IPM-8

# Kentucky Integrated Crop Management Manual for Field Crops

## "Canola"

UNIVERSITY OF KENTUCKY • COLLEGE OF AGRICULTURE • COOPERATIVE EXTENSION SERVICE
Agriculture • Home Economics • 4-H • Development

# KENTUCKY INTEGRATED CROP MANAGEMENT MANUAL

**Authors:**

*Jim Herbek*, Extension Grain Crops Specialist, Research and Education Center, Princeton, KY
*Donald E. Hershman*, Extension Plant Pathology Specialist, Research and Education Center, Princeton, KY
*Douglas W. Johnson*, Extension Entomology Specialist, Research and Education Center, Princeton, KY
*James R. Martin*, Extension Weed Control Specialist, Research and Education Center, Princeton, KY
*J.D. Green*, Extension Weed Control Specialist, College of Agriculture, Lexington, KY
*Lloyd Murdock*, Extension Soils Specialist, Research and Education Center, Princeton, KY

Editor: *Patty Lucas*, Extension Integrated Pest Management Specialist

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"1992 KY-IPM FIELD CROPS"

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The following individuals have provided information, expertise and/or revised portions of this manual:

Paul R. Bachi, University of Ky., Plant Pathology
Monroe Rasnake, University of Ky., Department of Agronomy
K. A. Shufran, University of Ky., Department of Entomology
Charles R. Tutt, University of Ky., Department of Agronomy

# PREFACE

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. A truly successful pest management program must take a multi- disciplinary, multi-crop approach in order to supply the farmer with reliable pest control information. An approach to crop production based on sound economic, ecological, technical and social considerations is required to assist the farmer to achieve needed production levels, while maintaining food safety and environmental quality.

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# CANOLA

**Note:** Unlike other field crops represented in this manual, Canola is a very new subject. We do not have available to us the experimental or experiential information that is available on common Kentucky grown field crops. This chapter is intended to provide a consistent method of examining canola for pests, combined with our best educated estimates of how to make decisions.

Scouting for pests in Canola will be similar to other crops. However, because of the growth pattern of this crop we have to adapt techniques from several different crops. Fall scouting will be relatively easy and straightforward. Spring scouting will be difficult, physically challenging and may require slight alteration to planting practices.

In order to get a complete look at a field it may be necessary to set across paths or "tram lines" in the field. This may be accomplished in several ways, planned "skips" during planting, cutting paths (after bolting) or simply tramping the same path each visit, are examples. It is important to understand that observing only field edges will **NOT** yield an accurate picture of field condition.

## MONITORING

| PEST | MONITORING STATION LOCATION | PROCEDURE/LOCATION |
|---|---|---|
| Insects | Random | 20 consecutive plants |
| Weeds | Random | 600 sq. ft. area |
| Disease | Random | 600 sq. ft. area |

NUMBER OF SAMPLING LOCATIONS:

| Field Size (acres) | No. of Locations | Field Size (acres) | No. of Locations |
|---|---|---|---|
| 1-14 | 2 | 151-164 | 14 |
| 15-24 | 3 | 165-174 | 15 |
| 25-34 | 4 | 175-184 | 16 |
| 35-50 | 5 | 185-200 | 17 |
| 51-64 | 6 | 201-214 | 18 |
| 65-74 | 7 | 215-224 | 19 |
| 75-84 | 8 | 225-234 | 20 |
| 85-100 | 9 | 235-250 | 21 |
| 101-114 | 10 | 251-264 | 22 |
| 115-124 | 11 | 265-274 | 23 |
| 125-134 | 12 | 275-284 | 24 |
| 135-150 | 13 | 285-300 | 25 |

## Canola Insect Scouting Calendar

| | Pre-emerg | Seedling | Rosette | Winter Dormancy | Spring Regrowth | Budding& Bolting | Flowering | Ripening |
|---|---|---|---|---|---|---|---|---|
| Striped Flea Beetle | ******** | " | " | | | | | |
| Aphids | | | | " | " | " | | |
| Cabbage Seed Pod Weevil | | | | | | | ******** | " |
| Root Maggots | | | | | ****** | ***** | | |
| False Chinch Bug | | | | | | | " | "******** |

# SCOUTING FOR CANOLA INSECTS

*Douglas W. Johnson*

Very little information exists about insect pests of canola in the U.S. and virtually none at all that deals with the Ohio River Valley production area. As a result, much current thinking about canola insect pests in Kentucky is derived from observations, very recent experiments and opinions that can be reasonably inferred from the existing literature.

As you read about insect pests, remember that very few acres of canola are grown in Kentucky. Because the distribution and concentration of food are major factors in insect population dynamics, the insect pest complex will probably change as acreage increased and/or becomes more concentrated. Traditionally, increased and/or more concentrated acres have led to greater and more diverse insect problems.

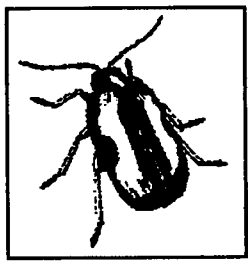
In general, canola supports a very large and diverse group of insects, including most of the insects found on the Brassica crops (cabbage, mustards). Fortunately, most species are parasites, or predators of other insects and plant feeders are of little importance. However, at least 3 pests are of immediate concern, and two species have a high probability of at least periodic concern. Additionally, remember that this situation will change (probably increase) as acreage increases.

