leaves. The tan lesions are often rectangular-shaped, boxed in by veins. White to purplish gray mold may be

seen on the undersides of lesions during humid weather. Downy mildew may also become systemic and be found throughout the cabbage plant.

Black Leg: Round, sunken, black lesions on the stem and lower leaves that eventually coalesce into larger black lesions are diagnostic. Small pepper-like specks in the lesions are strongly suggestive of the fungus causing Blackleg.

Wirestem, Bottom Rot And Head Rot: These diseases are caused by the fungus *Rhizoctonia* which invades at the soil line (girdling young plants at that point and moves up the plant in hot, wet weather causing a bottom and side rot of the heads. Infected areas may be slimy or dry and papery, but are almost always dark.

Other Diseases: Sclerotinia - heads are covered with white mycelium and hard, brown sclerotia. In KY, this disease mainly causes lesions on the stem and lower leaves similar to those of Blackleg, rather than the head rot phase. It is more common in spring than fall crops.

SCOUTING FOR CABBAGE DISEASE PESTS

1. Examine at least five (5) cabbage plants in 8 locations of a V-shaped transect across the field. **Examine a total of 40 plants.** Look for places in the field where plants appear **"abnormal"**. If such places are seen, go there and determine the cause(s) of any difference seen.

2. As you walk, survey constantly for disease symptoms, weeds, and any unusual problems. Look for “**disease spots**” in the field. Examine abnormal plants carefully. Look for disease symptoms on the upper and lower surfaces of each plant leaf, stems and roots. For each area examined, record the presence or absence of disease pests or problems.

DECISION-MAKING FOR CABBAGE DISEASE PEST MANAGEMENT

Fungicides are available to help control many of the diseases important in cabbage in KY. See ID-36 "Commercial Vegetable Crop Recommendations" for details. Specifically, fungicides are available for control of Damping-off fungi, Alternaria, Blackleg, Downy Mildew, White rot, and Wirestem. Most fungicides need to be in place in preventative roles rather than as rescue treatments. In nearly all cases, fungicides applied after a disease becomes active are designed to reduce spread and have little effect on symptom development in plants already infected; therefore, frequent scouting and early diagnosis is critical to the management of cabbage diseases.

DAMPING-OFF OF SEEDLINGS

Pythium sp. and *Rhizoctinia solani* are the usual causes of damping-off. Pythium can also cause seed to rot before it germinates. Seed rot and damping-off occur primarily during cool, wet conditions. For infections after germination lesions usually occur on the lower stems at or near the soil line. Stem tissue collapses and becomes dark and shriveled because there is little structural tissue in stems while they are young. Sometimes seedlings remain alive and grow slowly, with the infected areas giving rise to

the name wirestem. Most pythium species infect when temperatures are low and soil is wet. Pythium can be a serious problem in float bed production. Rhizoctonia is favored by warmer soils and may be a major problem in fall cabbage.

Management Guidelines: The following practices can all help reduce damping-off problems. Preparation of good seedbeds which have been fumigated, use of new soilless media for transplant production, use of fungicide treated seed, careful water management, drenching outside beds with recommended fungicides after planting, and choice of planting time.

WIRESTEM, BOTTOM ROT, AND HEAD ROT

These diseases are caused by *Rhizoctonia solani*. This fungus also causes damping-off in the field, in plant beds and in floatbeds. Wirestem is characterized by stems that are darkened and girdled near the soil line (*see figure*). Plants beyond the 3 or 4 leaf stage usually are resistant to wirestem. Infected plants are weak, produce small heads, and sometimes wilt and die. Bottom rot develops on plants after they have been transplanted to the field. Dark slightly sunken spots develop on basal leaves near the soil. Under moist conditions the rot spreads to adjacent leaves and causes a head rot. The causal fungus is present in all field soil. Disease is promoted by moist conditions and fresh decomposing organic matter. Green manure crops plowed down just before planting (within 2-3 weeks) may contribute to this problem.

Management Guidelines: Plow under all green manure crops and fescue sod early so that they have time to decay before planting. Raise transplants in fumigated soil, new soilless media or use Terraclor to control Rhizoctonia in seedlings. In the field a band

application of Terraclor or a Rovral application may help reduce disease problems (See ID-36).

ALTERNARIA LEAF SPOT

Alternaria leaf spot is caused by the fungus *Alternaria brassicae*. It is characterized by distinct spots with concentric rings (bull's eye patterns) on the lower leaves; the dark velvety, dusty fungus growth develops on these spots during moist periods (*see figure*). There are, however, no tiny dark bodies as in blackleg lesions. A good hand lens or microscope is required to see the growth. Spores are spread from plant to plant by the wind and rain under favorable conditions. During unfavorable periods, the fungus can survive in plant debris or on seed. This disease can become a problem on cabbage heads held in the field for long periods of time after reaching maturity. Alternaria leaf spot may be an economic problem on Chinese cabbage and cabbage during warm, rainy months. Soft rot bacteria may enter through dead leaf spots. The fungus overwinters in seed and in residue from diseased plants. Warm, wet conditions promote disease development. Certain fungicides applied as foliar sprays will control Alternaria leafspot.

