

KENTUCKY INTEGRATED CROP MANAGEMENT MANUAL FOR SMALL GRAINS

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For additional and current information please consult the following web sites:

For more IPM information and links to many pest and crop management sites view the IPM web page at: <http://www.uky.edu/Agriculture/IPM/ipm.htm>.

For the most current information on Pests view the Kentucky Pest News at:
<http://www.uky.edu/Agriculture/kpn/kpnhome.htm>.

For up-to-date weather and crop and pest models view Ag-weather at:
<http://www.agwx.ca.uky.edu/Kyagwx.html>.

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PREFACE

Agriculture is the world's most important industry. This level of importance will continue due to 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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SMALL GRAIN SCOUTING

The following table indicates the type of monitoring locations required for each pest group when scouting small grains.

The procedure to follow each week once these locations have been established is given in the right side of the table.

<u>Pests</u>	<u>Monitoring Stations</u>	<u>Procedure/Location</u>
Insects	Random	various
Weeds	Random	600 square feet
Diseases	Random	15 foot radius

The number of sample locations for a given field size.

<u>Field Size</u>	<u>No. of Locations</u>	<u>Field Size</u>	<u>No. of Locations</u>
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
125-135	12	275-284	24
135-150	13	285-300	25

ALSO SEE: ENTFACT-118, Procedure for Selecting Random Locations for Sampling.
<http://www.uky.edu/Agriculture/Entomology/entfacts/pdfs/entfal13.pdf>

Insect Pests

Douglas W. Johnson

Major Pests

Time of Occurrence

Aphids

Adults and nymphs can damage plants anytime after plant emergence. Large numbers of aphids can reduce stands during late fall and early spring or cause kernels to shrivel during late spring and early summer. Also, some species have been linked to the transmission of diseases such as Barley Yellow Dwarf. (Several

Scouting Procedures for Insects in Small Grains

Armyworm (aka True Armyworm)

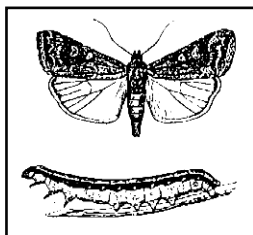
(Note: This is not the fall armyworm that may infest small grains in the fall.)

Occurrence: Mid-April to late May. Luxuriant or lodged vegetation in low wet areas is especially susceptible to attack. Cool, wet springs favor armyworm development.

When to scout: Mid-April through harvest.

Description:

Larvae are greenish brown with a narrow, middorsal stripe and two orange stripes along each side. The yellowish head is honeycombed with dark lines. Armyworms are about 1 ½ inches long when full grown.



Damage: Armyworms are primarily leaf feeders. However, they will feed on awns and tender kernels and may clip off the seed head. Infestations are more common in barley than in wheat. Armyworms may feed on oats, rye and some forage.

How to scout: Scout each field at least once a week. Sample the entire field; check five locations per 50 acres of field size. (See table on page 1).

First, check field margins and lodged grain. If armyworms are present begin surveying in the standing grain. Armyworms feed during late afternoon, night and early morning. They may be on the ground when you are in the field.

Enter at least 30 paces into the field before sampling. Pick the sample spots randomly. Look at the leaves for signs of chewing damage. Armyworms feed from the edge of the leaf in towards the mid rib. Examine the ground for dark fecal droppings. During the day, armyworms usually hide under surface litter or in soil cracks. Note average larval length. Walk to the remaining locations and repeat the process.

Record: Record the number of worms present in each four square foot area sampled. (See table on page 1 for number of sample sites.) Note the average length of the armyworms in each four square foot area.

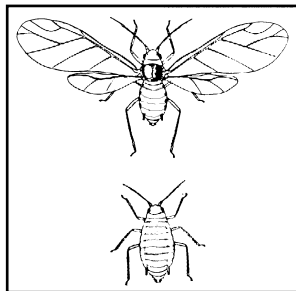
Economic Threshold: An average of 16, ½ to ¾ inch long armyworms per four square foot sample.

Comments: Worms longer than one inch have completed most of their feeding. If the grain is nearly mature and no head clipping has occurred, then controls are not advised. Warm spring weather favors **parasite and disease** development. Note the percentage of worms parasitized or diseased on the form.

Aphids

Occurrence:
Aphids can damage plants anytime after plant emergence.

When to scout: Fall and spring until hard dough.



Description: Aphids are small, soft-bodied, pear-shaped insects. Their piercing-sucking mouthparts look like a small tube arising from under the head. They vary from green to blue to yellow.

Damage: Feeding by aphids commonly found in Kentucky may cause two types of damage: 1. Direct damage of the aphid feeding on the plant and 2. Indirect damage as a result of moving a plant virus, primarily Barley Yellow Dwarf Virus (BYDV) into the plants. The BYDV damage will result in stunting and yellowing of the plants and may result in severe yield loss. The damage due to direct feeding is usually confined to the “head filling” stage and will result in low test weights.

Always be on the lookout for new aphid pests. Currently, feeding by aphids present in Kentucky produces little visible damage during the time of feeding. If you see a situation that produced dead or dying plants, tightly rolled leaves, and/or severe yellowing, be sure to collect the aphids and have them identified. The yellow sugarcane aphid and the Russian wheat aphid, currently are **not** present in Kentucky, but are never the less potential pests.

How to scout: Scout in the fall and in the spring before leaf emergence. (See

Growth Stages of Small Grains.) At each location examine 3 one-foot lengths of plants. Count the number of aphids on each sub-sample. Be sure to look over the entire plant especially near the soil line. Record the average number of aphids per 1 row-foot. This sample is for making decisions relative to movement of BYDV. Be sure to label your records “counts”.

In the spring, after heads have emerged, at each location examine 10 heads for the presence of aphids. Record a rating of infestation based on the number of aphids per plant:

<u>Rating</u>	<u>Number of Aphids</u>
0 -	none
1 – slight	<50
2 – moderate	50-100
3 – severe	>100

This examination is for direct damage done by aphids to grain test weights. Be sure to label these records as “Ratings”.

Decision Threshold: In the fall and during a warm winter (before Feeke’s growth state 4) when trying to reduce risk to BYD loss consider an insecticide application if aphid populations meet or exceed these values. (Advise the decision maker to consult ENTFACT 121: Aphids and Barley Yellow Dwarf on Kentucky Grown Wheat.)

Action thresholds for Aphid control to prevent/reduce incidence of Barley Yellow dwarf:

- Plant emergence to 30 days post – 3 aphids per foot of row
- 30 to 60 days post emergence – 6 aphids per foot of row
- More than 60 days post emergence – 10 aphids per foot of row

Applications at Feekes growth stage 4 or later are not recommended.