### Striped Flea Beetle

OCCURRENCE: In Kentucky this pest is usually confined to the fall season, feeding on the seedling and rosette stages throughout the state.

When to Scout: Plant emergence to winter dormancy.

Description: This insect is a close relative of the tobacco and corn flea beetles but much larger. The SFB is 1/8" long, and brown with two yellow stripes down the back. These insects have the habit of quickly jumping away when disturbed.



Damage: The striped and other flea beetles use their chewing mouthparts to remove the upper surface of plant parts. This leaves a "scarred" appearance, but not a hole at the damaged location. Canola, like soybeans, is most extensively damaged when this feeding occurs on the cotyledon (seed leaves).

How to Scout: Examine by observation twenty plants in each location for the presence of SFB and rate for feeding damage according to the scale below:

0 - no damage or feeding marks
1 - scattered feeding marks on less than 50% of plants; plants appear healthy
2 - feeding on new leaves of 50% or more of plants; some leaves whitish
3 - leaves browning, plant dying

Also, check to be sure the pests are still present.

Record: Record a rating of 0 to 3 and whether or not pests are present.

Economic Threshold: No yield loss is likely to occur unless plants die. There is no established number of SFB's, no level of damage to trigger treatment. However, as a guideline, do not control unless: (1) plants are beginning to be killed, (2) the number of live plants/sq ft. is approaching the recommended minimum (5-7 plants per sq. ft.) and (3) live feeding SFB are still present.

## APHIDS

Occurrence: Small populations of these pest may occur at almost any time after plant emergence. However, observation has indicated that the winter dormant period and immediately post flowering stages may support very large populations. Aphids may appear anywhere canola is growing.

When to Scout: Observe all season but particularly in late fall.

Description: A large number of aphid species are found on canola (e.g. red turnip, cabbage, etc.). Currently, green peach aphid is the most common aphid known to infest, debilitate, and under some conditions, kill canola plants in Kentucky.

Green peach aphids are small (1/16"), tear drop shaped, soft bodied insects. They are usually found in colonies on the underside of leaves. (Aphids are attracted to the color yellow, so look at yellowing leaves first). Most aphids are wingless, though a few have wings and these winged individuals (usually $<10\%$ of the colony) spread the infestation within and among fields. This particular group of aphids contains both green and red (rusty brown)

forms, and looks very much like the tobacco aphid.

Damage: Aphids feed by sucking plant juices through their piercing-sucking mouthparts. No noticeable physical damage may be seen. Usually, when substantial damage occurs, the plant takes on an unthrifty appearance, wilts and/or changes colors.

Canola may take on a purple and/or yellow color due to winter stress. Aphids are attracted to yellow and may congregate on yellow leaves which are normally older, lower on the plant and less thrifty. Aphids' presence on these leaves does not necessarily indicate that the aphids caused the color.

How to Scout: Examine twenty plants per location and estimate the population using the following ratio:

0 - No Aphids
1 - 1-50 Aphids/plant
2 - 50-100 Aphids/plant
3 - >100 Aphids/plant.

Record: Record a rating of 0 to 3 for each site.

Economic Threshold: There is no established number of aphids per plant nor percent infested plants that triggers a control situation. However, control may be warranted if: (1) infested plants show an unthrifty appearance when compared to uninfested plants in a similar situation and (2) a large number of live aphids (a rating of 2 or 3) are present, and (3) the plant population is in danger of falling below the recommended minimum per square foot.

Aphid populations are often very spotty. In many cases, border or spot applications provide very adequate control.

**Cabbage Seed Pod Weevil**

Occurrence: CSPW occurs throughout the canola growing area of Kentucky. This pest will feed on wild mustards and other related weeds and move into canola fields during bloom.

When to Scout: During bloom and early pod set. You may also evaluate damage by observing pods for the presence of holes 4-6 weeks after pod set.

Description: CSPW is a small weevil which feeds on flowers and pods of canola and several other "mustard" plants. The beetle is actually black but appears gray because of its body hairs. When wet, it looks black. It has chewing mouthparts on the end of a long curved snout. This snout is easy to see even though the insect is quite small.

Damage: In the normal weevil fashion, an adult female CSPW bites a hole in the surface of the developing pods. It then turns around and puts an egg into this cavity and once again turns around to replace part of the plant material, thus covering the egg. The egg hatches and a CSPW grub burrows its way into the pod's interior, where it feeds on developing seeds until it matures. The final larval stage CSPW grubs chew their way out of the pod, drop to the ground, pupate and emerge as adults.

Damage results from grub feeding and waste production inside the pod. No

external sign of damage exists until the pest has completed its life cycle and chewed its escape hole in the pod wall. Normally, only one grub is in each pod and often only a portion of the seeds in an infested pod are damaged.

How to Scout: At each location examine twenty plants for the presence of CSPW. Count the total number of CSPW observed.

Record: Record the total number of CSPW counted on twenty plants at each site.