Management Guidelines: A 2 - 4 year rotation will greatly reduce severity of this disease. Apply protective fungicides beginning with the seed bed or shortly after transplanting when the weather is wet. During dry weather a spray program can be delayed until the first symptoms are seen. A 7 - 10 day interval is recommended.

DOWNY MILDEW

Downy mildew is caused by the fungus *Peronospora parasitica*, is most serious in early spring or under cool fall conditions (46 - 61 F). It appears as small leaf spots which

first are yellowish-white and later turn brown with bluish-black lace-like markings. In moist weather, a white downy mold develops on the underside of the leaf spots. Vascular tissue may become discolored. The causal fungus overwinters on seed, in crucifer weeds, and perhaps in soil. Disease is promoted by cool, wet weather. Downy mildew predisposes plants to bacterial soft rot. Economic damage most often occurs during transplant production, where infections may kill large numbers of plants, especially in plant or float bed situations. Severe leaf infections or stem infections can stunt older plants, reducing yield and quality of a commercial crop. The downy mildew fungus may become systemic and move throughout the cabbage plant and head by way of the vascular system. In the stems and heads of cabbage, downy mildew produces dark purplish spots visible beneath the cortical tissue when the heads are cut open. These spots or lesions may be invaded by bacterial soft rot resulting in complete head decay. Occurrence of systemic downy mildew may result in rejection of the cabbage by the buyer.

Seasonal Development: The fungus survives from season to season on overlapping crucifer crops or as thick-walled resting spores, called oospores. These sexual spores can survive in the soil for extended periods and produce sporangia under favorable environmental conditions. During the growing season, the fungus produces sporangia on the underside of the leaf at night when conditions are moist. The sporangia are carried primarily by air currents and, to a lesser extent, by rain. Under favorable conditions the sporangia germinate, producing germ tubes that directly penetrate the leaves causing new infections.

Management Guidelines: A few cabbage varieties are now available that are tolerant to downy mildew. Fungicide treatment of susceptible varieties is needed when the

disease occurs early in crop development; repeated applications may be required, depending on the weather. Crop rotation to noncruciferous hosts is recommended. See ID-36 Commercial Vegetable Crop Production in Kentucky for recommended fungicides.

BLACK ROT

This disease is caused by the bacterium *Xanthomonas campestris* and affects young, as well as mature plants. Infected seedlings turn yellow and die. On older plants, yellow wedge or “V” shaped areas appear at leaf margins and expand toward the center of the leaf; infected areas later turn brown and die. Vascular tissue (veins) is black within infected areas. This discoloration develops from leaf margins toward the base of the plant. When plants are infected as seedlings, heads are dwarfed and lower leaves fall off. Frequently symptoms are most severe on one side of the head. Soft rot often develops in infected heads. If the disease spreads extensively, the cabbage field will have a scorched appearance and plant growth will be inhibited. The black rot bacterium overwinters on seed and in residue from diseased plants; it can persist in plant residue for 2 to 3 years. Plowing under debris so that it rots quickly is recommended. As with the blackleg fungus, the black rot bacterium is seed-borne and is spread on seedlings and by movement of contaminated water. All cole crops are susceptible, especially cauliflower and weeds like wild mustard. Cabbage varieties differ in susceptibility to black rot.

Management Guidelines:

1. Rotate transplant beds and do not locate a transplant bed near production fields or gardens with crucifers.
2. Raise or trench production beds. Flooding of plant beds can result in widespread infections.
3. Eliminate wild crucifer weeds near plant

beds or in production fields.

4. Preplant fumigate all plant beds.
5. Purchase hot water treated seed that has been certified as disease free.
6. Check transplant grower’s certification records.
7. Plant several small plant beds rather than 1 large one.
8. Use seed from different lots and sources for each bed.
9. Do not top or mow transplants.
10. Do not wet down or dip transplants to remove soil.
11. Do not work in or handle wet plants.
12. Spray to slow disease spread when noted in the field.

CLUBROOT

Clubroot is caused by the fungus *Plasmodiophora brassicae*, which causes stunting, wilting and yellowing of above-ground parts. Plants often die before making heads. The diagnostic symptom is the presence of large spindle-shaped galls on roots. Clubroot can infect wild mustard and shepherd’s purse. The causal fungus is soil-borne and persists in soil for at least 7 - 10 years. Soil pH of less than 7.2 favors disease development, as does wet, poorly drained fields. Optimum soil temperature for infection is 64-77° F. The fungus spreads from one field to another in soil clinging to tools, field equipment, transplants.

Management Guidelines: Clean transplants, and crop rotation help reduce disease problems. Seed beds should not have been in crucifers for 6 - 8 years or must be fumigated. If club root is a problem and fields are not available to rotate to, broadcast and disc in 1500 lb of hydrated lime per acre 2 to 3 days prior to transplanting if the soil pH is not over 7.5. This should not be done more than once every 3 years. Otherwise the soil pH should be over 6.5.

