Broadleaf Weed Characteristics

The leaves of broadleaf weeds are wider than grasses and have branching, netlike veins.

The seed of broadleaf plants has two halves or cotyledons, which separate on germination. The cotyledons emerge with the seedling, expand and become the first visible leaves. The true leaves develop above the seed leaves.

The shapes of cotyledons and first true leaves are important in weed identification.

Cotyledon size provides additional clues. Large cotyledons indicate large-seeded weeds such as cocklebur, jimsonweed, morningglory and giant ragweed. Small cotyledons are typical of weeds such as pigweed, lambsquarters, nightshade, kochia and many others.

Cotyledon and Leaf Shapes

Since shape can sometimes vary, the approximate length to width ratio is also given to assist identification.

Cotyledon Size

In this key, small cotyledons are generally less than 1/2" long; large cotyledons are more than 1" long.

Relative Position of True Leaves

The next important plant characteristic is the relative position of the first true leaves on the stem.

Alternate Leaves
- One leaf per node.
- Newest leaf is smaller than preceding leaf.

Opposite Leaves*
- Paired leaves of similar size attached to opposite sides of the same node.

*Note: On some weeds, all true leaves are opposite. But, on many weeds, the later leaves are alternate.
WEED SEEDLING IDENTIFICATION

Broadleaf Weed Seedling Identification Key

Are the first true leaves alternate or opposite?

Ocrea present?

Large cotyledons with prominent, recessed midvein?

• Hair on stems and bud area.
• Rough leaves, oval to ovate.

NO

YES

TRUE LEAVES HEART SHAPED?

NO

YES

Other weeds with **Linear-Lanceolate** cotyledons and first true leaves **alternate**:
• Buffalobur
• Cutleaf Nightshade

Other weeds with an **ocrea**—membranous, papery sheath encircling nodes and petioles:
• Swamp Smartweed
• Dock
• Knotweed
• Red Sorrel

NO

YES

JIMSONWEED

PENNSYLVANIA SMARTWEED

WILD BUCKWHEAT

REDROOT or SMOOTH PIGWEED

COMMON or TALL WATERHEMP

PALMER AMARANTH

(See other Pigweed species below.)

• Nick in tip of first true leaves.
• Stem reddish-violet.

• Smooth stems, glossy leaves.
• Oblong to lanceolate.

• Smooth stems, glossy leaves.
• Oval to ovate.
• Long petioles.

• Hypocotyl reddish-violet tinged.

• Unpleasant odor when bruised.
• Later leaves coarsely toothed.

• Large cotyledons—thick and waxy?

NO

YES

COMMON COCKLEBUR

• Lanceolate cotyledons.
• Older true leaves with three prominent veins.
• Older stems develop purple spots.

• Small linear cotyledons.

• True leaves and stems hairy?

NO

YES

RUSSIAN THISTLE

COMMON LAMBSQUARTERS

KOCIA

• True leaves linear, forming basal rosette.
• Red-violet below.
• Frosty above.
• Later leaves alternate.

• True leaves long and very thin (needle-like).
• First true leaves ovate.
• Red-violet below.
• Frosty or mealy above.

• True leaves linear, forming basal rosette.

• Small linear cotyledons.
Broadleaf Weed Seedling Identification Key

**Cotyledon Shape**

**OVATE (Egg Shaped)**
- Narrow tip. Broad base.
- Length-width ratio near 2:1
- First true leaves alternate.
- Often purple leaves alternate.
- Leaves sparsely hairy or smooth.

**EASTERN BLACK NIGHTSHADE**

Other weeds with **Ovate** cotyledons:
- First true leaves alternate:
  - Ground Cherry
  - White Dockle
  - Shepherd’s-Purse

**HAIRY NIGHTSHADE**

**Spatulate or Oval or Oblong**
- Broad tip. Narrow base.
- Rounded sides.
- Straight sides.
- Length-width ratio 2:1 to 3:1
- First true leaves opposite?
  - (Later leaves may alternate.)

**COMMON RAGWEED**

Other weeds with **Spatulate** or **Oval** or **Oblong** cotyledons:
- First true leaves alternate:
  - Blue Mustard
  - Canada Thistle
  - Musk Thistle
  - Marijuana*, Devil’s claw*
  - Dandelion

**ANNUAL (COMMON) SUNFLOWER**

**WILD CUCUMBER or BURCUCUMBER**

**Cotyledon Shape**

**ROUND or ROUND WITH TAPERED TIP**
- “Heartshaped”
- Length-width ratio near 1:1
- First true leaves alternate?

**YES**
- Heart-shaped true leaves with short hairs?

**VELVETLEAF**

**VENICE MALLOW**

**PRICKLY SIDA**

**BUTTERFLY**
- Deeply notched tip and base

**KIDNEY**
- Notched tip

**TALL MORNINGGLORY**

**IVYLEAF MORNINGGLORY**

**PITTED MORNINGGLORY**

**WILD MUSTARD**

**FIELD BINDWEED**

Other weeds with **Round** cotyledons:
- First true leaves alternate:
  - Common Mallow
  - Spurred Anoda
  - Sicklepod
  - Henbit
  - Copperleaf
  - F. Pennycress (later alternate)

Other weeds with **Butterfly** cotyledons:
- Most Morningglory species

Other weeds with **Kidney** cotyledons:
- Hedge Bindweed
- Wild Radish

* Later leaves alternate

**GIANT RAGWEED**

**ANNUAL (COMMON) SUNFLOWER**

**WILD CUCUMBER or BURCUCUMBER**

**Cotyledon Shape**

**ISOGLYCEMIC**
- Large cotyledons.
- True leaves star shaped (wild cucumber) or pentagon shaped (burcucumber).
Grass Weed Seedling Identification

Useful vegetative characteristics to help identify a young grass seedling:

- The leaf **blades** are long, narrow, alternate with parallel veins.
- The leaf **sheath** encircles the stem.
- The junction of the leaf blade with the leaf sheath is called the **collar**.
- Most grasses have a projection at the base of the leaf blade called a **ligule**, which may be a membrane, a fringe of hairs or a combination of both. A ligule is absent on the first leaf.
- Grasses may be **smooth** (glabrous) or **hairy** (pubescent).
- Some grasses have claw-like projections at the leaf collar called **auricles** that partially encircle the stem.