Economic Threshold: No research based threshold has been established. Observations suggest the threshold will be very low. Some authors suggest implementing control when populations reach 2 CSPW/plant (40 per sample site).

**Pests Resulting from Specific Conditions**

Poorly Drained Soils

Several Kentucky producers have suffered extreme loss in plant stands and at first the cause was unknown. Water saturated soils were a common factor in these cases and examination revealed small fly maggots and pupae. Species identification has not been established, but they are probably flies from the genus *Delia*. *Delia radium* (L.) the cabbage root fly and *D. platura* (Melgen) the seed corn maggot are likely culprits.

No thresholds or treatments are known. Canadian research indicates that these pests are common and are not important under good growing conditions. But under stress, especially water saturated soils, this insect is extremely important, with no rescue control available.

Drought

Drought contributes to a complicated set of pest problems. Three conditions produce a perfect situation for infestation by the false chinch bug; drought, canola production and double crop, no-till soybeans. The actual damage is to soybean seedlings but the heavy residue left from canola production produces the environment. Drought conditions favor false chinch bug development and slow soybean growth.

This combination has seriously damaged soybeans in Kentucky. However, in all production years, when one or more of these factors were absent, no infestation occurred. It is very likely that drought is the most important of these factors.

It appears that application with an insecticide with known soil activity gives the best results. Plants are growing too slowly for systemic soil insecticides to have much effect and are too small for treatment of only the plant. For best results, use a broadcast spray with "lots" of water, which saturates the canola residue, forcing the false chinch bug to crawl through a layer of insecticide residue.

# Scouting Procedures for Weeds in Canola

*James R. Martin and J. D. Green*

Fields should be scouted for weeds at weekly intervals beginning as early in the spring as possible until harvest.

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Number of locations per field:

Randomly select the number of sites according to the field size:

| Field Size (acres) | No. of Locations |
|---|---|
| 1-14 | 2 |
| 15-24 | 3 |
| 25-34 | 4 |
| 35-50 | 5 |

Select the survey sites so that they will cover the entire field. Do not survey within 100 feet of a fence or roadway.

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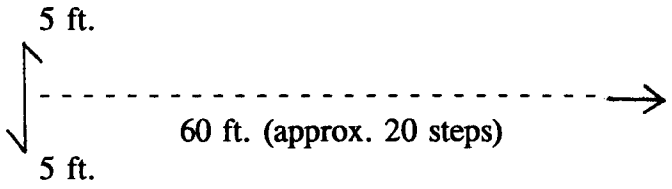
Sampling Procedure:

At each survey site within the field, walk forward 30 feet (approximately 30 steps) and count weeds occurring within 10 feet of either side, record the number of seeds.

Each site should be approximately 600 $ft^2$.




Weeds Scouted

**Wild Garlic
*Giant Ragweed
*Common Ragweed
*Smartweed
*Johnsongrass

Wild Garlic Infestation Levels

Light = less than 3 plants/600 $ft^2$
Moderate = From 4 to 25 plants/600 $ft^2$
Severe = Greater than 25 plants/600 $ft^2$

**Wild garlic reduces seed quality by contaminating the small grain with aerial bulblets, when harvesting. This usually results in a severe penalty in the price received for the seed. Be especially observant for this weed and make notations on the weed map, of areas in the field which have wild garlic.
*These weeds are capable of germinating in established canola and causing a significant problem in double-cropped soybean. Knowing what weeds are present prior to double-cropping soybeans will allow the farmer to know what weeds he may need to control.

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At present there are few management opportunities for weed control in canola. Generally the successful establishment of a proper canola stand will provide most of the necessary weed control. However, similar to small grain we may be able to help the producer by looking for the presence of weeds that could become a problem in double-crop soybeans that follow the canola crop.

# MAPPING FIELDS FOR WEEDS

One of your most important duties as a scout is to prepare a "weed map" of each field that you survey. This map will be of benefit to the grower in planning his weed control program for the coming years.