BACTERIAL SOFT ROT

This disease is caused by *Erwinia carotovora* and some other bacteria. Infected areas appear to be water-soaked, develop a soft decay, and have a foul distinctive odor. Infected cabbage heads decay rapidly and turn dark. The bacteria usually infect plants through surface areas injured by insects, cold, other diseases or mechanical means. Warm, wet conditions promote disease development.

BLACK LEG

Black leg is caused by the fungus *Phoma (Plenodomus) lingam*. Symptoms begin as dark sunken cankers at the base of the stem and as light brown circular leaf spots. Stem cankers enlarge and girdle stems, causing plants to wilt. A diagnostic feature of blackleg is the presence of distinct black pycnidia (speck-size fungus reproductive structures) within stem cankers and leaf spots. Infected seed is the major source of disease. The greatest spread occurs in the seed bed or seedling stage. Weather conditions during the growing season determine severity. Fungal spores are carried by splashing rain or insects to nearby plants. Fruiting bodies may develop on the leaves. The causal fungus overwinters on seed and in residue from diseased plants, and can persist in residue for 3 to 4 years depending on how quickly the roots and stems decay. The fungus can be carried on seed and on transplants; it can be spread within fields when diseased and healthy plants are dipped in the same water, when workers and implements move through fields that contain diseased plants, and by splashing and running water.

Management Guidelines: Blackleg can be managed by combining preventive measures. Always use disease-tested, fungicide treated seed. Fumigate seed beds under a polyethylene tarp with a mixture of methyl bromide and chloropicrin. Do not locate plant

beds in or near fields that were planted to cole crops the year before. Harvest any field with disease symptoms last. Plow under debris in diseased fields to allow for more rapid and thorough decomposition. Rotate infested fields out of cruciferous crops for 3 to 4 years.

WHITE ROT

White rot is caused by the fungus *Sclerotinia sclerotiorum*. This disease is expected to increase with the use of float beds for transplant production. Symptoms appear on leaves, petioles or stems nearest the ground or on the top of cabbage heads. The fungus is favored by high humidity and temperatures (77-81° F). Infected areas appear as water-soaked spots; these enlarge to irregular-shaped areas which become covered by white mold. The white colored fungus grows upward over the maturing plant, often producing a soft water-soaked mass. Numerous black sclerotia (seed-like fungus reproductive structures) form on and in diseased parts. Often float bed plants suffer the greatest loss. Severely infected plants may wilt or topple. Sclerotia produced by the fungus can survive in soil for many years. The fungus can infect and survive on wild mustard. Spores from wild mustards can be blown to nearby cabbage.

Management Guidelines: Rotate to grass crops. Avoid beans, potatoes and tomatoes in rotations. Deep plowing of debris buries sclerotia.

MOSAIC or VIRUS DISEASES

Cauliflower and turnip mosaic viruses occasionally occur on cole crops, but they usually do not cause significant damage. However, on the related crops Chinese cabbage or bok choy, they can significantly reduce yield and quality.

Leaves of infected plants are mottled in a mosaic of light green or yellow to dark green

and may have varying amounts of necrosis, depending on the virus strain and other factors. Some plants show vein clearing. Plants may be stunted if infection occurs early. Cauliflower and turnip mosaic can cause a problem known as pepper spot on mature cabbage heads. Initially the spots are on the interveinal tissue of the outer leaves but in time will infect leaves in the head. The most important time of infection is in the seedling stage. Plants infected then may suffer yield reductions, whereas plants infected later may show little effect. Aphid control in the plant bed is recommended as is control of weeds around the bed. The viruses cannot survive in the absence of a living host; they depend for survival on perennial and annual plants. They are spread from plant to plant by aphids. Avoid planting next to old virus-infected crucifer fields, and control such weed hosts as wild mustard.

SCOUTING FOR EARLY SEASON CABBAGE DISEASES

Control recommendations for production areas will be based on diseases found in scouted fields in that area. All diseases should be confirmed by the plant diagnostic lab.

1. **Black Rot** Copper fungicide sprays should begin if presence of this disease is confirmed. If only an occasional plant is infected, removal might slow spread. If greater than 10% spray and pray. Black rot is often carried in seed lots or transplants from the same production source. Alert all growers using that seed lot or transplant producer to begin a spray program if the infection source is transplants or seed.

2. **Blackleg** If this disease is found in isolated plants in the field, remove these and destroy. Blackleg is often found in fields with wild mustard populations. It may be carried on

transplants from the same source or in seeds from the same seed lot. A 3-4 year rotation with control of cruciferous weeds is required.

3. **Downy mildew** Begin a Bravo spray program with the first tobacco blue mold alert.

4. **Rhizoctonia** Wirestem is often seen in fields with a freshly turned green manure crop. It may get its start on transplants that have been injured due to pulling and/or shipping. Wet soils may aggravate this problem.