Descriptions of plant parts and growth habits are very useful for identifying grass seedlings. Example grasses are listed (list not complete).

**Ligules**

<table>
<thead>
<tr>
<th>Hairy</th>
<th>Membranous</th>
<th>Absent</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="Foxtail" /></td>
<td><img src="image" alt="Shattercane" /></td>
<td><img src="image" alt="Barnyardgrass" /></td>
</tr>
</tbody>
</table>

Note: Ligule is absent on the first leaf of most grasses.

**Leaf Sheath and Stem Type**

<table>
<thead>
<tr>
<th>Round to Somewhat Flattened</th>
<th>Distinctly Flat</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="Most Common Grasses" /></td>
<td><img src="image" alt="Yellow Foxtail Sandbur Barnyardgrass Goosegrass Orchardgrass" /></td>
</tr>
</tbody>
</table>

**Sheath Margins**

<table>
<thead>
<tr>
<th>Split</th>
<th>United (Not Split)</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="Most Common Grasses" /></td>
<td><img src="image" alt="Smooth Bromegrass Annual Bromegrass Goosegrass Orchardgrass" /></td>
</tr>
</tbody>
</table>
Grass Weed Seedling Identification

**Auricles**
- Prominent Clasping
  - Quackgrass
  - Jointed Goatgrass
  - Wheat, Barley, Rye
- Absent
  - Most Grasses

**Leaf Midrib or Midvein**
- Prominent
  - Fall Panicum
- Faint or Obscure
  - Foxtail

**Growth Habit – Developing Plant**
- Erect
  - Shattercane
- Decumbent (Reclining)
  - Crabgrass

**Growth Habit – Seedling (1st Leaves)**
- Erect
  - Wild Oats or Annual Bromegrass
- Horizontal
  - Woolly Cupgrass or Crabgrass

**Leaf Twist**
- Clockwise
  - Wheat
- Counter Clockwise
  - Annual Bromegrass
- No Distinct Twist
  - Wild Oats
  - Most Grasses

Direction of twist is consistent on first leaves only.

**Leaf or Sheath Pubescence (Hair)**
- Smooth
- Hairy
  - Short Hair “Fuzz”
  - Long Hair

**Seed Size and Shape**
The seed of grasses often remains attached to the primary root after germination. If the grass seedling is carefully removed from the soil, the seed size and shape may help identify the plant.
Grass Weed Seedling Identification Key

- **Stems triangular.**
  - No ligule.

- **First leaf wide, short, not erect.**
  - Horizontal growth habit.

- **Yellow Nutsedge**

- **First leaf blades with dense hairs.**
  - Blades with distinct twist.
  - Sheath united.
  - Winter annual.
  - Long, awned seed.

- **Large Crabgrass**

- **Blade or sheath with dense hairs.**
  - Stems round or flat.

- **Ligule Membranous**
  - Blade and sheath hairless or sparsely hairy.

- **Japanese Brome or Downy Brome**
  - Auricles absent.
  - Similar to shattercane but seed is oblong shape.
  - Stems wire-like.
  - Prominent nodes.
  - Scaly rhizomes.

- **Jointed Goatgrass**
  - Winter annual.

- **Smooth Brome**

- **Ligule absent**
  - Sheath distinctly flat by third leaf stage.

- **Barnyardgrass**

- **Ligule hairy**
  - Sheath very hairy.

- **Smooth Crabgrass**

- **Goosegrass**

- **Johnsongrass**
  - Perennial with rhizomes.
  - Stems wire-like.
  - Prominent nodes.
  - Scaly rhizomes.

- **WIRESTEM MUHLY**
  - Sheath distinctly flattened.
  - Prominent ligule.

- **Quackgrass**
  - Smooth, white rhizomes.
  - Narrow, twisting leaves.

- **Wild Oat**

- **smooth brome**

- **Sheath hairy to smooth.**

- **Auricles present (except first few leaves).**
  - Note: wheat, barley and rye also have auricles.

- **Western wheat region.**
  - Hair on blade margin.
  - Long, joint-like seed.
  - Leaves with distinct twist.

- **Jointed Goatgrass**
Grass Weed Seedling Identification Key

**LIGULE HAIRY**

- Blade with hair.
- Blade hairy upper surface only.
- Sheath margins hairy.
- Prominent sheath hairs at 90º angle to stem.
- Blades hairy to nearly smooth.
- Random hairs on first leaf and sheath.
- Blades and sheaths later smooth and shiny.
- First blade horizontal, wide with blunt tip.
- One blade margin often crimped.
- Very large flattened seed.

- Sheath margin hairy.
- Prominent, white midrib on older plants.
- Sheath smooth, often with reddish base.
- Occasional sparse hair on collar margins.
- Small ovate seed.
- Sheath rounded, hairless or sheath occasionally with hair.
- Sheath flattened, large spiny seed.

- Sheath margin without hair or sheath occasionally with hair.
- Sheath nearly round, small oblong seed.
- First blade horizontal, wide with blunt tip.
- One blade margin often crimped.
- Very large flattened seed.

- Blade and sheath hair very short, dense and difficult to see.
- Blade with long hair on upper surface near base by third leaf stage.
- Blade hairy on both surfaces or blade margins.
- Underside of blade smooth or sparsely hairy.
- Sheath margins hairy.
- Very large flattened seed.
- Small ovate seed.
- Sheath flat, without hair.
- Sheath margin hairy.
- Sheath nearly round, small oblong seed.
- Sheath flattened, large spiny seed.