**Steps in preparing a "weed map".**

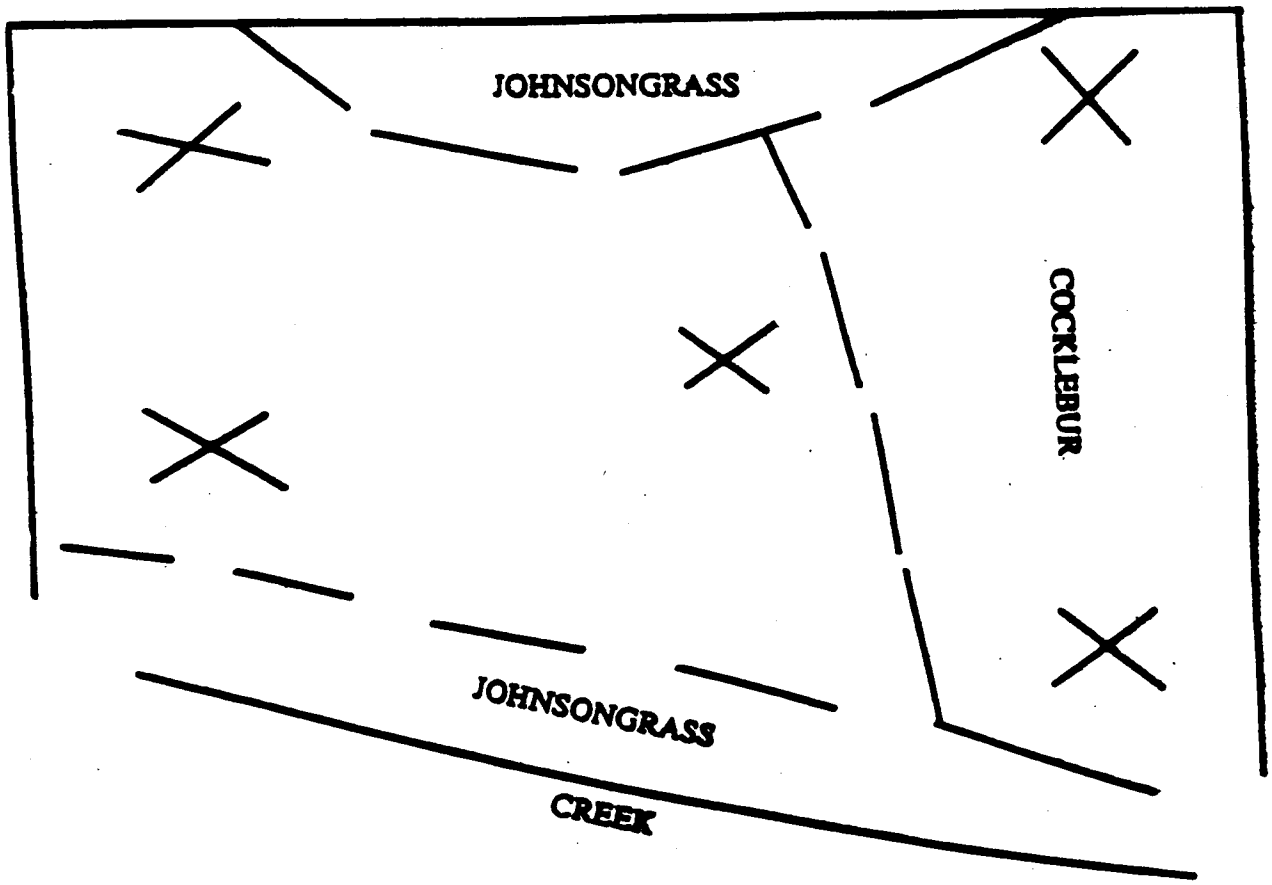
1) Outline the shape of the field on the report form. Make notations as to locations of fences, roads, woods, etc.

2) Mark the approximate locations of severe weed infestations or weeds not listed on the survey form and mark the locations where you make your counts.

3) This map should be drawn each time you scout the field.

4) Be sure and indicate any weed problems on the map that would assist the grower in making management decisions.

The following example can be used as a guide in preparing a "weed map" of your fields.

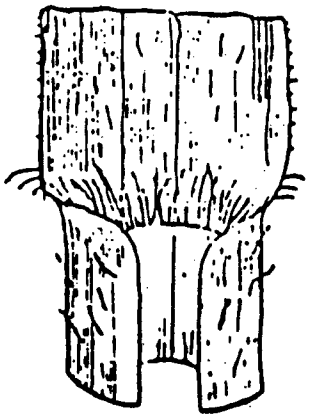



"1992 KY-IPM FIELD CROPS"

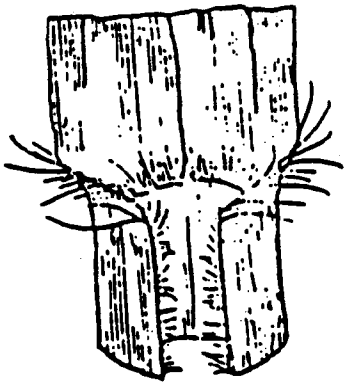
# IDENTIFICATION OF COMMON WEEDY GRASSES BY VEGETATIVE CHARACTERISTICS

| GRASS | VEGETATIVE CHARACTERISTICS | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Ligule | | Sheath | | Blade | | | |
| | None | Hairy | Membrane | Smooth | Hairy | Smooth | Hairy | Rough |
| Large crabgrass | | | X | | X | | X | |
| Smooth Crabgrass | | | X | X | | X | at base | |
| Giant foxtail | | X | | X | | | | X |
| Green foxtail | | X | | X | | | | X |
| Yellow foxtail | | X | X | X | | X | at base | |
| Goosegrass | | | X | | at top | X | at base | |
| Johnsongrass | | x fused | X | X | | X | | |
| Fall panicum | | at base | | X | | X | | |

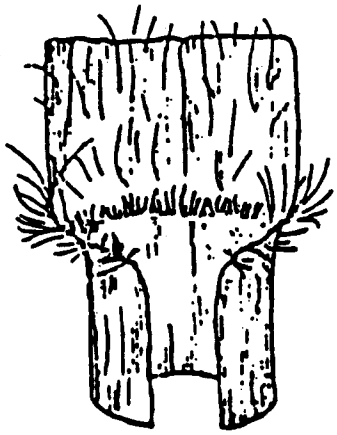
Note: These are the usual characteristics, however, there may be variations.