5. **Sclerotinia** If white rot is found in isolated plants, pull these and remove them. This may occur in fields with or near high wild mustard populations. It is sometimes found in fields where wild mustard was recently plowed down.

TIPBURN AND OTHER PHYSIOLOGICAL DISORDERS

TIPBURN

Tipburn is a serious physiological disorder of cabbage, involving death of leaf tissue in the developing head. Tipburn may involve a few spots along the leaf margin or the entire edge of the leaf may be affected. The tissue turns brown and eventually black and may continue to decay. Tipburn is caused by calcium deficiency in this leaf tissue. This deficiency may be due to low Ca^{++} levels in the soil (pH) and/or poor uptake of Ca^{++} by the plant and distribution to the leaves in the head. The problem is often associated with fields which received excess nitrogen, especially the ammonium (NH_4^+) forms of nitrogen or potassium (K^+) fertilizers. Competition between NH_4^+ , K^+ , and Ca^{++} for uptake by cabbage plant roots results in less Ca^{++} reaching the head leaves. Anything that reduces size of the cabbage plant's root system will also reduce the level of Ca^{++} reaching the head leaves, simply because there will be fewer sites for uptake. Excess soil moisture can also induce the problem by reducing calcium uptake. All plant nutrients taken up by the roots are carried by water throughout the plant. Dry soil conditions can increase the possibility of tipburn because less water is available to carry nutrients to the leaves. When weather conditions are hot and dry, most plant transpiration is highest through those leaves directly exposed to the air. Interior head leaves do not require as much water, so Ca^{++} flow to these leaves is less. Varieties may also differ in susceptibility to tipburn.

Control Recommendations:

- 1) Maintain uniform plant growth throughout the season.
- 2) Fertilize according to soil tests. Applying mostly nitrate forms of nitrogen rather than ammonium forms.
- 3) Maintain uniform soil moisture with irrigation where possible and avoid poorly drained fields.
- 4) Maintain good soil tilth (no compaction, or hard pans) to promote root growth.
- 5) Avoid excess cultivation (root pruning).

EDEMA

Edema appears as small brownish gray wart-like growths on the leaf surface. These growths are thought to be initiated by leaf injury caused by sand or insects. Edema usually develops during cool nights following warm muggy days. Under these conditions water uptake is faster than water loss; consequently, the leaf epidermis bursts and expanding leaf cells are exposed and become corky.

SOIL COMPACTION

Signs of soil compaction include: slow plant growth, variable stands, variable plant size in the field, off-color leaves, shallow root systems. Plowing, disking and planting when the ground is too wet can lead to serious yield losses. Compare soil penetrometer readings in affected areas with normal areas.

CABBAGE DISEASES PICTURE SHEET



ALTERNARIA



BLACK ROT



BACTERIAL SOFT ROT



DOWNY MILDEW



FREEZE DAMAGE

CABBAGE CULTURAL REQUIREMENTS

See ID-36, Commercial Vegetable Crop Recommendations for specific cultural and variety recommendations.

FIELD SELECTION

Sandy, silt or loam soils are more desirable than clay soils. Soils with high organic matter levels are also preferred. Avoid wet or poorly drained soils. The field should be free of weeds, particularly perennial weeds. A south or southwest exposure allows earlier planting and promotes earlier crop harvest.

Select fields where deer and ground hogs are not a problem or put control measures into effect prior to crop planting. Both or these can cause considerable crop loss. Follow a good crop rotational program.

CROP ROTATION

Never grow cabbage, related cole crops or related weeds in the same field more than once every 3 years and preferably 4 years. Cole crops include cabbage, broccoli, Brussels sprouts, cauliflower, Chinese cabbage, kale, kohlrabi, mustard, radishes, rutabagas, and turnips. Related weeds include, wild radish, shepherds purse, wild mustards etc. There can also be some rotational problems from crops that are outside the cole crop family. (See Appendix 4.)

Fescue sod plowed down in the fall, soybeans, corn, wheat and grasses are good rotational crops. Be sure that there are no carry-over herbicide residues.

VARIETY SELECTION

Select varieties that are desired by the intended market. It is preferable that the varieties have black rot tolerance/resistance, as well as yellows resistance. Some varieties are less prone to bolting, caused by prolonged

cold periods below 50° F encountered in spring plantings and some have more resistance to head splitting. Ideally the variety should have a small core and produce hard compact heads. Varieties that produce smaller heads in the 2-3 lb range are desired for the fresh market, while large head sizes are desired for the slaw or processing market.

SOIL TESTING AND FERTILIZATION

Test the soil the year before planting for pH, phosphorus (P), potassium (K), calcium (Ca), Magnesium (Mg) and boron (B). Adjust the pH to 6.5 to 7.0 with lime preferably in the fall or very early spring and work into the soil. A pH in this range promotes optimum availability of most nutrients needed to produce a good cabbage crop. A minimum of 2,000 lb of calcium per acre is recommended.

On soils with a history of club root, adjust the soil pH to over 6.8. Broadcast and disc in 1,500 lb per acre of hydrated lime 2-3 days prior to transplanting if the soil pH is less than 7.5 for club root control. Do not do this more than once every 3 years.