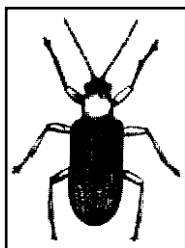
In the spring during “headfilling” when using rating scale for direct aphid damage, a control should be considered if an average rating of 2 (moderate) or greater is recorded.

Cereal Leaf Beetle

Occurrence: April to maturity.

When to scout: April until maturity.

Description: Adults are shiny black beetles with red legs and thorax, approximately ½” long. Larvae are pale yellow and soft-bodied. They “glue” pieces of trash and leaf on their backs as camouflage.



Damage: Adults and larvae eat out long narrow strips of tissue between veins.

High Management Strategy – (for high yield potential)

When to Scout: Begin scouting at GS 7 (two nodes present). This will generally be in very late March or early April but will vary some with the season.

How to Scout: Samples of 10 tillers should be examined at each of 10 randomly selected sites (100 stems per field). The sites should be representative of the field as a whole. Check all the leaves and stems for cereal leaf beetle eggs and larvae (grubs).

Record: Count and record the number of eggs and larvae found on

each tiller. Calculate the total number of eggs and larvae found.

Threshold for egg/larval Counts: Treat if you find any combination of 25 or more eggs and/or larva total per 100 tillers. (An average 1 per every four tillers or 0.25 per tiller).

Scouting Frequency: Under the high management system, you want to catch the cereal leaf beetle population at a time when most of the eggs have been laid. If your counts indicate that more than 50% of the CLB are in the egg stage, then sample again in 5 to 7 days. Once your counts indicate that more than 50% of CLB you are finding are larva or adults, then you do not need to sample again. Use these counts to compare to the thresholds for making control decisions.

Low to Moderate Management Strategy

Larval and Adult Counts: If you are unable to complete the egg/larval sampling scheme, then you should examine the crop for larval/adult damage when the flag leaf is present. This procedure will prevent most yield reduction; however, it is not as sensitive as the egg/larval method recommended for the high management strategy.

When to Scout: Begin by at least GS 8 (Flag) and continue through GS 10.5 (Flowering).

How to Scout: Examine 10 head-bearing stems at a minimum of one location for each 10 acres of field size. Look carefully at the top three leaves (Flag, F1 and F2) on each head-bearing stem, for CLB larvae and/or adults.

Record: The number of larvae and/or adults on ten stems.

Threshold: Treat if you find an average of ½ larva and/or adult per head bearing stem. (Or one larva and/or adult for every two head bearing stems.)

CLB Insecticide management: The optimum time to apply insecticides (if the threshold is reached) is from after the appearance of the flag leaf (GS 8) until the head emerges (GS 10.1).

Do not apply insecticides if the threshold is not reached. Many wheat pests are held in check by natural enemies. When you apply an insecticide, these natural enemies will be killed.

Do not put an insecticide in with nitrogen application. This occurs too early. You will not get optimum control.

Consider if other insect pests are present when choosing an insecticide. Depending upon the pest pressure, you may choose one insecticide over another.

Fall Armyworm

(Note: This is not the “True” armyworm that may infest small grains in the spring.)

Occurrence: Fall Only – FAW migrates into our area each year from the gulf coast area during June and July. It does not overwinter in Kentucky. However, it can remain active until a solid freeze or at least a very hard frost. Normally, the pest is not much of a factor in small grains but on occasion it can be important.

When to scout: From plant emergence until freeze or heavy frost.

Description: Fall armyworm vary from light tan to black with three light yellow stripes down the back. There is a wider dark stripe and a wavy yellow-red blotched stripe on each side. Larvae have four pairs of fleshy abdominal prolegs in addition to the pair at the end of the body. Fall armyworm resembles both armyworm and corn earworm, but fall armyworm has a white inverted “Y” mark on the front of the dark head. The corn earworm has an orange-brown head, while the armyworm has a brown head with dark honeycombed markings. Fall armyworm has four dark spots arranged in a square on top of the 8th abdominal segment. You are VERY unlikely to see either true armyworm or corn earworm in small grains during the fall.

Damage: Fall armyworms are leaf feeders on small grains in the fall. They will generally “graze” off the above grown tissue which can result in the death of young seedlings, but usually do not kill established plants. The damage may appear like deer or rabbits so it is important to find the insect in order to be sure of the pest.

How to scout: Scout each field at least once each week, checking five locations per 50 acres of field size. (See table on page 1.) At each location examine the plants looking for “cut off” or “grazed off” plants. This will likely appear in a “patchy” pattern. The insects do not burrow in the ground, but will hide under residue. Count the number of insects (worms) ½ - ¾” long per square foot. Average these counts for the field, or infested areas.

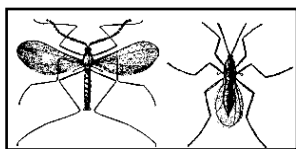
Economic Threshold: There is no real threshold for this pest. In pastures, a general number of 2 or more worms ½” to ¾” long, per square foot is used. Certainly, in high quality small grains, populations should not be allowed to exceed this, unless a killing frost is eminent. This pest should only be controlled for grains managed for “high-yield” potential.

Hessian Fly

Occurrence: Both fall and spring infestations may occur.

When to scout: Early spring until June. In the Fall, survey fields one time after first frost.

Description: The Hessian fly adult is a small white fragile fly. The larvae is a very small white legless maggot. The larval stage is damaging and may be found between the leaf sheath and the stalk. However, the pupal or “flax seed” stage may be found if an infestation has occurred. This is a small brown seed-like pupal case, usually found at the base of the plant between the leaf sheath and stalk.



Damage: A fall infestation can result in stand loss and broken (lodged) plants. Spring infestations usually result in plants of reduced vigor and bad color.

How to scout: Look for thin, stunted, chlorotic patches in the field. Examine the base of these plants for presence of the “flax seed”.

Record: Record the number of “flax seed” found per ten stems examined at each sample site. Not the presence of adults or larvae.

Economic Threshold: Consult your supervisor or county agent on a case by case basis. There is no rescue treatment; however, preventative measures may be used to avoid future infestations.