GIANT FOXTAIL

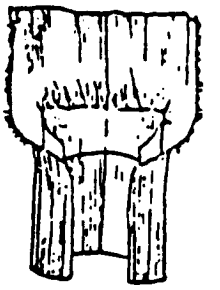


GREEN FOXTAIL

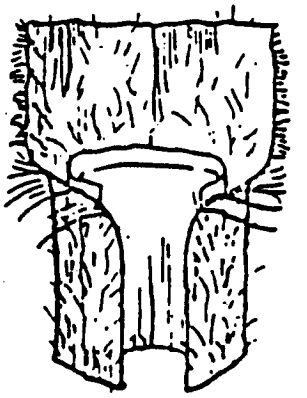


YELLOW FOXTAIL

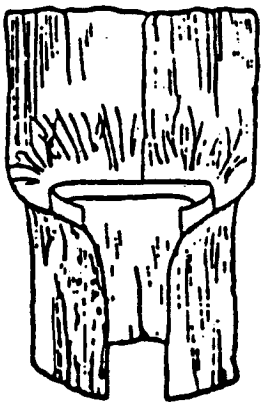
WILD CANE



LARGE CRABGRASS



SMOOTH
CRABGRASS



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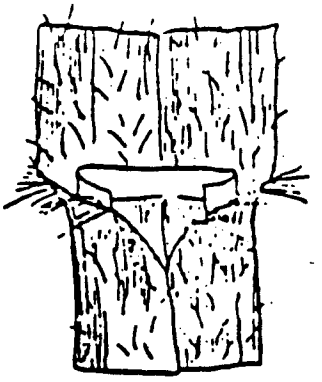
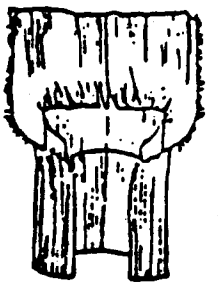
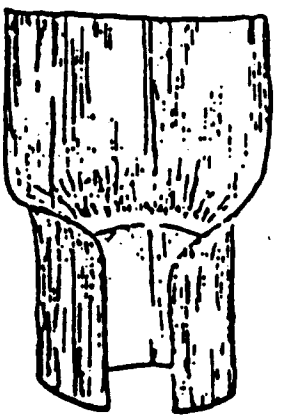


GOOSEGRASS



JOHNSONGRASS



FALL PANICUM

# IDENTIFYING CHARACTERISTICS FOR CERTAIN SEEDLING BROADLEAF WEEDS

| | Cotyledon | Leaf | Other |
|---|---|---|---|
| 1. Chickweed | Small and thick<br>Oval shaped<br>Pointed tip | Oval shaped<br>Pointed tip<br>Opposite | |
| 2. Cocklebur | Thick<br>Long and Narrow | Oblong<br>Toothed edges<br>Alternate | |
| 3. Cucumber, Wild | Thick<br>Oblong | Somewhat lobed<br>Alternate | Viney Stem |
| 4. Eastern Black Nightshade | Small and Spoon shaped | Oval shaped<br>Alternate | Lower surfaces of leaves often purple |
| 5. Henbit | Round | Round shaped<br>Toothed margins<br>Deep crevices in surface<br>Opposite | Square stem |
| 6. Honeyvine Milkweed | Heart-shaped<br>Opposite | Viney stem<br>Long stem | |
| 7. Hophornbean Copperleaf | Oval shaped<br>Toothed margins<br>Opposite | | |
| 8. Jimsonweed | Thick<br>Long and narrow | Heart-shaped with smooth edges near base and irregular edges at tip<br>Alternate | Pungent odor |
| 9. Lambsquarters | Small and Narrow | First 2 leaves are opposite and subsequent leaves are alternate | Leaves appear white, especially on underside |
| 10. Morningglory Bigroot | Butterfly shaped with long narrow blades | Heart-shaped<br>Hairless<br>Alternate | Viney stem<br>Established plants develop large perennial root |
| 11. Morningglory, Entire leaf | Butterfly shaped | Heart-shaped<br>Hairy<br>Alternate | Viney stem |
| 12. Morningglory, Ivy leaf | Butterfly shaped with prominent veins | 3-lobed<br>Hairy<br>Alternate | Viney stem |

| | Cotyledon | Leaf | Other |
|---|---|---|---|
| 13. Morningglory, Pitted | Butterfly shaped with long narrow blades | Shape is variable<br>Hairless<br>Alternate | Stem and leaf margin often purple<br>Viney stem |
| 14. Morningglory, Tall | Butterfly shaped with prominent veins | Heart shaped<br>Alternate | Viney stem |
| 15. Pigweed, Redroot | Narrow and about 1/4 inch in length | Oval Shaped<br>Alternate | Taproot is red<br>Stems are hairy |
| 16. Prickly sida | Oval shaped<br>3 veins on upper surface | Oval shaped<br>Toothed margins<br>Alternate | 2 to 3 spiney projections below each node |
| 17. Ragweed, Common | Thick, spoon-shaped and small | Deeply divided<br>Hairy<br>Opposite | Emits a strong odor when crushed |
| 18. Ragweed, Giant | Thick<br>Spoon-shaped | Develop lobes with growth<br>Opposite | |
| 19. Shepherdspurse | Fleshy<br>Small (2-3 mm)<br>Round shaped | First leaves are round, other leaves are somewhat lobed | |
| 20. Smartweed, Ladysthumb | Fleshy<br>Narrow<br>3/4 inch long | Oblong and pointed<br>Alternate | Membrane sheath at node is hairy |
| 21. Smartweed, Pennsylvania | Fleshy<br>Narrow<br>3/4 inch long | Oblong and pointed<br>Alternate | Membrane sheath at node is hairy |
| 22. Velvetleaf | Fleshy and oval shaped<br>Small hairs | Pubescent on leaf and stem<br>Alternate | Pungent odor |