Apply P and K based on the soil test recommendations and plow these in prior to planting.

Cabbage yields are increased by higher rates of nitrogen (N). However, N levels that are too high increase internal tipburn. Prior to planting broadcast and plow down 50 lb of N per acre. Sidedress with 50 to 100 lb of N per acre when heads begin forming (150-300 lb of ammonium nitrate or 330-660 lb of calcium nitrate). Make a second sidedressing of N 2 to 3 weeks later. Late N applications can lead to head bursting. Use calcium nitrate where

tipburn has been a problem.

If the soil test indicates that magnesium (Mg) is low and if lime is recommended, apply dolomitic limestone. The soil test should show 100 lb Mg per acre as a minimum. If magnesium is low and lime is not recommended, apply enough magnesium oxide or other source of magnesium such as Epsom Salts ($MgSO_4$) to achieve 100 pounds of elemental magnesium per acre. Cabbage has a fairly high Mg requirement. If a Mg deficiency develops in the field, spray with 10 lb of Epsom salts in 100 gallons of water per acre.

Apply a minimum of 10 pounds of sulfur per acre using a fertilizer such as potassium sulfate, K_2SO_4 (0-0-50) which is 18% S. Apply up to 50 lb S if it is necessary. Sulfate of potash magnesia (Sul-Po-Mag or K-Mag) may also be used to supply a portion of the recommended K_2O and to supply Mg and S. Most tobacco ground probably has plenty of S.

For cole crops, one to two pounds of actual boron (B) per acre is recommended, particularly if your area of the state tends to be low in B or your soil test shows less than 1 lb of B per acre. Two pounds of B is equivalent to 18 lb of Borax which is 11% B. Boron can also be applied to the leaves as Solubor at 1.5 lb per acre. Be careful when applying boron, since the range between deficiency and toxicity is very narrow. Too much boron causes serious problems.

If the soil test indicates that zinc (Zn) is low (see corn recommends in AGR-1), apply five pounds of actual Zn as zinc sulfate, $ZnSO_4$. Growth responses are likely when the soil test shows less than 2.5 lb/acre.

FOLIAR APPLICATION OF NUTRIENTS

The fact that plants can absorb a number of fertilizer elements through their leaves has been known for some time. However, leaves of many vegetable plants are not especially well adapted for absorbing nutrients because they have a waxy cuticle. In fact, plants may appear to benefit from foliar uptake when the actual cause of improvement may be from that component of the nutrient spray which reaches the soil and provides essential nutrients for subsequent root uptake. **Foliar application is beneficial if soil nutrient levels are low or if nutrients are unavailable to the plants and the plants are showing a deficiency.** Foliar applications are often effective in rapidly correcting micronutrient deficiencies.

The effectiveness of applying macronutrients such as nitrogen, phosphorus, and potassium to plant leaves is questionable, high rates often cause damage to plant tissues. It is virtually impossible for greens (waxy leaved cabbage, collards and kale) to absorb enough N, P or K through their leaves to meet their nutritional requirements, furthermore, it is unlikely that they could absorb sufficient amounts of macronutrients to correct major deficiencies. Although nitrogen may be absorbed within 24 hours after application, up to four days are required for potassium uptake and seven to 15 days for phosphorus to be absorbed from foliar application.

The crucial question is whether foliar N, P, or K actually increase yield and/or enhance quality. Although some growers feel that foliar fertilizer should be used to supplement a soil-applied fertilizer program, research findings do not support this practice. If proper fertilizer management of soil-applied nutrients is used, *supplementation* by foliar fertilization is not usually required.

Foliar nutrients often are expected to cure a variety of plant problems, many of which may be unrelated to nutrition, such as reducing stress, aiding in healing frost or hail damaged plants or increasing plant resistance to various stresses and pests. Nutrients are effective as long as they are supplying a nutritional need.

Following a damaging frost or hail, some cabbage and leafy greens growers apply foliar nutrients to give the plants an "extra shot" to promote rapid recovery. However, if a proper fertilizer program is being used before foliage damage occurs, it becomes evident that the plants *don't need additional fertilizer*. What they do need is time and the proper environment for the normal recovery processes to occur. The likelihood of deriving significant nutritional benefits from a foliar application of fertilizer to plants that have lost some of their leaves (or have a large proportion of their leaves severely damaged) is questionable.

Foliar application of sulfur, magnesium, calcium and micronutrients (based on a soil test) may help alleviate deficiencies. An application of water-soluble boron such as Solubor (approximately 0.25 lb of actual B per acre) can be used when a deficiency occurs. However, foliar nutrient sprays should be applied *only if there is a real need for them* and only in quantities recommended for foliar application. Application of excessive amounts can cause fertilizer burn and/or toxicity problems. Once deficiency symptoms occur, some yield loss can be

expected. Foliar applications are usually a poor substitute for proper soil testing prior to planting.