For Additional Information See:

Entfact – 101, Hessian Fly in Kentucky
<http://www.uky.edu/Agriculture/Entomology/entfacts/pdfs/entfa101.pdf>

Entfact – 107 Cereal leaf beetle in Kentucky wheat.
<http://www.uky.edu/Agriculture/Entomology/entfacts/pdfs/entfa107.pdf>

Entfact – 111, Armyworms in Small Grains
<http://www.uky.edu/Agriculture/Entomology/entfacts/pdfs/entfa111.pdf>

Entfact – 117, Wheat Streak Mosaic Virus and the Wheat Curl Mite
<http://www.uky.edu/Agriculture/Entomology/entfacts/pdfs/entfa117.pdf>

Entfact – 121, Aphids and Barley Yellow Dwarf (BYD) in Kentucky Grown Wheat
<http://www.uky.edu/Agriculture/Entomology/entfacts/pdfs/entfa121.pdf>

Weed Scouting in Wheat

James R. Martin

I. When To Scout For Weeds: Ideally it is helpful to monitor wheat fields periodically to observe for the development of weed problems. Indicated below are periods of time that are especially critical to monitor for weeds in wheat:

A. Mid to late October. Near the time of planting, especially in no-tillage plantings, observe for cool-season weed species that may cause problems in wheat.

B. Mid to late November (about 1 month after planting). Once wheat has emerged observe for cool-season annuals such as common chickweed, henbit, or ryegrass that begin to emerge during early fall and become too large to control with spring applications of herbicides.

C. Early March to early April. Begin soon after winter dormancy but before plants are jointing, because many herbicides are applied after tillering but before jointing stage of the small grain.

D. Late May to early June. After wheat has headed, observe for warm-season weeds emerging. A preharvest treatment after hard-dough stage may be needed for weed control or to improve harvesting efficiency of wheat, especially where weed infestations are heavy and wheat stands are poor.

II. Procedures: The scouting procedures for weeds in wheat involve 1) Collecting specific information such as infestation level and size of major weed species present at various random survey sites across the field and 2) Developing a general weed map of the wheat field.

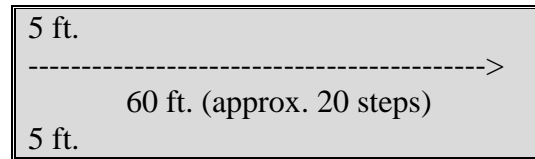
A. Survey Site Procedures:

1. Randomly select survey sites so that they will be representative of the entire field. Do not survey within 100 feet of a fence or roadway. The number of sites will vary according to the field size:

Field Size (acres)	No. of locations
1 – 20	3
20-30	4
30 – 40	5
40 – 50	6

At each survey site within the field, walk forward 60 feet (approximately 20 steps) and observe for weeds occurring

within 5 feet of either side. Each site should be approximately 600 ft². (See diagram below.)



2. Information to Collect:

- a. **Weed size:** Record average size of each weed species present. Information about the size of each weed species present can help growers select herbicide options and determine when to treat.
- b. **Percent weed cover:** Estimate the percent ground cover that is occupied by weed species (except wild garlic) that are present at each survey site. A general guideline for estimating ground cover is light (1 to 5%), moderate (6 to 30%), severe (>30%). It may help to first visualize the total percentage that is occupied by all weeds, then estimate percentage of each weed species in order that the sum of all species will equal the total. For example, if you estimate a site has approximately 20% total weed cover and you determine that common chickweed occupies about half of the weed cover whereas the infestation of henbit and annual ryegrass are about equal, then common chickweed accounts for 10% and henbit and ryegrass each occupy 5% ground cover.

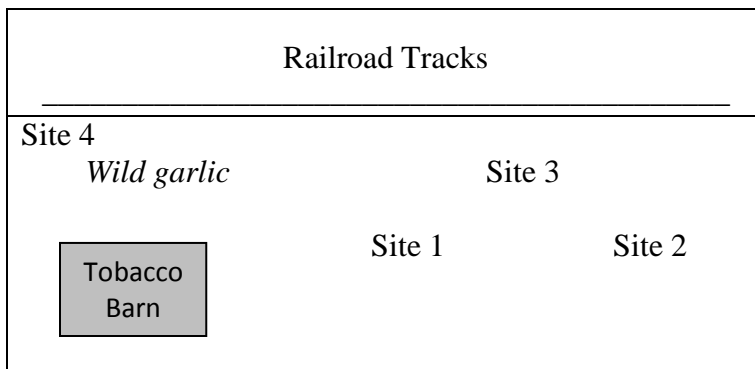
Wild garlic counts: Wild garlic reduces seed quality by contaminating the small grain with aerial bulblets during harvesting. This usually results in a severe penalty in the price received for the grain. Be especially observant for this weed and estimate the infestation of wild garlic at each site as light (≤ 3 plants/600 ft²), moderate (4 to 25 plants/600 ft²), or severe (>25 plants/600 ft²). It is not necessary to count all wild garlic that grow in clusters of small plants. Most of these plants will not develop aerial bulblets and thus are not a problem. Focus primarily on plants that are present as a single plant, and count each cluster of small plants as single plants.

Economic thresholds for weeds in wheat are not well defined, however there may be situations where general guidelines can be of help to some growers.

B. Weed Map Procedures:

- 1 Outline the general shape of the field and indicate approximate locations of fences, roads, buildings, 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. Indicate any weed problems on the map that will help in making management decisions. The following example can be used as a guide in preparing a “weed map” of wheat fields.

A weed map can help chart special weed problems and may isolate areas of the field that need treatment. The map can also be a useful reference for planning future weed management programs.



Weed Identification

Correct identification of weeds during early stages of plant development is helpful in selecting and initiating control strategies in a timely manner. Many Weed species look similar during early stages of development. Vegetative characteristics such as shape, color, and arrangement of leaves, and location of pubescence (hairs) can aid in identification, providing these

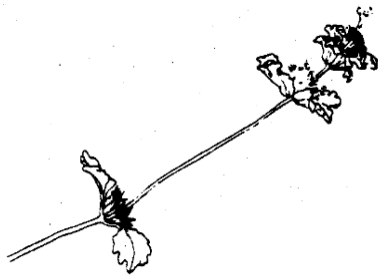
characteristics remain consistent under a wide variety of conditions. However, it is not unusual for vegetative characteristics of some weed species to vary, and thus, are not always reliable for identification.

The following are key identifying characteristics of a few major problem weeds that occur in wheat in Kentucky.

Henbit

(Lamium amplexicaule)

- Cool-season annual.
- Decumbent growth with ascending branches.
- Leaves are opposite with indented margins.
- Square stems.
- Purple deadnettle is a similar species but has Leaves that tend to be reflexed downward.



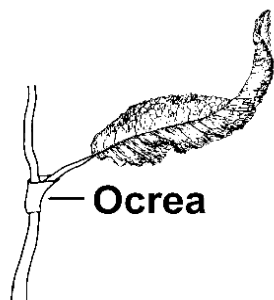
Common Chickweed (*Stellaria media*)

- Cool-season annual.
- Grows prostrate.
- Leaves are opposite and oval in shape and may be smooth or hairy toward the base.
- Stems may have hairs arranged in lines.
- Mouseear chickweed is a similar species but grows as a perennial and is very pubescent.