# Scouting Procedures For Diseases In Canola

*Donald E. Hershman*

The following canola diseases have been documented in Kentucky and have the potential for causing serious crop losses.

## Sclerotinia Stem Rot

Examination Period: Every week beginning in the spring just after flowering and continue until harvest.

Symptoms: Stem rot is characterized by narrow-elliptical, slightly sunken, light tan to gray lesions usually in the mid to lower stem. Cankered areas of stems are easily crushed and resting bodies of the fungus (sclerotia) will be found within the stem cavity of the affected plants. The bodies of fungus will be hard, black and irregular in shape (1/8 to 1/2 inch long by 1/8 to 1/4 inch wide). The fungus may also develop on the outer stems of plants under extremely humid/wet conditions. Infected plants generally ripen prematurely and may suffer severe lodging.

Occurrence: Symptoms appear from May onwards. Stem rot is most common in dense, vigorously-growing canola stands, especially where continuous canola production is common. High stem rot levels are also associated with severe annual weed problems in sparse crops.

Rating Scale:
0 = no disease;
1 = scattered diseased plants;
2 = small portions of field affected (groups of plants);
3 = large areas of field affected

Record: Record a rating of 0 to 3 for each site.

## Blackleg

Examination Period: Every four weeks from planting up to harvest.

Symptoms: The fungus will infect plants during extended periods of wet weather. Infections can occur on all plant parts but are most common on the leaves and stems. Leaf spots are light green to off-white, circular (1/8 - 1/2 inch diameter) and bear numerous black pimple-like structures (pycnidia).

Leaf and stem infections result in canker formation. Cankers can occur anywhere on the stem, but are most common at the base. They have a distinct brown to purple-black margin with a tan center that contains pycnidia. As the season progresses, cankers enlarge and eventually girdle the stem, leading to the crop's premature ripening and to severe lodging.

Occurrence: The fungus survives in infected woody canola stubble and produces airborne spores from late summer onward. The spores infect canola during extended periods of wet weather. Stem infections are occasionally seen in the early spring, but usually appear towards the end of flowering in late May.

Infested seed is the primary way to bring blackleg into an uninfested area. Preventive measures should include sowing only certified seed that has been treated with benomyl.

Rating Scale:
0 = no disease;
1 = scattered diseased plants;
2 = small portions of field affected (groups of plants);
3 = large areas affected, severe lodging in crop.

Record: Record a rating of 0 to 3 for each site.

**Alternaria Black Spot**

Examination Period: Every four weeks from planting through harvest.

Symptoms: All above-ground plant parts are susceptible to infection. The most common symptoms will appear on the leaves, pods and stems supporting the pods. Leaf spots can be found any time the crop is in the ground and range from small black spots the size of a pinhead, to larger spots with concentric rings up to ¼ inch in diameter. The spots can range in color from gray to black, depending on the weather. Spots may or may not have a purplish to black border. The most serious phase of the disease occurs when infections spread to newly set pods. Spots, similar in appearance to leaf spots, discolor and weaken the pods and seed. This results in premature ripening and seed shrinkage, followed by shattering.

Occurrence: The fungus overwinters in infected crop residue, on or in seed and in certain weeds such as wild mustard. The disease is favored by early maturation, lodging, insect damage to the pods, and by warm, wet conditions during flowering.

Rating Scale:
0 = no disease;
1 = scattered plants showing minor leaf and/or pod infection;
2 = most plants showing low to moderate leaf and/or pod spotting;
3 = severe leaf/pod spotting common throughout the field.

Record: Record a rating a rating of 0 to 3 for each site.

**Minor Diseases of Canola**

The following canola diseases are known to occur in Kentucky, but are presently considered to be of minor importance.

Gray Mold

Gray mold occurs worldwide on many different crop plants. Infections usually start on tissues damaged by frost or other agents such as insects or fertilizer. However, the fungus can infect undamaged plant parts when these come in contact with infected tissue. Avoiding crop damage is the surest way to reduce losses due to gray mold.

Gray mold can be recognized by the development of a fuzzy, gray mold developing on injured tissues during humid or wet weather.

Powdery Mildew

Powdery mildew can be recognized by the white dusty growth of the casual fungus on all above-ground plant parts. Generally the disease is favored during periods of moderate temperatures and high humidity.

In Kentucky, powdery mildew develops in the canola crop well after flowering, usually in late May. Excess nitrogen fertilization and canopy density are also favorable to the development of powdery mildew.