TRANSPLANTS

If plants are purchased from the south, purchase certified disease free bare root plants. A better alternative is to purchase plug plants, preferably locally grown. A third and even better option in most cases is to grow your own transplants. If you grow your own, use western grown, hot water treated seed and treat this with a fungicide prior to planting. Seed for the spring crop should be seeded around January 20 and seed for the fall crop should be planted from late May to July 1.

When growing your own transplants for a fall crop in a seedbed, choose a site where cole crops have not been grown before or fumigate prior to seeding. Four to 6 ounces of seed will sow a standard 9' X 100' seedbed and produce enough plants for an acre. Drill seeds 1" apart in rows 6" apart and 5/8 inch deep, 5-6 weeks before transplanting. Seeds should be planted in late afternoon or evening to improve germination. A light layer of straw over the bed will also improve germination and frequent light irrigations are absolutely necessary for success.

To grow your own transplants in a greenhouse, precision seed into 200 cell flats containing a peat vermiculite mix or other suitable growing media. Seed will germinate in 3-6 days, approximately 4 days at 70° F. Temperatures should be maintained above 45° F at night and below 85° F during the day.

Transplants should be hardened off when grown in a greenhouse before going to the field. A transplant taken directly from a greenhouse and set in a field on a hot sunny day will sunburn and die. Hardening off involves slowing the plant growth to toughen the plants up so that they will withstand field conditions. This is achieved by decreasing the temperature 5-15° F, reducing watering frequency, increasing light exposure, increasing ventilation, and/or reducing N levels. Too great a reduction in N will cause yellowing, stop growth, delay maturity, and reduce head size.

Most Kentucky growers progressively increase the amount of sunlight exposure on their transplants over a period of time to harden them off. This can be done by placing the transplants on a wagon and moving them out of a barn for progressively longer intervals.

HANDLING CABBAGE TRANSPLANTS

Soon after you get your cabbage plants home, they should be prepared for field setting. You will receive field packed plants in wooden crates or boxes. Plant counts will vary from crate to crate based on plant size at the time of harvest and packing but you should receive enough to plant your intended acreage.

A. Open the crates as soon as possible, remove the plants and gently pull the entangled roots apart. Plants should be graded into two size groups, large and small, for separate planting. The larger cabbage plants normally will produce heads first, so planting them separately will make harvesting easier. **Check the plants for diseases as you sort them.** Contact your county agent if you feel you may have a disease in your cabbage transplants.

B. Put the graded plants back in separate crates. Mark each crate according to plant size so you can easily plant all the large and small plants in separate locations. If you are not going to plant within a few hours keep the crates in the shade or place them in a barn.

C. If the cabbage plant count was short or if you feel you have diseased plants tell your county agent or Coop director immediately!

D. When your plants arrive get them in the ground as soon as possible without working wet soil.

CARE OF TRANSPLANTS PRIOR TO PLANTING

You may not have the ground ready or it may be too wet to plant immediately. Transplants can be held safely for 10 to 14 days if necessary by doing the following.

A. Remove some of the plants from each crate so they are not packed too tightly. Place the extra plants in a separate box or crate.

B. If plants become wilted the crates can be set in 1-2 inches of water for several hour. The crate should be packed so that only the cabbage plant roots are in the water. Do not leave them in the water for more than two hours. Be sure that only the roots are touching the water. **DO NOT WET THE LEAVES!**

C. Set the crates in a well-ventilated and shady place (a barn, crib, or any well ventilated building).

D. Do not wet the tops of the plants! and Do not leave the plants outside where the tops can get wet if it rains.

E. Many growers place sawdust, straw, hay or any similar material on the floor of the barn,

then wet the area thoroughly with a water hose before setting the crates on the moistened material. If it is necessary to hold the plants more than 5 days it may be necessary to move the crates and remoisten the sawdust or straw. This is an easy, safe method to keep the plants in good condition. **There is less chance of accidental disease spread with this method than soaking the roots in water.**

TRANSPLANTING

Prior to transplanting prepare a good firm seedbed by discing. Transplant by mid-March for the spring crop and from June to August 1 for the fall crop. Set plants 8-10 inches apart for fresh market cabbage and 12-14 inches apart for slaw cabbage in rows 32-42 inches apart. (See Appendix 5 for various plant spacings and plant populations per acre.)

Apply 1 cup of starter solution that is high in P per plant to the root system at transplanting. The starter solution is made by adding 3 lb of a starter fertilizer such as 10-52-17 to 50 gallons of water. It is important to apply the starter solution immediately after transplanting. These nutrients are very important to get the cabbage off to a good start in the spring, because the soil is cold and nutrient uptake is slow. The water is particularly important in combination with the dilute nutrients to get the transplants established under hot dry conditions for the fall crop. For the fall crop increase the amount of solution applied, but make it half strength to avoid burning the plants.

IRRIGATION

Irrigation is important to achieve high cabbage yields. Growers can often get by without irrigation for the spring crop, particularly if the spring is a wet one. However, irrigation is a must for fall cabbage. Plants should receive 1" of water per week either as rain or irrigation.