Curly Dock (*Rumex crispus*)

- Perennial with deep yellow-orange taproot.
- Produces seed in the spring.
- Grows erect and unbranched.
- Leaves are glabrous with waved and crimped edges.
- Ocrea (membranous sheath) at base of stem petioles.



Wild Garlic (*Allium vineale*)

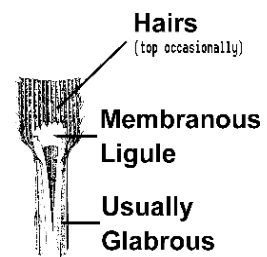
- Perennial.
- Leaves are nearly round, hollow and attached to lower half of stem.
- Underground bulbs.
- Aerial bulblets occur in a cluster(s) at the top of the plant.
- Wild onion is a similar species but its leaves are flat and are not hollow.



Cheat (*Bromus secalinus*)

- Cool-season annual.
- Grows 1 to 3 feet in height.
- Leaf blade with or without hairs.
- Leaf sheath usually glabrous.
- Hairy chess, field brome, and downy brome look similar to cheat but have hairs on leaf blade and sheath.

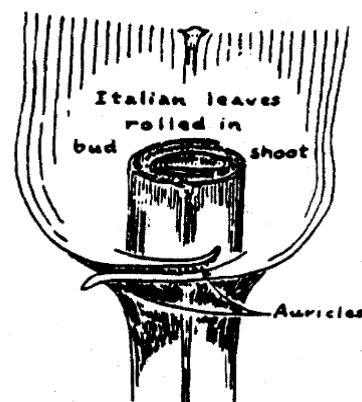
Seedhead



Italian Ryegrass
Annual Ryegrass
(*Lolium multiflorum*)

- Cool-season annual.
- Leaf blade glabrous.
- Leaf sheath glabrous and often shiny.
- Auricles present.

Seedhead



Small Grain Diseases

Donald E. Hershman and Paul R. Bachi

Observation Times For Small Grain Diseases

	Jointing		Boot	Heading	Ripening
	March	April		May	June
Leaf Problems					
Viruses	*****	*****		*****	
Leaf Blotch Complex		*****		*****	*****
Powdery Mildew		*****		*****	*****
Leaf rust		*****		*****	*****
Tan Spot				*****	*****
Take-All			***	*****	*****
Loose smut				*****	*****
Glume Blotch				*****	*****
Fusarium Head Blight				*****	*****

Viruses

Examination Period: Every four weeks from late March until full heading. With yourself as a focal point, examine plants by scanning a 15-foot radius. If stunted or discolored plants are observed, look closely at leaves for symptoms described below.

Symptoms: Many virus diseases occur on wheat, those most common in Kentucky are barley yellow dwarf virus (BYDV) and wheat spindle streak mosaic virus (WSSMV). Soil-borne wheat mosaic (SBWM) and wheat streak mosaic (WSM)

also occur, but more rarely. In general, virus-infected plants may be stunted and have streaks or mosaic patterns in leaves that become yellow or reddish in color. Infected plants may be single or in small groups, and be at edges of the field or throughout the field. Virus-infected plants do not generally follow a row pattern. When affected plants do follow row patterns or appears to be associated with high or low areas of the field, look for environmental causes (e.g., flooding), nutritional problems (e.g., application miss or change of soil type or chemical injury (e.g., faulty equipment or failure to clean out a sprayer).

Suspected virus problems should be confirmed by sending a diseased specimen to the Plant Disease Diagnostic Laboratory.

Occurrence: Look for virus problems to be most severe in early fall-planted wheat. Some of the viruses present in Kentucky are transmitted by aphids, soil fungi, and leaf curl mites. Virus infected plants are sometimes found to follow insect flight patterns, at edges of field, etc.

Rating Scale:

- 0 = no plants expressing virus symptoms;
- 1 = a few plants showing some stunting, streaking of leaves, or yellowing or reddening of leaf tips;
- 2 = several locations within 15-foot radius contain plants showing virus symptoms;
- 3 = more than one-third of plants appear to be virus infected.

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

Leaf Blotch Complex

Examination Period: Every two weeks from early April until flowering. Examine plants within a 15-foot radius.

Symptoms: Leaf blotch complex is the result of two distinct diseases caused by two species of fungi. The diseases may occur individually, but at some point in the season the two form a complex with both being present at the same time. General symptoms are oblong to lens-shaped lesions, often surrounded by a yellow halo, and with regular to irregular margins. Lesions caused by *Septoria tritici* are typically a rounded-rectangular shape with distinctly irregular margins. Lesions will have numerous black pycnidia dispersed throughout. Pycnidia are

spore-producing structures which, in the case of this fungus, are visible with the naked eye. Lesions caused by *stagonospora nodorum* tend to be more lens-shaped than rounded-rectangular, and usually have a distinct yellow margin. Lesions will have pycnidia, but these are difficult to see except by using a 20X magnifying lens and looking at lesions by holding diseased leaves up to light. Pycnidia will have a honey-brown color and are almost a perfect circle, with a dark brown center. Pycnidia of *S. nodorum* are 1/3 larger than those of *S. tritici*, but they are difficult to see because of their color and because they tend to be embedded in the leaf, as opposed to being superficial, as is the case with *S. tritici*. Both fungi may be in the same lesion, so specific identification is often difficult. Nonetheless, it is important to know when *S. nodorum* is present because this fungus also causes glume blotch later in the season. Thus, the presence of the fungus in a crop prior to heading is often used to determine the need for fungicide sprays to control glume blotch later in the season. If you are having difficulty distinguishing between the two species in the field, send samples to one of the Plant Disease Diagnostic Laboratories for species determination.

Occurrence: *Septoria tritici* infection is highly temperature dependent and requires rather cool, wet conditions in order to occur. Infection is independent of the stage of development. As a result, infections can occur anytime during the season, but are most common in the early half when temperatures are cooler. Infections by *Stagonospora nodorum* are independent of temperature, but are highly dependent on growth stage; specifically infections are most common and important from mid-season on, with disease being increasingly severe as crop maturity moves

forward. Leaf blotch complex tends to first develop on lower leaves and continues up the plant during disease-favorable conditions. Disease development will be slowed or stopped altogether during very dry periods.

Rating Scale:

- 0 = no leaves showing lesions;
- 1 = most plants containing lesions on lower third of leaves;
- 2 = lesions observed on leaves two-thirds of the way up the plant, some of lower leaves becoming totally necrotic and drying up;
- 3 = all plants have spot blotch lesions up to and including the flag leaf. Leaves half way up the plant are beginning to dry up.

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

Powdery Mildew

Examination Period: Every two weeks from early April until full heading. Examine plants with a 15-foot radius.