Damping-off Diseases

These diseases occasionally cause damage by rotting seed or seedlings shortly following germination. Losses, while rarely serious, usually occur when seed are planted under adverse soil conditions, especially excessively cool, wet soils. Planting seed too deep may increase the incidence of damping-off. The risk of damage due to damping-off can be greatly reduced by avoiding adverse soil conditions when planting. Using fungicide seed treatments such as captan or benomyl offers only limited protection against damping-off diseases.

Winter Decline Syndrome

A rot of the roots and crowns of canola has been seen sporadically in Kentucky. Damage caused by various soil-borne fungi and bacteria, is associated with weakened or winter-damaged plants especially in fields unsuited to canola production(i.e. poor drainage, etc.). Severe maggot infestation in these plants is also common and leads to further deterioration of the roots and crowns. Affected plants may die or suffer severe lodging. This results in premature ripening and problems with shattering.

Aster Yellows:

This disease is caused by an organism that is somewhat intermediate between a bacterium and a virus; it is quite common and can affect at least 300 plant species. The organism causing Aster Yellows is apparently spread during the feeding activities of leaf hoppers.

Infected plants fail to set pods or develop sterile, hollow bladders in place of normal pods. Although symptoms due to aster yellows are quite noticeable, only negligible yield damage has been associated with it in Kentucky and elsewhere.

Downy Mildew

The downy mildew fungus causes yellowing in irregular patches on upper leaf surface; this frequently gives the leaf a stippled appearance. Areas on the undersides of leaves corresponding to the yellow patches on the upper surface will have a white, somewhat granular appearance. Affected areas usually become bleached with age. The disease is occasionally seen as sparse wefts of fungal growth on stems and pods. In Kentucky, downy mildew usually shows up in the crop following spring infections, which cause little damage. More severe damage, generally in the form of reduced winter hardiness, is usually associated with seedling infection in the fall.

Occasionally, a disease know as staghead is seen in some canola fields. Staghead is the result of dual infection by the downy mildew fungus and another disease organism, ***Albugo candita***, the cause of a minor but common disease called white rust. When both fungi infect canola, the terminal parts of flower stalks turn brown and hard and dry up. Portions of individual flowers may also become distorted.

Black Rot

Black rot is a bacterial disease which affects canola. Infected leaves develop a bright yellowish discoloration in their margins. Leaf veins in infected areas appear as dark in color. The causal bacterium is seed-borne and overwinters in infested canola stubble and in residue from other susceptible crops. Bacteria enter pores in leaf surfaces during periods of wind and splashing rain.

Although the symptoms of black rot are quite visible and can cause great alarm to the producer, the disease has so far caused very little damage.

# Agronomic Measures

*Jim Herbek and Lloyd Murdock*

## Identifying Compacted Soil

Most compaction results from the use of machinery on soil which is too wet to work well, or from overworking soil and destroying its natural structure. Pressure from tires and tillage tools compress more soil into a given volume. In the process, the natural soil aggregates are broken down and large pores become smaller.
This generally causes the soil to be more difficult for plant roots to penetrate.

A tiling rod or a three foot length of 3/8-inch diameter steel rod sharpened on one end and having a handle welded to the other end are easy tools to use in identifying compacted layers. Such tools should be marked in six inch increments and should uniformly be pushed into the soil when the moisture content is too wet for tillage. Under these conditions, compacted layers can be "felt" due to resistance in pushing the rod through the soil, and depth to and thickness of the compacted zone can be identified.

The best method for identifying soil compaction is with a soil penetrometer. This is similar to a tiling rod but has a gauge that measures the amount of pressure required to push the rod into the soil. An Annual Field Compaction Record Sheet is on page 175 and gives instructions on how to use the penetrometer and how to make a field recording.

Regardless of the method used, a number of sites in each field should be checked (similar to a soil test) and if severe compaction is found it needs to be confirmed. In addition to a compacted soil, the penetrometer will give high readings for a dry soil and heavy clay layer. Therefore, if severe compaction is found in a field then a soil probe or shovel needs to be used to look at the layer that was found compacted and confirm that high readings were not due to a clay or dry layer.

# GROWTH STAGES OF WINTER CANOLA

| GROWTH STAGE | DESCRIPTION |
|---|---|
| Pre-emergence | Seed planted but prior to plant emergence. |
| Seedling | Plant has emerged (4 to 10 days after seeding). Two leaf-like cotyledons at the top of the stem have unfolded and expanded. |
| Rosette | Seedling develops its first true leaves (occurs within a week after emergence). The plant grows rapidly forming a dense canopy of leaves and establishes a rosette with older leaves at the base increasing in size, and smaller, younger leaves developing in the center.<br><br>Leaf Count can be recorded as they develop and expand. A plant can have from 2 to 8 or more leaves developed prior to winter dormancy depending on planting date and other management factors. |
| Winter Dormancy | Growth slows; plants become dormant as temperatures drop in late fall and winter. Leaves discolor and also die as much of the leaf tissue is frozen. |
| Spring Regrowth | Growth resumes in early spring as temperatures increase. New leaves develop near the soil surface from the plant crown. |
| Budding and Bolting | A cluster of flower buds becomes visible at the center of the rosette and rises as the stem rapidly "bolts" or lengthens. Secondary branches arise from axils of upper leaves of the main stem and also develop flower buds. Bolting usually lasts 1-2 weeks. |

Flowering

Flowering begins when the lowest bud(s) opens on the main stem. Flowering continues upward with 3 to 5 or more flowers opening per day. Flowering on branches usually begins 2-3 days after initial flowering on the main stem. During flowering the plant continues to grow and develop new buds. Flowering normally lasts about 3 weeks depending on weather conditions.