WEED MANAGEMENT

Survey the field that will be planted to cabbage the year before and identify and control problem weeds. This may involve spot sprays of a systemic herbicide or spraying the entire field to kill problem perennial weeds. Plant a crop or covercrop with the intent of reducing weed populations in the field the year before.

Do not let weeds go to seed in fields, alleyways, and roadways. Keep fence rows clean and mow field margins on a regular basis. This will avoid the production of unwanted weed seeds that blow into the field. Regular mowing will avoid the build up of problem insects such as aphids and their forced movement into the cabbage field which occurs with infrequent mowing.

Cabbage has a shallow root system and cultivation should be shallow (2 inches or less) and should only be used as needed to control weeds. See ID-36, Commercial Vegetable Crop Recommendations for the latest chemical weed control recommendations. Plan on using at least one preemergence herbicide and do not depend solely on post emergence materials. It is a good idea to rotate the materials that are used to avoid building up populations of certain weed species.

HARVEST

Harvest while heads are cool and after they have dried off. Keep harvested heads shaded. Avoid rough handling and maintain a high humidity during storage.

Harvest heads for the fresh market when they are firm. A 2 to 3 pound head is the size desired by the fresh market. Harvest with 2

to 3 wrapper leaves leaving ½ inch of basil plate below the head. Get cabbage out of the sun to avoid sunburn.

Harvest 5 to 8 pound heads for the processing (slaw) market and remove the wrapper leaves. Slaw cabbage is hauled in bulk bins.

KEY TO CABBAGE NUTRIENT DEFICIENCY SYMPTOMS UNDER FIELD CONDITIONS

In a large field the symptom of any deficiency usually occurs in spots so plant growth should be compared between areas. The first symptom is usually a slowdown of growth which may go undetected. Sometimes soil characteristics, crop characteristics and cultural practices can give clues when a problem is seen.

I. Slow plant growth with slow developing visual symptoms. Leaf shape is normal.

A. Entire plant is involved.

1. Generally dark green, stunted plant with dark purple on leaves, leaf veins and stems. Some yellowing on older leaves in severe cases. Phosphorus
2. Pale green or yellowish stunted plant with woody stem and tough leaves. Gradual dying of older leaves. Bright purpling on stems and leaves in some plants. Usually only seen when soils are wet and cold. Nitrogen

B. Older leaves showing symptoms with progressively milder symptoms on younger leaves.

1. Yellowing of leaf margins, moving inward in large blotches, followed rapidly by death of yellow tissue. Affects oldest leaves first and upper part of plant may be normal in appearance. Potassium
2. Yellowing in interveinal areas with veins remaining green. May be blotchy or in stripes but leaf stays yellow without necrosis for sometime. Oldest leaves are affected most and often puckered. Sometimes magnesium deficiency occurs when excessive applications of potassium have been made. Magnesium
3. Plants stunted with a purplish cast to the older leaves. Deficiency symptoms frequently occur during cold weather when temperatures are below 50F. Phosphorus

II. Rapidly developing symptoms with yellowing of younger leaves, deformed leaves, or death of terminal buds or older plant parts.

A. Leaf shape normal.

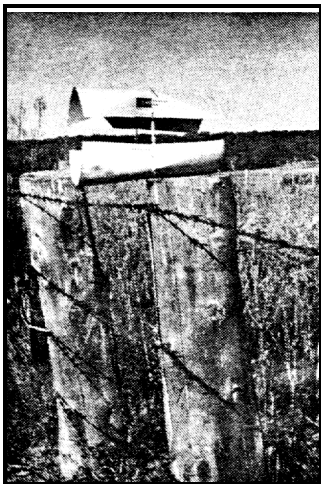
1. Chlorosis most severe on young leaves, severe stunting of plant.
 - a. Young leaves uniformly golden yellow. Usually on alkaline or overlimed soils. Iron
 - b. Young leaves with severe yellowing but green veins. Plant growth may be stunted. Usually on alkaline or over limed soils. Manganese
 2. Chlorosis over most of plant, moderate to slight stunting.
 - a. Leaves with alternate yellow and green stripes, yellow blotch at base of leaf, some white or necrotic spots. Zinc
- B. Young leaves deformed.
1. Symptoms on leaves only.
 - a. Twisting of young leaves with chlorotic spots on older leaves. Zinc
 - b. Younger leaves progressively more strap-like and brittle, usually with slight to moderate chlorosis. Molybdenum
 - c. Young leaves deformed, cupped with some chlorosis and terminal bud death. Boron
 - d. Young leaves suddenly water soaked turning black rapidly. Calcium
 - e. Margins of young leaves cupped downward; brown to black preceded by water soaking. Calcium
 2. Death or abnormalities on plant parts other than the leaf blades.
 - a. Cracking or blistering of petioles or midribs, sometimes turning black and hard. Boron
 - b. Water soaked areas on stems, storage organs followed by red or brown color then turning black and hard. Internal discoloration of the stem may occur. Boron
 - c. Tips of leaves in heads turn brown then black (Tipburn). Calcium