Symptoms: Upper (and to a lesser extent lower) surface of leaves and stems may contain white cottony fungal growth that later may turn to a dull gray-brown color. Yellowish patches may be seen on the other side of leaves directly opposite mildew areas. Distinct brown-black dots may be seen on older mildew-infected leaves. A white dust may be stirred up when walking through heavily infected fields. Wheat heads of susceptible varieties may also be infected.

Occurrence: Lower plant parts are usually first affected. Temperature between 60° and 72° F and high humidity are favorable conditions for disease

development. Dense stands, heavy nitrogen fertilization and rapid growth increase wheat susceptibility to mildew. Dry, hot weather is detrimental to the disease. Similarly, hard-driving rain may retard disease development because spores are washed off plant surfaces. Severely diseased wheat is very susceptible to lodging problems.

Rating scale:

- 0 = no mildew pustules developed;
- 1 = lower leaves contain the pustules, leaves on the upper part of plant do not contain pustules;
- 2 = all leaves contain a few pustules or lower half leaves are heavily infected with mildew;
- 3 = all leaves including uppermost leaf are heavily covered with mildew pustules.

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

Leaf Rust

Examination Period: Every two weeks from early April until full heading. Examine plants within a 15-foot radius.

Symptoms: Upper sides of lower leaves and/or stems are usually the first to develop the reddish-brown rust pustules. Leaf rust pustules contain a thin membrane that ruptures exposing the brightly colored spores of the fungus. Pustules are small, numerous and circular to oblong in shape. Leaf rust pustules black in color may also be seen on occasion but are rare.

Occurrence: Warm temperatures and high humidity or rain favor rust development. Nearly every year leaf rust disease is present in some part of Kentucky, however many years it develops too late to do extensive damage.

Rating Scale:

- 0 = no rust pustules developed;
 1 = lower leaves contain a few pustules;
 2 = most leaves contain rust pustules, the most infected leaves have from 5-20% of leaf surface infected.
 3 = some leaves are more than 20% covered with rust pustules.

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

Stripe Rust

Examination Period: Every two weeks from early April until full heading. Examine plants within a 15-foot radius.

Symptoms: Pustules of the fungus (sporulating areas) are light yellow and occur on leaves in distinct, straight-sided stripes about 1/16 inch wide and of irregular length. A single infection can result in a stripe the length of the leaf. Sporulation may be so abundant in advanced stages of the disease that stripes are not noticeable. Pustules also may develop on the heads.

Occurrence: Stripe rust (also called yellow rust) has been increasing in the South and Midwest since 2000. Recent races of the stripe rust fungus have caused the development of the disease at warmer temperatures than traditional stripe rust; more similar to leaf rust.

Rating Scale:

- 0 = no rust pustules developed
 1 = symptoms evident and may include stripes with necrosis and chlorosis, limited sporulation, and affected leaf area up to 15%
 2 = sporulating areas arranged in stripes with some chlorosis, affected leaf area up to 50%

- 3 = sporulating stripes merging into broader leaf areas supporting symptoms; chlorosis and necrosis evident; leaf area affected is greater than 50%

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

Tan Spot

Examination Period: Every two weeks from early heading to harvest. Examine leaves of plants within a 15-foot radius.

Symptoms: Symptoms of tan spot appear as small yellow brown spots that develop into broad oval or lens-shaped light brown blotches on leaves, usually with a yellow border. As lesions merge, large areas of leaves turn yellow/brown and die. When the causal fungus sporulates, the centers of lesions usually darken somewhat. Lesions are sometimes confused with those caused by leaf blotch complex; however, tan spot lesions do not develop the pycnidia.

Occurrence: Infected straw and overwintering of volunteer wheat are sources of the tan spot fungus. Disease development is favored by wet weather and temperatures in the 70's and 80° F.

Rating Scale:

- 0 = no leaves showing lesions;
 1 = most plants containing lesions on lower third of leaves;
 2 = lesions observed on leaves two-thirds of the way up the plant, some of lower leaves becoming totally necrotic and drying up;
 3 = all plants have spot blotch lesions up to and including the flag leaf. Leaves half way up the plant are beginning to dry up.

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

Take-all

Examination Period: Every two weeks from boot until harvest. Examine several plants within a 15-foot radius by pulling up plants and looking for root and lower stem symptoms described below. Scan an area as far as you can see to look for stunting symptoms described below. If found, dig up plants from affected area and examine for root and stem symptoms.

Symptoms: Infected plants are stunted, slightly yellowed, have few tillers and ripen prematurely. Wheat heads are bleached and contain few, if any, small shriveled seed. Roots are sparse, blackened and brittle. A black-brown dry rot extends from root to crown and basal stem where beneath the lowest leaf sheath a superficial dark shiny skin may be present. Early Take-all looks quite a bit like Barley Yellow Dwarf Virus.

Occurrence: Take-all disease is favored by soils high in pH and compacted, infertile, poorly drained soils. Early planting continuous wheat cultivation, and unbalanced soil fertility increase the disease problem.

Rating Scale:

- 0 = no symptoms on roots or stems of plants examined.
- 1 = a few plants contain root and stem symptoms, but only one or two locations in field were found;
- 2 = more than two locations to nearly ¼ of field affected by stunting symptoms and discolored roots and stems;
- 3 = over ¼ of field affected with Take-all

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

Loose Smut

Examination Period: Every two weeks from heading to harvest. Examine plants within a 15-foot radius.

Symptoms: Diseased heads are blackened and infected heads emerge slightly earlier than normal heads. Spikelets are transformed into a dry olive-black spore mass that is covered by a membrane which, upon rupturing, exposes the black spores. After several days only the rachis remains.

Occurrence: Infections occurred during flowering of the previous year (the disease is seed borne). Wet and cool to moderate temperatures ranging from 60° to 72° F favor seed infection. Most easily detected at early heading stages.

Rating Scale:

- 0 = no plants containing loose smut;
- 1 = few smutted heads observed, 1-2%;
- 2 = 2-10% of heads infected with loose smut;
- 3 = more than 10% of heads contain loose smut.

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

Glume Blotch

Examination Period: Every two weeks from early heading to harvest. Scan heads and examine plants within a 15-foot radius.

Symptoms: Infected glumes usually show irregular gray-brown lesions with a purple-brown border. The infection will start at the tips of glumes and move towards the base. Pycnidia (brown pimple-like structures visible with a 10X lens) on discolored glumes are the best sign of this

disease. Entire heads may become dark in color and kernels are often shriveled and lightweight. Do not confuse genetic discoloration often associated with some varieties or surface mold of over-mature wheat with glume blotch.

Occurrence: Straw, seed and overwintering and volunteer wheat are sources for new infections each year. Disease development is favored by wet windy weather and temperatures ranging from 68° to 80° F.