Within 3-5 days after a flower has opened, the flower petals wilt and drop and a young pod will be visible if the flower has been pollinated and fertilized. Seed pods develop from the bottom of the flower cluster and proceed upward since the first buds to open on main stems and branches are the lowest buds. During flowering, there will be pods, flowers, and buds occurring simultaneously on plants with pods on the lowest part of stems and branches; open flowers above them; and above the flowers, buds which are yet to open. By mid-flower, lower pods have started to elongate. By the time flowering is complete; lower pods have started to fill with the seed enlarging.

The % flowering stage can be determined by counting the opened buds (flowers and pods) on the main stem in relation to the total number of buds (opened and unopened). As a general rule, at 30% bloom there are at least 20 open flowers on the main stem.

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Ripening

The ripening stage begins with the petal falling from the last formed flower on the main stem. Canola ripens from the bottom of the main stem and branches and continues upward. Thus, pods at the bottom may reach maturity while pods at the top are still developing. At the beginning of this stage, flowering may still be continuing on some of the later, secondary branches.

During seed development, seeds attain full size quickly. At full size, the seed initially is somewhat

translucent (resembling a water-filled balloon). At this time, the seed's embryo begins rapid development within the seedcoat filling the space occupied by fluid. This results in a firm, green seed and an increase in seed weight. About 35 to 45 days after a flower has opened, seed filling is complete.

Seed filling is followed by a maturing stage characterized by plant color changes. By the time flowering has finished, most leaves, pods, and stems have turned yellow. Seeds, contained in two rows in the pod divided by a membrane, complete filling (physiological maturity) at about 40% moisture and then slowly turn color from green to brown to black. When 30 to 40% of the seeds on a plant have begun to show seed color change to brown or black, the average seed moisture is about 30 to 35%. When all the seeds in all pods have changed color, the plant dies.

# DETERMINING PLANT POPULATIONS IN CANOLA

After the canola has emerged, a stand count should be made to determine the plant population achieved.

**When to make counts**:

Normally, fall stand counts can be made 1-2 weeks after emergence. However, factors such as weather (dry soil, etc.) may delay or prolong emergence so that stand counts may need to be delayed. Fall counts should be made only after it has been determined that all potential plants have emerged. A spring stand count may also be needed, particularly if severe winter damage has occurred that has reduced the initial plant population obtained in the fall. These counts should be made after spring regrowth and prior to bolting.

**How to make counts**:

1. Plant populations will be determined on a plant per square foot basis.

2. Utilize a tape to make counts by placing the tape beside a row if drilled canola or forming a square if broadcast canola (See procedure for each as discussed below.)

3. Each count should consist of a total of 4 square feet.

4. Make a total of 10 counts in the field for each 50 acres or portion thereof, thus giving a total of 40 square feet for each 50 acres or less.

A. Broadcast canola: Plant populations for canola not planted in rows can be obtained by making counts of the number of plants contained in a four foot square area (a two foot x two foot square). Repeat this process in 10 locations in the field for each 50 acres or portion thereof for a total of 40 square feet for each 50 acres or less.

B. Drilled canola: Measure the distance between rows at several locations to determine row width used or check with the producer to find out the row width used. The following table lists the linear length of row needed, based on drill row width, to equal a four square foot area. Place the tape by a row and count the number of plants in the length of row needed for 4 square feet based on the row width. Repeat this process in 10 locations in the field for each 50 acres or portion thereof for a total of 40 square feet for each 50 acres or less.

| Row Width (Inches) | Linear length of row in **INCHES** needed for: 1 square foot | 4 square feet |
|---|---|---|
| 5 | 28.8 | 115.2 |
| 6 | 24.0 | 96.0 |
| 7 | 20.6 | 82.4 |
| 8 | 18.0 | 72.0 |
| 9 | 16.0 | 64.0 |
| 10 | 14.4 | 57.6 |
| 12 | 12.0 | 48.0 |

**Determining Plant Populations**: Divide the total number of plants obtained in 40 square feet by 40 to determine the number of plants per square foot and record on the report form.

Example: Number of plants in 40 square feet = 285

285 ÷ 40 = 7.1 plants per square foot.

When more than 50 acres are involved in a field, determine the plant population of the field by averaging the plant populations obtained for each 50 acre portion.

Also, draw a map of the field indicating the location of each 50 acres or portion thereof counted and the plant population obtained in each location.

It is best to make counts in representative areas of the field. However, if areas of the field are quite different in respect to stands, these areas should be counted and noted separately.

Canola plant populations may range from 1 to over 10 plants per square foot. An optimum population is considered to be 5 to 7 plants per square foot.