**GIANT FOXTAIL**

- Blades and sheaths later smooth and shiny.
- Prominent, white midrib on larger plants.

**YELLOW FOXTAIL**

- Blades and sheaths later smooth and shiny.
- Prominent, white midrib on larger plants.

**WITCHGRASS (small seed)**

- Blades and sheaths later smooth and shiny.
- Prominent, white midrib on larger plants.

**FALL PANICUM**

- Blades and sheaths later smooth and shiny.
- Prominent, white midrib on larger plants.

**WILD PROSO MILLET (large black to olive seed)**

- Blades and sheaths later smooth and shiny.
- Prominent, white midrib on larger plants.

**WOOLLY CUPGRASS**

- Blades and sheaths later smooth and shiny.
- Prominent, white midrib on larger plants.

**FIELD SANDBUR or LONGSPINE SANDBUR**

- Blades and sheaths later smooth and shiny.
- Prominent, white midrib on larger plants.

- Sheath nearly round, small oblong seed.
- Sheath flattened, large spiny seed.
- Sheath margin hairy.
- Sheath nearly round, small oblong seed.
GRASS WEED SEEDLING IDENTIFICATION

1. Barnyardgrass
2. Giant Foxtail
3. Green Foxtail
4. Yellow Foxtail
5. Fall Panicum
6. Wild Proso Millet
7. Large Crabgrass
8. Shattercane
9. Johnsongrass
10. Quackgrass
The vegetative identification of weeds requires a close examination with the aid of a hand lens. Grass plants are distinguished vegetatively by differences in their ligule, collar, leaf blade, leaf sheath, and auricles. The ligule is located on the inner side of the leaf blade and appears as an extension of the sheath at its intersection with the blade. Ligules are hairlike or membranous and vary in length and shape; some plants lack ligules. The blade is the part of the leaf that we usually think of as the leaf itself. The leaf sheath encloses the short (stem) and is connected to the leaf blade at the collar region. Blades and sheaths vary among species in hairless texture and length to width ratio. The auricles are fingerlike projections that extend from the collar. Auricles, which may or may not be present, vary in length. Long auricles may cross one another and clasp the stem, as do quackgrass auricles.

The underground parts also yield information. Plants emerging from seeds usually retain their seedcoat attached to the root system for some time after germination. You can find it if you carefully dig and remove the soil from the underground parts. Either annual or perennial plants may emerge from seed. However, if the plant is emerging from rhizomes then it is a perennial species.

BARNYARDGRASS, *Echinochloa crus-galli* (annual). Ligule is absent. Collar is broad and divided by a prominent midvein. Leaf blade is hairless and slightly keeled below. Leaf sheath is hairless to slightly hairy and may be flattened and reddish near the base of older plants. Auricles are absent.

GIANT FOXTAIL, *Setaria faberii* (annual). Ligule is hairlike. Collar is without a prominent midrib. Leaf blade is densely hairy on the upper surface and sparsely hairy to hairless on the underside. Leaf sheath is hairless to sparsely hairy. Auricles are absent.

GREEN FOXTAIL, *Setaria viridis* (annual). Ligule is hairlike. Collar is without a prominent midrib. Leaf blade is hairless. Leaf sheath is hairless to sparsely hairy. A few hairs may line the sheath margin. Seed is small and roundish (ovate).

YELLOW FOXTAIL, *Setaria lutescens* (annual). Ligule is hairlike. Collar is narrow and has no prominent midrib. Leaf blade has long hairs (3X the length of the ligule) on the upper surface near the base of the blade only; the rest of the blade is hairless to the tip. Leaf sheath is hairless and may be flattened and reddish near the base of older plants. Auricles are absent.

FALL PANICUM, *Panicum dichotomiflorum* (annual). Ligule is hairlike. Collar has a prominent midrib. Leaf blade is hairless with a prominent midrib; blade of first leaf may be hairy but all subsequent leaves are hairless. Leaf sheath is usually hairless and may be flattened and reddish on older plants. Auricles are absent. Seed is small and narrow (oblong).

WILD PROSO MILLET, *Panicum miliaceum* (annual). Ligule is hairlike. Collar is without a prominent midrib. Leaf blade is densely hairy above and hairless to sparsely hairy beneath, with hairs protruding from the blade margins at a 90-degree angle. Leaf sheath is very hairy; hairs project at a 90-degree angle. Seed is large and roundish (ovate).

LARGE CRABGRASS, *Digitaria sanguinalis* (annual). Ligule is membranous. Collar has a fairly prominent midrib. Leaf blade is densely hairy on both surfaces and wider relative to its length than most other grasses. Leaf sheath is densely hairy and may be flattened on older plants. Auricles are absent.

SHATTERCANE, *Sorghum bicolor* (annual). Ligule is membranous, long and jagged. Collar is without a prominent midrib. Leaf blade is hairless and of medium width. Leaf sheath is hairless and may be reddish on older plants. Auricles are absent. Seed is large and roundish (ovate).

JOHNSONGRASS, *Sorghum halepense* (perennial). Ligule is membranous, long, and jagged. Collar is without a prominent midrib. Leaf blade is hairless and narrow. Leaf sheath is hairless and may be reddish on older plants. Auricles are absent. Seed is large and narrow (oblong).