Rating Scale:

- 0 = no infected heads;
- 1 = 1-5% of heads infected;
- 2 = 5-25% of heads infected;
- 3 = more than 25% of heads infected.

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

Fusarium Head Blight (Head Scab)

Examination Period: Every two weeks from mid-dough to harvest. Scan heads within a 15-foot radius.

Symptoms: Scab is best recognized on emerged immature heads where one or more spikelets or the entire head appears bleached. Bleached spikelets usually contain no seed or small shriveled seed. A white, pink, or purplish-yellow mold may grow on infected heads, especially in wet weather conditions. To distinguish from glume blotch, look for individual or groups of infected spikelets that become bleached while other spikelets on the same head are green and remain healthy. Checking for discolored, shriveled grain is the only sure way to determine the presence of head scab once heads have matured.

Occurrence: Head scab occurs most rapidly during moist warm weather with temperatures ranging from 75° to 85°F during the flowering period.

Rating Scale:

- 0 = no infected heads;
- 1 = 1-5% of heads infected;
- 2 = 5-25% of heads infected;
- 3 = more than 25% of heads infected.

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

2008 Kentucky Wheat Disease Ratings*¹

Variety	Leaf Blotch	Powdery Mildew*	Leaf Rust*	WSMV*	Stripe Rust**
AgriPro COKER 9511	3.0	4	1	1.8	3.4
AgriPro COKER Branson	5.2	3	2.8	3	2.9
AgriPro COKER W1377	3.2				
ARMOR 9901	4.2				
Beck117	5.5	2.4	1.8	1	3.1
Beck 122	5.2	3.8	5.8	2	
Beck 164	5.8				
Bess	4.8				
Chesapeake	8.0	1.3	3.5	3.3	8.4
Clark	5.0	5	2.8	1.8	7.5
Cumberland	5.8	3.2	5.0	1.8	
Delta Grow 1600	5.8	4.0	1.8	1.5	
Delta Grow 4500	5.8				
Delta Grow 5200	7.0				
Delta Grow 7400	3.5				
Delta King 7710	6.5	6.3	1.0	1.3	1.9
Delta King 9108	5.5				
Delta King 9577	6.8	4.3	2.8	2.3	3.3
Dixie 907	6.2				
Dixie 989	5.0				
Ebberts 570	3.8				
Ebberts 575	3.5				
EXCEL 343	5.0				
EXCEL 345	3.8				
EXCEL 357	3.8				
Exsegen Candace	5.0				
Exsegen Dinah	4.0				
Exsegen Hannah	4.5				
Exsegen Lydia	7.0	3	3.8	1	
KY 96C-0769-7-3	6.5				
KY 96C-0786-3-2	6.2	2.8	3.3	2	
KY 97C-0321-02-01	6.0				
KY 97C-0321-05-2	5.2				
KY 97C-0508-01-01A-1	5.0				
KY 97C-0519-04-07	6.2				
KY 97C-0540-01-03	5.8				
KY 97C-0546-20-05	5.8				
KY 97C-0574-01-04	6.5				
KY 99C-1051-03-1	6.8				
MO 011126	6.2				
Pembroke	8.5	2.4	3.3	1.8	2.1
Pioneer variety 25R35	3.0				
Pioneer variety 25R37	4.5	3.0	4.3	2.3	2.5
Pioneer variety 25R54	7.2	3.0	2.0	1.5	3.1

Variety	Leaf Blotch	Powdery Mildew*	Leaf Rust*	WSMV*	Stripe Rust**
Pioneer variety 25R63	6.8				
Pioneer variety 26R15	5.8	2.8	1.0	2.3	3.8
Pioneer variety 26R22	6.5	4.3	2.8	2.5	
Pioneer variety 26R87	7.2	2.4	1.8	1.3	
PROGENY 117	6.0				
PROGENY 122	4.5				
PROGENY 127	5.0				
PROGENY 145	7.2				
PROGENY 166	8.2				
PROGENY 185	5.8				
Red Ruby	7.2				
SC 1298	4.0				
SC 1318	6.2				
SC 1325	4.5				
SC 1337	4.2				
SC 1339	5.2				
SC 1348	6.8				
SS 520	6.0	1.3	1.8	1.0	7.6
SS 548	6.5				
SS 560	7.5	3.0	2.3	2.0	4.6
SS 8302	6.0	5.5	1.8	1.8	2.2
SS 8309	5.8	4.0	1.3	2.5	4.1
SS 8404	8.0	6.5	1.5	2.0	
SS 8641	6.8				
SS MPV-57	7.5	3.0	3.6	1.0	5.9
Steyer EXP 703	4.0				
Steyer Fatzinger	5.0				
Truman	3.8				
USG 3350	6.8	7.7	1.4	2.8	2.3
USG 3633	4.5				
USG 3860	4.2				
VA 01W-205	7.2				
VA 03W-409	3.8				
Vigoro V9710	5.5				
Vigoro V9712	4.2				
Vigoro V9812	6.0				
AVERAGE	5.6	4.2	2.4	2.2	4.4

*Data collected in 2006; **Data collected in 2005.

Disease ratings (1=excellent; 9=poor)

WSMV= Wheat streak mosaic virus.

Leaf Blotch Complex -- ~80% Septoria tritici and 20% Stagonospora nodorum.

¹Table 15 from PR-568, 2008 Kentucky Small Grain Variety Performance Test, B. Bruening, C. Tutt, S. Swanson, J. Connelley, G. Olson, N. Mundell, A. Clark and D. Van Sanford.

SOIL SAMPLING AND SOIL TESTING

Lloyd Murdock

The most important factor of soil testing and fertility recommendations is obtaining a good soil sample. There is more room for error in this step than any other in getting reliable soil test results and recommendations.

Method:

The proper procedures for obtaining a good soil sample are well-established. Publication AGR-16 contains a complete explanation of these procedures.

Time of Sampling:

Recent fertilizer applications can distort the soil test results and fertilizer recommendations. To ensure proper sampling, soil samples should be taken at least six weeks after the last fertilizer application. Fall is when most soil samples for wheat will be taken. Attention needs to be paid to sampling location to ensure a more representative sample when sampling after a row crop.

An equal number of samples should be taken from the row middle and from next to the row.

Soil cores should not be taken from where fertilizers were banded in or beside the row. If it is not known where the fertilizer band is located, then no soil cores should be obtained within 4 to 6 inches of corn rows if row fertilizer was used.

Soil samples for alfalfa, small grains and soybeans can be taken anytime in summer or fall as long as it is at least six weeks after the last fertilizer application. It is always best to sample after the final harvest for the year or before spring planting or regrowth begins. In a double-cropping system (small grains and soybeans), sampling before the small grain planting is sufficient for fertilizer recommendations for both crops.