Appendix 1

INSECT TRAPS

The basic principle of pest management is that you do not take action against a pest unless you are certain the pest is present and will be a threat to your crop. Insect traps are a good method of determining if an insect is present and can also give an estimate of their concentration and distribution. Food, light, color or chemicals can be used to attract insects to a trap. However, if you are interested in only one species of insect, such as only the beet armyworm or only cabbage looper, a pheromone would be the best choice to attract the insect. A pheromone is a secretion from an unfertilized female insect that attracts only male insects of the same species. The male insects are attracted by the odor of the pheromone. The traps consist of a plastic top and bottom that are held together by a wire hanger. The tops of the traps can be reused and the disposable bottoms are coated with a sticky gel to hold the insects once they land in the trap. The trap can be mounted to a fence post.

We are interested in catching many insects when they are in the moth stage of their life cycle because this is when they will be laying eggs and males will be attracted by the odor of the pheromone. The moths lay eggs which develop into worms that feed on crops. To complete their life cycle the worms change to moths that in turn lay more eggs thus producing more worms. By knowing that the moth stage of a pest is present the farmer can be on the look out for damaging worms that are sure to follow.



Appendix 2

USING PHEROMONE TRAPS

The following are guidelines to be followed when using pheromone traps in cabbage:

- Store replacement lures in freezer or refrigerator when not in use. Lures can be stored from one season to the next in the freezer. Write the date the lures were placed in the freezer on each package.
 - Change gloves or wash when handling pheromones for different species of insects to prevent cross-contamination. Minute traces on one pheromone contaminating another will render the second completely ineffective.
 - Begin pheromone trapping as soon as the cabbage is set in the field.
 - Mark the type of insect that the trap attracts on the outside of the trap and be sure to place the correct pheromone lure into the correct trap.
 - Hang traps on field margins and separate the traps by at least 15 to 20 yards..
 - Use 1 trap of each type per each 5 acres.
 - Monitor traps at least once a week, particularly during peak flight periods.
 - Record trap catches on IPM scouting log. I find it helps to keep a running graph of the information.
 - Remove moths collected in trap during each visit and dispose of them away from field.
 - Change pheromone lures every 4 weeks. DO NOT dispose of any lures in the field, these will compete with the traps and affect trap catches.
- If you cannot identify a particular insect in a trap, send it to your county CES office or to UK Lexington for identification.

Appendix 3 CABBAGE INTEGRATED PEST MANAGEMENT FORM

COOPERATOR:				SCOUT:				FIELD #:			
ADDRESS:											
CITY:				ZIP:		VARIETY:				ACRES:	
COUNTY:				PHONE:				DATE PLANTED:			
SOIL CONDITIONS				WEATHER				TIME/DATE:			
WET		MOIST		DRY		COOL		WARM		HOT	
LOOSE		HARD		LIGHT		CRUST		SUNNY		CLOUDY	
						CALM		LIGHT		STRONG	
								RAINY		WIND	
								NO LEAVES:			
								GROWTH STAGE:			
INSECTS/DISEASES:	1	2	3	4	5	6	7	8	TOTAL	AVG	% INFESTATION
PHEROMONE TRAP INFORMATION											
LURE TYPE		# MOTHS LAST VISIT		# MOTHS THIS VISIT		TOTAL FOR 2 WEEKS (LAST + THIS VISIT)			DATE LURES CHANGED		
BEET ARMYWORM											
DIAMONDBACK MOTH											
CABBAGE LOOPER											
PESTICIDES APPLIED				RATE/ACRE				DATE APPLIED			
FERTILIZER APPLIED				RATE/ACRE				DATE/APPLIED			
COMMENTS:											
WEEDS: PREDOMINANT SPECIES											
PRESENCE OF WILD MUSTARD		IN FIELD		LOW		MEDIUM		HIGH			
				<input type="checkbox"/>		<input type="checkbox"/>		<input type="checkbox"/>			
		NEARBY		<input type="checkbox"/>		<input type="checkbox"/>		<input type="checkbox"/>			

Appendix 4

Rotation from Various Crop Groups for Planting Cabbage	
Crop Group	Probability of Disease Overlap
Cabbage, Broccoli, Cauliflower	Very High
Tobacco, Tomato, Pepper	Medium*
Soybean, Alfalfa, Peas	Low/Medium
Pumpkin, Melon, Cucumber	Low
Corn, Wheat, Grasses	Very Rare
* Root Knot Nematode	

Appendix 5

Row Spacing and Plant Population Per Acre		
Row Spacing	Plant Spacing in Row	Plant Population Per Acre
32"	8"	24,540
32"	10"	19,666
32"	12"	16,376
34"	8"	23,084
34"	10"	18,481
34"	12"	15,375
36"	8"	21,801
36"	10"	17,493
36"	12"	14,520
38"	8"	20,644
38"	10"	16,519
38"	12"	13,758
42"	8"	18,695
42"	10"	14,969
42"	12"	12,446