QUACKGRASS, *Agropyron repens* (perennial). Ligule is membranous, short, and jagged. Collar is narrow and without a prominent midrib. Leaf blade is hairless and rough-textured on the upper surface and hairless to hairy on the under surface. Leaf sheath may have sparse, short hairs. Auricles are long and slender, but they are difficult to find on mature leaves and are not present on plants emerging from seed until several weeks after germination.
Redroot Pigweed
(Redroot and smooth pigweed seedlings appear similar)

Redroot Pigweed
(Hairy, rough stem)

Waterhemp (Common or Tall)
(Smooth, shiny stem)

Prostrate Pigweed

Spiny Amaranth

Palmer Amaranth

Note: The leaf tips of most pigweed species are indented, particularly in the seedling stage.
PIGWEED (AMARANTH) IDENTIFICATION

REDROOT PIGWEED (Amaranthus retroflexus)
- Redroot pigweed is found throughout the USA.
- Smooth pigweed is found primarily in the eastern USA extending to the eastern Great Plains.

IMMATURE STAGES:
- Very small fine hairs found throughout the plant. Stem and leaf surfaces are rough.
- First leaves are rounded.
- Seedling redroot pigweed, smooth pigweed and Powell amaranth are very similar in appearance.

MATURE STAGES:
- Very small fine hairs found throughout plant.
- Height: Redroot 3-4 feet; Smooth 6-8 feet.
- Male and female flowers on same plant.
- Flowering structures are branched. Smooth pigweed seed heads are highly branched. These branches are slightly longer and thinner than redroot pigweed.
- Smooth pigweed foliage and seed head tend to turn reddish purple or dark green on maturity.

SMOOTH PIGWEED (Amaranthus hybridus)
- Smooth pigweed is found primarily in the eastern USA extending to the eastern Great Plains.

IMMATURE STAGES:
- Cotyledons are often more egg-shaped than other pigweed species.
- Leaves are longer and narrower (lanceolate) than other pigweeds. Leaf shape is highly variable.
- There are no hairs on the plant.
- Leaf and stem surfaces are smooth and often waxy or shiny.

MATURE STAGES:
- Leaves are long and narrow but can vary in shape. Leaves and stems are smooth.
- Height: 6-8 feet.
- Each plant is either male or female. Male plants shed pollen, while females produce seed.
- Flowering structures are open and located near the top of the plant and the tips of branches.

COMMON WATERHEMMP (Amaranthus rudis)
- Common waterhemp tends to predominate in the Great Plains and the western portions of the Midwest. Tall waterhemp is distributed in the Eastern USA, west to IA, MN, SD, ND and eastern MO.

IMMATURE STAGES:
- Cotyledons are often more egg-shaped than other pigweed species.
- Leaves are longer and narrower (lanceolate) than other pigweeds. Leaf shape is highly variable.
- There are no hairs on the plant.
- Leaf and stem surfaces are smooth and often waxy or shiny.

MATURE STAGES:
- Leaves are long and narrow but can vary in shape. Leaves and stems are smooth.
- Height: 6-8 feet.
- Each plant is either male or female. Male plants shed pollen, while females produce seed.
- Flowering structures are open and located near the top of the plant and the tips of branches.

POWELL AMARANTH (Amaranthus powellii)
- Found primarily in western and northern-most states.
- Immature stages similar to redroot but the first leaves are more tapered and pinched toward the tip.
- Male and female flowers on the same plant. Flower branches usually 4-8" long and thicker than a pencil.

PALMER AMARANTH (Amaranthus palmeri)
- Found primarily in southern USA – common species in KS and AR.

IMMATURE STAGES:
- Stem and leaves with little or no hair (smooth).
- Petioles often as long or longer than leaf blades.
- Plants often have poinsettia-like appearance with leaves arranged symmetrically.
- Leaves occasionally with V-shaped variegation (light colored to reddish markings).

MATURE STAGES:
- Height: 8-10 feet. Tallest pigweed species.
- Flowering structure is 1-2 feet long, thick with little or no branching.
- Each plant is male or female. Male flowering structure feels soft to the touch and sheds pollen. Female seed head is prickly to the touch.
- Petioles as long or longer than the leaf blade.
- Stems and leaves are smooth – no hairs.

SPINY AMARANTH (Amaranthus spinosus)
- Distribution: Southeastern USA extending northeast to eastern Nebraska.
- Stems smooth and do not have hairs.
- Sharp spines in leaf nodes and flower clusters.
- Leaves often have a V-shaped variegation.
- Mature plants with female flowers toward bottom and middle of plant, male flowers at top. Plants often have nodding appearance.

TALL WATERHEMP (Amaranthus tuberculatus)
- Common waterhemp tends to predominate in the Great Plains and the western portions of the Midwest. Tall waterhemp is distributed in the Eastern USA, west to IA, MN, SD, ND and eastern MO.

IMMATURE STAGES:
- Cotyledons are often more egg-shaped than other pigweed species.
- Leaves are longer and narrower (lanceolate) than other pigweeds. Leaf shape is highly variable.
- There are no hairs on the plant.
- Leaf and stem surfaces are smooth and often waxy or shiny.

MATURE STAGES:
- Leaves are long and narrow but can vary in shape. Leaves and stems are smooth.
- Height: 6-8 feet.
- Each plant is either male or female. Male plants shed pollen, while females produce seed.
- Flowering structures are open and located near the top of the plant and the tips of branches.

POWELL AMARANTHR (Amaranthus powellii)
- Found primarily in western and northern-most states.
- Immature stages similar to redroot but the first leaves are more tapered and pinched toward the tip.
- Male and female flowers on the same plant. Flower branches usually 4-8" long and thicker than a pencil.

PROSTRATE PIGWEED (Amaranthus blitoides)
- Distributed throughout the Midwest and the Great Plains states.
- Cotyledons larger than other pigweed species.
- True leaves small (<1" long), shiny and waxy.
- Leaves spatulate-shaped and narrow at base.
- Height: Low growing and prostrate.
- Flowers are located at leaf-stem nodes.

TUMBLEWEED PIGWEED (Amaranthus albus)
- Distributed throughout USA.
- Leaves are egg-shaped with wavy edges.
- Plant is often an olive green color.
- Leaves are small, usually less than 1.5" long.
- Height: 2-3 feet. Spherical in shape.
- No distinct flowering structure; flowers at point of leaf attachment to stem.
- At maturity, plant may break off and roll.