<u>Soil Sampling Depth</u>	
<u>Crop</u>	<u>Depth of Sample</u>
Alfalfa and pastures	4"
No-till corn, soybeans or wheat	4"
Conventional corn, soybeans or wheat	6-8"

Identifying Compacted Soil

Lloyd Murdock

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 soil penetrometer, 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 43 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.

ANNUAL FIELD COMPACTION RECORD
University of Kentucky
Department of Agronomy

FARM _____ FIELD _____ ACRES _____

MAJOR SOIL TYPE _____ YEAR _____

SITE	READING	Depth of Highest Reading
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		

Site	Reading	Depth of Highest Reading
21		
22		
23		
24		
25		
26		
27		
28		
29		
30		
31		
32		
33		
34		
35		
36		
37		
38		
39		
40		

SUMMARY

% of reading 200 or less _____

% of reading 300 or more _____

Most common depth
of readings 300 or more _____

METHOD

Push penetrometer into the soil slowly (do not surge). Note the highest psi reading and the depth at which it occurs. Continue to push until the resistance drops and note the depth where this happens.

Always use the penetrometer when the soil is too wet for proper tillage and when it is not saturated with water.

Avoid or test separately field entrances and turn row areas that have excessive traffic and do not represent the field. Readings should be taken in a random manner over the rest of the field.

INTERPRETATION

With readings of 300 psi or above, the compaction is considered severe. If 1/3 of the readings are 300 or more, a corrective action and change in tillage practices should be considered. When 1/2 of the field readings are 300 or more, then changes definitely need to be made. If severe compaction is identified in only a portion of the field, then corrective action should only be considered in that portion.

EXAMPLE RECORD

<u>Site</u>	<u>Reading</u>	<u>Depth of Highest Reading</u>
1	175	6-12
2	200	9-15
3	300	9-15
4	175	6-12
5	300+	9-15
6	225	9-15
7	200	6-12
8	300+	6-15
9	150	3-18
10	250	9-15

SUMMARY

% of readings 200 or less 50

% of readings 300 or more 30

Most common depth of readings 300 or more 9 - 15.

Recognizing Nutrient Deficiencies in Small Grains

The common deficiency symptoms of nitrogen (N), phosphorus (P), and potassium (K) in wheat, oats, barley and rye are very similar. Once the plants are 6-8 inches tall there are no recommended practices, other than nitrogen fertilization, that can be used that will benefit the crop. The best practice to follow is to have your soil tested before planting. The following are symptoms of nutrient deficiencies:

Nitrogen (N)

Young plants will be stunted, spindly and have short erect leaves. Leaves will be a pale green to yellow in color. In older plants the oldest leaves may be yellow to brown, the middle leaves yellow, and the newest leaves pale yellow. Another indication of a Nitrogen deficiency can be seen in the grain. The grain may appear glassy with opaque patches.

Potassium (K)

If a small grain plant has a potassium deficiency, the edges of the leaves will appear to be scorch. In early stages the older leaves will turn yellow, then brown and eventually die.

Phosphorus (P)

It is difficult to recognize a phosphorus deficiency because the plant will not show any specific outstanding symptom. Slow growth and a lack of shoots are common symptoms. The plant can still be green and appear healthy. Old leaves may also turn a dark orange-yellow at the tips and along the edges towards the base. In the winter, the lower part of the grass leaf and stem will often turn purple.

Frost and Freeze Damage To Wheat

Jim Herbek

Wheat is most susceptible to freeze damage when the plant is heading, flowering or after it has jointed.

Most freeze damage occurs in the spring. An autumn freeze is much less damaging than a spring freeze. Frosts and cool temperatures in the fall actually help by hardening plants for the months of cold winter weather ahead. If wheat is seeded in the fall at recommended planting dates, you can expect little freeze damage in the fall.

But, when exposed to warm temperatures in the spring, plants will tend to lose their cold hardiness, thus making a spring freeze more damaging. Spring freeze injury occurs when low temperatures coincide with sensitive plant growth stages.

A late spring freeze can reduce yield because of damage to the head and stem. Damage to the head and stem will have the greatest effect upon yield. Head and stem damage may not be visible for a week to 10 days after the freeze. The stem will likely be damaged close to the ground. The stem will become discolored and may also be collapsed, bent or split. These weakened stems will likely break over or lodge as the plant matures.

To check for damage to an unemerged head, you must cut into the stem to find the growing point (developing head). An undamaged, healthy head normally appears light green in color, glossy and turgid. It will be about 1/8 to 1/4 inch in length depending on the stage of development of the plant. A head that has been killed by freezing temperatures will be white to tan in color, limp, shrunken and not developing in size.

Leaf burn resulting from a spring freeze is relatively unimportant unless the damage has been severe. If it occurs early in plant development, the plant will soon generate new leaves.

Growing plant tissue that has been frozen will be discolored, shrink and become dry. A freeze at heading results in heads appearing bleached or white and also sterile.

The extent of freeze damage to wheat will depend upon the wheat growth stage, the temperature achieved, and the length of time the wheat was exposed to the critical temperature (see following table on next page).

Freeze injury in wheat.*

Growth stage	Approximate Injurious Temp. (two hours)	Primary symptoms	Yield effect
Tillering (1-5)**	12° F	Leaf chlorosis; burning of leaf tips; silage odor; blue cast to fields	Slight to moderate
Jointing (6-7)	24° F	Death of growing point; leaf yellowing or burning; lesions, splitting or bending of lower stem; odor	Moderate to severe
Boot (10)	28° F	Floret sterility; spike trapped in boot; damage to lower stem; leaf discoloration; odor	Moderate to severe
Heading (10.1-.5)	30° F	Floret sterility; white awns or white spikes; damage to lower stem; leaf discoloration	Severe
Flowering (10.51-.54)	30° F	Floret sterility; white awns or white spikes; damage to lower stem; leaf discoloration	Severe
Milk (11.1)	28° F	White awns or white spikes; damage to lower stems; leaf discoloration; shrunken, roughened, or discolored kernels	Moderate to severe
Dough (11.2)	28° F	Shriveled, discolored kernels; poor germination	Slight to moderate

*Table from ID-125 (A Comprehensive Guide to Wheat Management in Kentucky).

**Numbers in parentheses refer to the Feekes scale.

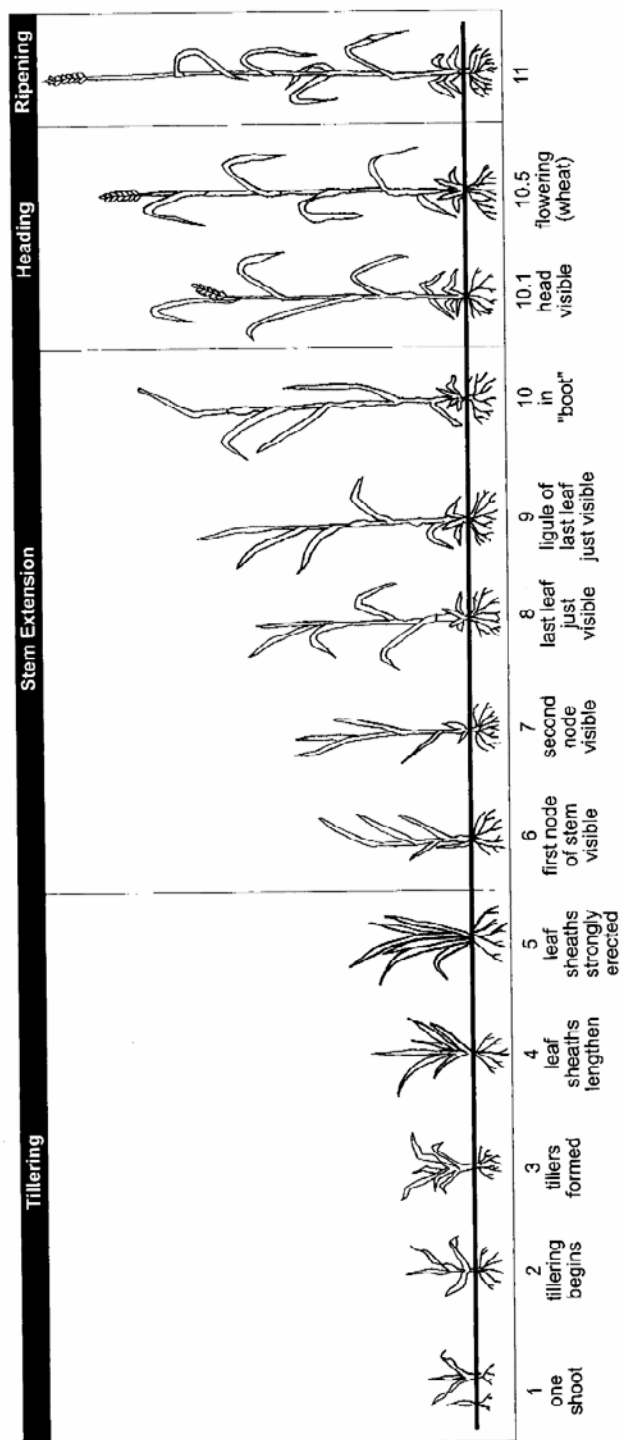
Growth Stages of Wheat

Jim Herbek

The following is a brief description of the growth stages of wheat (Feekes scale)

- Stage 1: One shoot: Can have several leaves (coleoptiles through three leaves).
- Stage 2: Beginning of tillering; main shoot and one tiller.
- Stage 3: Tillers formed and are in their primary growth stage; main shoot and several tillers.
- Stage 4: Leaf sheaths (the lower part of the leaf which surrounds the stem) begin to lengthen. Tiller formation has ended.
- Stage 5: Leaf sheaths are strongly erected and the stems start to grow in length.
- Stage 6: Jointing stage: The first node (joint) is visible at base of the shoot near the soil surface, and can be felt inside the stem. The node gives a swelled appearance in the lower portion of the stem.
- Stage 7: 2-Joint Stage: the second node of the stem has formed.
- Stage 8: Flag leaf (last leaf) is visible but still rolled up. Head beginning to swell.
- Stage 9: Ligule Stage: The ligule (a membrane at the junction of the leaf base and leaf sheath) of the flag leaf is just visible.
- Stage 10: “Boot” Stage: Sheath of flag leaf completely visible. Wheat head swollen, but enclosed by leaf sheath and not yet visible.
- Stage 10.1: Head Emergence Stage: First spikelet of head visible. Emergence continues until head is completely out of sheath (stages 10.1 to 10.5).
- Stage 10.5: Flowering Stage: Anthers protruding from head (stages 10.51 to 10.54).
- Stage 11: Ripening Stage: During this growth stage, the milk (11.1), soft dough (11.2), hard dough (11.3), and harvest ripe (11.4) stages occur.

The Feekes scale of wheat development from ID-125 (A Comprehensive Guide to Wheat Management in Kentucky).



Determining Plant Populations in Wheat

Jim Herbek

Make *fall* stand counts after all potential plants have emerged (one to two weeks after emergence) to determine the wheat population achieved. Make *spring* stand counts, if needed, to determine if winter damage has reduced the initial plant populations.

Take stand counts in 6-10 locations in the field for each 50 acres or portion thereof.

Draw a map of the field indicating the location of each 50 acres or portion thereof counted and record the average stand count obtained.

It is best to make stand 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. The stand count for the whole field can be determined by averaging the stand counts obtained for each 50 acre portion.

Procedure for stand counts:

To determine the number of plants per square foot, use the following steps:

Step 1. Use a yardstick, or cut a wooden dowel to a 3-foot length.

Step 2. Place the measuring stick next to a row, and count all the plants in the 3-foot length of row. Record the number.

Step 3. Repeat the counting process in at least 6-10 other locations well spaced in the

field (for each 50 acres or portion thereof). Record all numbers.

Step 4. Average all of the plant stand counts taken in each 50 acre portion.

Step 5. Calculate plants per square foot with the following equation:

$$\text{Plant number (per sq. ft.)} = \frac{(\text{average plant count} \times 4)}{\text{row width in inches}}$$

Example:

- a) Plant counts (per 3 ft of row) = 52, 48, 54, 47, 51, 49, 51, 52
- b) Average plant count (per 3 ft or row) = 50.5
- c) Row width (inches) = 7
- d) Plants per sq ft =

$$\frac{50.5 \times 4}{7} = \frac{202}{7} = 28.9$$

Wheat plant populations may range from 5 to over 30 plants per square foot. An optimum population is considered to be 25 to 35 plants per square foot. The following table provides an estimate of yield potential based upon the wheat stand. This table is only a guide. Many factors can influence how a wheat stand will ultimately respond to achieve its yield potential. These include weather, diseases, fertility mgt., planting date, variety, and tillering capacity. The following table is based on the premise that maximum wheat yields are achieved at stands of 30-35 plants per square foot.

<u>% WHEAT STAND</u>	<u>PLANTS / FT²</u>	<u>% YIELD POTENTIAL</u>
100%	30 – 35	100%
80%	24 - 28	100%
60%	18 – 21	90 – 95%
50%	15 – 18	75 – 80%
40%	12 – 14	60 - 70%
20%	6 - 7	40 – 50%