28. Jointed goatgrass (Aegilops cylindrica)

29. Wild oats (Avena fatua)

30. Quackgrass (Agropyron repens)

31. Cheat (Bromus secalinus)

32. Downy brome (Bromus tectorum)

33. Sandbur (Cenchrus longispinus) bur, grain and floret

34. Yellow nutsedge (Cyperus esculentus)

35. Crabgrass (Digitaria sanguinalis)

36. Barnyardgrass (Echinochloa crus-galli)

37. Woolly cupgrass (Eriochloa villosa)

38. Witchgrass (Panicum capillare)

39. Fall panicum (Panicum dichotomiflorum)

40. Wild proso millet (Panicum miliaceum)

41. Giant foxtail (Setaria faberi)

42. Yellow foxtail (Setaria glauca)

43. Green foxtail (Setaria viridis)

44. Shattercane (Sorghum bicolor)

45. Johnsongrass (Sorghum halepense)
28. Jointed goatgrass (Aegilops cylindrica): A large, tough, cylindrical spikelet with two prominent awns. About 10 mm long, 3 mm in diameter.

29. Wild oats (Avena fatua): There is a conspicuous long, dark, bent awn which arises from the base of the floret. The outer half of the awn is delicate and often broken off, but the lower half of the awn is sturdy and persistent. With magnification the lower portion of the awn can be seen to be tightly twisted. There is a large circular attachment scar at the base of the floret. The grain has a tuft of hairs near the base. The floret is about 12 mm long; the grain itself is about 7 mm long.

30. Quackgrass (Agropyron repens): The floret is firm, elliptical, with its tip tapered to a straight awn. One side is convex, the other concave, so that a cross-section would appear C-shaped. About 9 mm long.

31. Cheat (Bromus secalinus): The floret appears folded lengthwise, so that a cross-section would be U-shaped. On the outer side, there is a keel which ends in an awn. The awn is about 6 mm long; it diverges from the floret below the tip. On the inner (concave) side of the floret, there is a short stalk which arises from the base. About 8 mm long.

32. Downy brome (Bromus tectorum): The floret is narrow, flattened, and delicate. It often appears bent backwards. The surface is dark, ribbed, and hairy. The tip of the floret is membranous. An awn arises below the tip. Floret about 11 mm long; awn about 15 mm.

33. Sandbur (Cenchrus longispinus): The grains are enclosed in spikelets within a very spiny bur. There are about 40 sharp spines per bur; the surface of the bur between the spines is hairy. The spikelets can be seen through a gap at the top of the bur. Spikelets, florets and grains may be found in processed grain. The grain has a tuft of hairs near the base. Scar at the base of the floret. The grain has a tuft of hairs near the base. About 1.3 mm long, 0.9 mm wide. If the floret is still enclosed in the spikelet, the lowest bract (first glume) will be present. It is pointed, and about half the length of the spikelet.

34. Yellow foxtail (Setaria faberi): The floret has one flat and one convex face. With magnification the convex face appears slightly cross-corrugated. Gray-brown, sometimes pale. The outer papery bract on the convex face (if present) is about 2 mm long and has a rounded margin. Floret about 2.7 mm long.

35. Crabgrass (Digitaria sanguinalis): A narrow floret with one flat and one slightly convex face. On the flat face, there is a tiny triangular bract at the base. On the convex face, there is a narrower triangular bract, half the length of the floret. The outer bracts are pale, but the inner surfaces are olive-colored, shiny. About 3 mm long.

36. Barnyardgrass (Echinochloa crus-galli): Often found as a spikelet with outer bracts attached. The bracts have conspicuously spiny nerves and a single long awn. When the outer bracts are missing, the floret appears smooth, shiny, and pale, with one flat face and one strongly convex face. In outline, it is elliptical with a tapered tip. The convex face of the floret appears swollen in the middle, but flattened near the tip and base. Floret is about 3.5 mm to 4 mm long.

37. Woolly cupgrass (Eriochloa villosa): The floret is nearly flat, elliptical in outline, about half as wide as long. One side has three nerves, the other side has five nerves. Color ranges from pale greenish to deep purple and may be mottled. Surface smooth, shiny. About 5 mm long.
1. Common lambsquarters (Chenopodium album)
2. Kochia (Kochia scoparia)
3. Russian thistle (Salsola iberica)
4. Redroot pigweed (Amaranthus retroflexus)
5. Waterhemp (Amaranthus rudis)
6. Wild buckwheat (Polygonum convolvulus)
7. Smartweed (Polygonum pensylvanicum)
8. Velvetleaf (Abutilon theophrasti)
9. Prickly sida (Sida spinosa)
10. Wild cucumber (Echinocystis lobata)
11. Bur-cucumber (Sicyos angulatus)
12. Wild mustard (Brassica kaber)
13. Blue mustard (Chorispora tenella)
14. Tansy mustard (Descurainia pinnata)
15. Flixweed (Descurainia sophia)
16. Pennycress (Thlaspi arvense)
17. Common milkweed (Asclepias syriaca)
18. Jimsonweed (Datura stramonium)
1. Common lambsquarters (Chenopodium album): The seed itself is lens-shaped, smooth, black, shiny, about 1.2 mm in diameter, 0.5 mm thick. The seed is usually enclosed in a thin, dull, close-fitting membrane, and often there are small papery flower parts still attached.

2. Kochia (Kochia scoparia): The seed itself is flat, pear-shaped, dark brown, about 1 to 2 mm long, but it is typically found enclosed in papery flower parts. The single seed is positioned horizontally in the flower.

3. Russian thistle (Salsola iberica): The seed itself is shaped like a blunt, irregular cone, about 1.8 mm long; it has a coiled green embryo inside a very thin seed coat. The seed is often still enclosed in papery flower parts.

4. Redroot pigweed (Amaranthus retroflexus): Lens-shaped, oval, with a tiny notch at one end, smooth, black, and shiny. With magnification, a narrow dull border is visible on each face. About 1.2 mm long.

5. Waterhemp (Amaranthus rudis): Lens-shaped, nearly circular in outline, smooth, black, and shiny. With 10x magnification, a narrow reddish border is visible on each face. About 0.9 mm in diameter.

6. Wild buckwheat (Polygonum convolvulus): Three-sided; each of the three faces concave. Surface is black and dull, but shiny on the angles. About 4 mm long.

7. Smartweed (Polygonum pensylvanicum): Flat, nearly circular, with a small, pointed tip. Smooth and glossy, red-brown to black. About 3 mm in diameter.

8. Velvetleaf (Abutilon theophrasti): A rounded shape with two uneven lobes, the longer lobe more pointed than the shorter one. Dull brown; with magnification sparse hairs are visible on the surface. About 3 mm long.

9. Prickly sida (Sida spinosa): Wedge-shaped, with a distinct notch in one end. Surface smooth, lusterless, dark brown. About 2.2 mm long.

10. Wild cucumber (Echinocystis lobata): A very large but lightweight seed, flattened, with dull, uneven surfaces, patchy light and dark brown. About 1.5 to 2 cm long.

11. Bur cucumber (Sicyos angulatus): Oval shape, with 2 rounded teeth at the small end. Surface dull, dark brown. About 8 mm long.

12. Wild mustard (Brassica kaber): Nearly spherical, red-brown to black. Surface is dull; with magnification it may appear smooth or netted. About 1.5 mm in diameter.

13. Blue mustard (Chorispora tenella): Seeds are usually found still securely enclosed in short rectangular segments of the capsule. The seed itself is a thin, flat oblong with a noticeable groove on each face; yellow-orange, about 1.2 mm long.

14. Tansy mustard (Descurainia pinnata): Rounded oblong, with one tapered end, orange-brown, with fine, lengthwise fingerprint-like ridges visible at 10x magnification; about 1 mm long, 0.6 mm wide.

15. Flixweed (Descurainia sophia): Rounded oblong, with one tapered end, dull orange, with very fine lengthwise striations visible at 10x magnification; about 1.1 mm long, 0.5 mm wide. Very similar to tansy mustard, but on average flixweed seeds are slightly longer and narrower, and have fainter lengthwise markings than tansy mustard.

16. Pennycress (Thlaspi arvense): Flat, oval, very dark reddish-brown. With magnification, concentric fingerprint-like ridges are visible on each face; about 1.8 mm long.

17. Common milkweed (Asclepias syriaca): A very thin pear shape, but not perfectly flat. One face has a narrow margin; the other face has a dark center, surrounded by a lighter band, and then a narrow margin. About 8 mm long.

18. Jimsonweed (Datura stramonium): Flat, with a rounded but irregular outline. Surface is black, dull. With magnification it appears finely honeycombed. About 3.5 mm long.
19. **Black nightshade** (*Solanum ptycanthum*): Thin, flat, chip-like, with an irregular oval outline. Surface is dull, smooth, yellow to orange; with magnification it appears finely textured. Size varies; about 1.5 to 2.2 mm long.

20. **Buffalo bur** (*Solanum rostratum*): Flat, with an irregular outline. Surface black, dull; with magnification it appears wrinkled and finely honeycombed. About 2.5 mm long. Very similar to jimsonweed, except buffalo bur seed is distinctly smaller.

21. **Field bindweed** (*Convolvulus arvensis*): Wedge-shaped, with two flat faces at right angles to each other, and an outer convex face. The surface is rough, lusterless, red-brown to dark brown. The hilum (attachment scar) is at one end of the angle and is oblong. About 3.5 mm long.

22. **Morning glory** (*Ipomoea purpurea*): Variable in shape, but generally like a wedge with two flat faces and one convex face. Surface is dull; with 10x magnification dense tiny hairs are visible. Brown-black. The hilum (attachment scar) is located at one end of the angle and is circular. About 4.5 to 5 mm long, distinctly larger than field bindweed seed.

23. **Common ragweed** (*Ambrosia artemisiifolia*): The seed is securely enclosed in a bur which has a finely tapered tip and a ring of short spines. The spines are readily worn off. Surface gray-brown, dull; with magnification short hairs are visible. About 3.5 to 4 mm long.

24. **Giant ragweed** (*Ambrosia trifida*): The single seed is enclosed in a woody bur which is somewhat five-sided, with a pointed tip. There is a ring of five small teeth below the tip. Surface smooth, gray-brown, sometimes mottled. About 6 mm long, 3 mm thick.

25. **Musk thistle** (*Carduus nutans*): A slightly curved oblong, with a small projection at the tip, which is surrounded by a circular rim. Surface smooth, shiny, straw-colored; with magnification fine dark stripes are visible. About 4 mm long.

26. **Common sunflower** (*Helianthus annuus*): Flattened but somewhat four-sided shape. Mottled light and dark gray-brown, faintly striped and ribbed. There are many short pale hairs, especially near the tip, but the hairs are easily worn off. About 4 to 5 mm long.

27. **Common cocklebur** (*Xanthium strumarium*): There are two seeds enclosed in a tough, spiny, durable bur. The bur has two large teeth at the top; the teeth and the multiple spines are hooked at their tips. Reddish-brown, about 2.5 cm long. The seeds may be found separate from the bur in processed grain. The seed itself is about 9 mm long, gray, and resembles an edible sunflower seed. It may be found with the hull attached (that is, as an achene), and again it resembles a sunflower seed in its hull.

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**ACTUAL SIZE**

19. Black nightshade
20. Buffalo bur
21. Field bindweed
22. Morning glory
23. Common ragweed
24. Giant ragweed
25. Musk thistle
26. Common sunflower
27A. Common cocklebur: seed
27B. Common cocklebur: seed and achene
General characteristics of weeds can be used to group them into a “family” which can help you identify the specific genus and species. Some of the most common weed families are:

**Buckwheat or Smartweed (Polygonaceae):** Stems encircled by a paper-like membranous sheath called an ochrea just above the node. The leaves are mostly alternate with colored sepals and no true petals. Examples: curly dock, Pennsylvania smartweed, prostrate knotweed, wild buckwheat.

**Composite or Sunflower (Asteraceae):** Leaves are mostly alternate and flowers are in heads with numerous small flowers in each head. There are central and margined ray flowers or all rays flowers and contain milky juice. Examples: Canada thistle, sunflower, dandelion.

**Dogbane (Apocynaceae):** Plants mostly containing milky juice and leaves are mostly opposite and entire. Plants are branched. Examples: hemp dogbane.

**Goosefoot or Lambsquarters (Chenopodiaceae):** Very similar to the pigweed family but the small greenish flowers do not have a bristly bract. Often, there is a white mealy look to leaves and stems and leaves are usually alternate. Examples: common lambsquarters, kochia, Russian thistle.

**Grass (Poaceae):** Leaves are in two rows on opposite sides of the stem and are narrow and parallel veined. Stems are round or flat, with definite nodes and internodes. Flowers are simple without showy petals. Examples: downy brome, giant foxtail, quackgrass, Johnsongrass.

**Legume (Fabaceae):** Mostly compound and alternate leaves that are trifoliate or pinnate and bear a pair of stipules at base of leaf petiole. Flowers have two petals fused with a total of five petals. Examples: alfalfa, yellow sweet clover, black medic, lupine.

**Mallow (Malvaceae):** The leaves are alternate and generally round and flowers have five petals. Examples: common mallow, Venice mallow, velvetleaf.

**Milkweed (Asclepiadaceae):** Plants mostly containing milky juice and leaves are opposite or whorled. Flowers are in umbels. Plants are mostly branched. Examples: swamp milkweed, milkweed.

**Mint (Lamiaceae):** Square stems with opposite leaves that are often toothed or lobed. The flowers have petals of unequal size and shape. The plant is usually hairy and often aromatic. Examples: henbit, catnip, Mediterranean sage.

**Morningglory or Bindweed (Convolvulaceae):** Plants are viny and leaves are alternate and entire with a pair of basal lobes. The flowers have showy petals and are fused into a tube. Examples: field bindweed, hedge bindweed, dodder.

**Mustard (Brassicaceae):** Leaves are usually alternate and some have a basal rosette. The flower has four separate petals. Examples: shepherdspurse, mustard, hoary cress, field pennycress.

**Nightshade (Solanaceae):** Flower parts are mostly in 5’s and fruit is a capsule or berry with many seeds. The petals and sepals are united at base and leaves are often lobed or divided. The plant is often strongly scented and sometimes spiny or vine like. Examples: hairy nightshade, black nightshade, buffalobur, groundcherry.

**Pigweed (Amaranthaceae):** Leaves usually alternate but may be opposite. Flowers are small and without true petals so they appear greenish, small bristly bracts at the base of the flowers. Examples: redroot pigweed, palmer amaranth, waterhemp.

**Sedge (Cyperaceae):** Leaves are in three rows along the stem with triangular stems. They lack definite nodes and internodes and leaves are parallel veined and entire. Examples: yellow nutsedge, purple nutsedge.

**Spurge (Euphorbiaceae):** Plants with milky juice that mostly lack true petals and sepal but bearing showy bracts. Examples: leafy spurge, prostrate spurge. Other plants with milking sap: Dandelions, western salsify, and prickly lettuce.
For safe and effective use of insecticides, always identify the problem correctly.

1. Alfalfa Weevil Adult, Larvae and Damage
2. Clover Leaf Weevil Larva
3. Army Cutworm
4. Variegated Cutworm
5. Grasshopper
6. Green Clover Worm
7. Potato Leafhopper (Greatly Enlarged) and Leafhopper Damage to Alfalfa
8. Meadow Spittlebug and Nymphs
9. Spotted Alfalfa Aphid
10. Pea Aphid (*see text for blue and cowpea aphids)
1. **ADULT ALFALFA WEEVIL**  Overwinters in alfalfa. Females lay eggs in alfalfa stems from September through June. New adults leave alfalfa fields in June to estivate in field margins, woods and other sheltered areas until fall when they return to alfalfa. Adults feed primarily on alfalfa, but will infest clovers and several other plants if alfalfa is not available. Adults are 1/4-inch long, brown colored with a darker stripe down the back.

**ALFALFA WEEVIL LARVAE**  The larvae shown are fully developed and ready to pupate for the change to adults. The larvae normally hatch in April, May and June. Newly hatched larvae are yellowish with black heads. They imbed themselves in the growing tips of alfalfa stems. After several days feeding, the larvae turn green and have a white stripe down the back. When fully developed, the larvae are about 3/4-inch long. Chemical control of the larval stage is the best method of control available at this time.

**ALFALFA WEEVIL DAMAGES**  Close inspection of infested fields in the spring is necessary to detect the beginning of leaf skeletonization caused by larval feeding. As more and more leaf tissue is removed, the field assumes a silvery appearance. Feeding may continue until stems are also eaten which may kill young alfalfa plants. Hay quality will be very poor if feeding damage reaches the degree shown.

2. **CLOVER LEAF WEEVIL**  A close relative of the alfalfa weevil occasionally injures alfalfa and red clover. These insects usually pass the winter as partially grown larvae and may be found at the base of plants during the day. The larvae are green with a pale white stripe edged with pink down the back. Full grown larvae are about 1/2 inch long. Adult weevils are twice as large as the alfalfa weevil and lay their eggs in September and October. Disease and a parasitic wasp keep this species in check most of the time.

3. **ARMY CUTWORM**  Body grey to brown, usually with a broad brownish band running the length of the back. Head is distinctly freckled. Mature length is 1 1/2 inches. Overwinters as half-grown larvae. One generation per year. Feeds above ground but may burrow into plain shallow soil surface. Attack winter wheat and alfalfa in late winter as partially grown larvae and may be found at the base of plants. The cutworm overwinters as a pupa. When fully developed the larvae measure 1-1 1/2 inches long. They have pale yellow dots along the middle of the back, and often have a W on the eighth abdominal segment. The skin is smooth, generally ashen in color, or a light dirty-brown, lightly mottled with dark brown. Three to four generations occur.

4. **VARIEGATED CUTWORM**  Larvae of this pest are frequently found in alfalfa and other crops. The cutworm overwinters as a pupa. When fully developed the larvae measure 1-1 1/2 inches long. They have pale yellow dots along the middle of the back, and often have a W on the eighth abdominal segment. The skin is smooth, generally ashen in color, or a light dirty-brown, lightly mottled with dark brown. Three to four generations occur.

5. **GRASSHOPPER**  Several species of grasshoppers are commonly found in forages. Outbreaks severe enough to cause economic damage are usually associated with prolonged periods of drought. Undisturbed areas, such as fence rows, roadsides and pastures are the preferred habitats for early development.

6. **GREEN CLOVERWORM**  Nearly always present in alfalfa and clover, the green cloverworm occasionally attains economically important numbers. It overwinters both in the pupal and adult stage. The adults are dark brown, black spotted or mottled moths with a wing spread of about 1 1/4 inches. The larvae are about the color of alfalfa leaves with two narrow white stripes down each side of the body. When fully grown, they are 1-1 1/4 inches long. Two to three generations probably occur in Missouri.

7. **POTATO LEAFHOPPER**  This pest is known to feed on 100 cultivated and wild plants. The 1/8-inch-long, yellowish-green, wedge-shaped adults migrate into the state each spring. The females live a month or more and deposit 2-3 eggs a day in plant stems and leaf petioles. The eggs hatch in 10 days, and the yellowish-green nymphs become full grown in about two weeks. The nymphs are similar in shape to the adults, but lack wings. They feed on the underside of the leaves, usually where they hatched. The leafhoppers pierce the leaf vein and suck the sap from the plant, causing the leaves to turn yellow. In dry seasons, the added stress of drought to “hopperburn” can cause serious damage to alfalfa plants, as well as loss of the current cutting. Two to four generations may occur in Missouri each year.

8. **MEADOW SPITTLEBUG**  Nymphs are found inside the spittle masses in April, May and June. They are pink when very young, but turn yellowish-green as they develop. Soon after hatching, the nymphs secrete a liquid (mostly plant sap) and force air through it to produce the spittle masses. The grey or mottled-brown winged adults, about 1/4 inch long, emerge in June. Almost all damage is caused by the nymphs sucking sap from the plant.

9. **SPOTTED ALFALFA APHIDS**  These plant lice are usually pale yellowish-green with six or more rows of black spots on their backs. The spotted alfalfa aphids seen on alfalfa are nymphs or winged and wingless females. Males are rare. Both adults and nymphs suck sap from the plants. Resistant alfalfa varieties, including Cody, offer adequate protection against this pest.

10. **PEA APHID**  These plant lice are usually pale yellowish-green, darker than the spotted alfalfa aphid, and do not have spots on their bodies. Antennae are green with dark joints. BLUE APHIDS have uniformly dark antennae. Infestations may build up in April, May and June. Predators usually hold the populations in check. Smaller (1/16”) than pea aphids.
1. Lodging

2. Corn Rootworm Larvae

3. Severe Root Pruning

4. Wireworms

5. Garden Symphyllans

6. Slender Seedcorn Beetle

7. Seedcorn Beetle

8. Seedcorn Maggots

9. Black Cutworms

10. White Grubs

11. Corn Root Aphids

12. Grape Colaspis

13. Billbugs
1. LODGING is a symptom of corn rootworm damage. When rootworms destroy the root system, the stalk tips over or is blown over. With sufficient moisture, new roots develop and the corn will grow upright in an elbowed or goose-necked condition. Such damaged plants are often weak and produce poor ears. Fields where lodging is severe are also difficult to harvest because of tangled rows resulting from the elbowing.

Three species of corn rootworms may be found in Illinois cornfields. Northern and western corn rootworms are common corn pests in most of Illinois. Both species deposit eggs near corn plants in August and September. These eggs winter and hatch the following June and July, and the larvae feed on corn roots for several weeks. When mature they pupate in the soil, and emerge as beetles in July and August to feed on pollen and cornsilks before depositing their eggs in the soil. Southern corn rootworms migrate into Illinois where they deposit eggs in cornfields regardless of crop rotation. They are not as common as the northern and western species.

2. CORN ROOTWORM LARVAE are white worms with brown heads, and when fully grown are over 1/2 inch long. They will destroy the roots by boring through them or scarifying the surface and leaving elongated channels. Most of this damage occurs to the roots just below the ground level.

3. SEVERE ROOT PRUNING can greatly reduce yields. The northern and western corn rootworms cause the most damage where corn is grown year after year. This is because corn is a principal host, and they do not develop to any great extent on other plants. Rootworms are not ordinarily a problem where corn is rotated regularly with other crops.

4. WIREFORMS are most common in May and June in low, poorly drained spots in fields. They are most common in muck soils or soils that contain high amounts of organic matter. In the summer the insects move deeper into the soil, seeking moisture and cooler temperatures. The wireworms are slow to mature, and many of them remain in the soil as long as six years before they reach maturity, when they pupate and emerge as common click beetles. Wireworms damage corn by hollowing out the seeds before they germinate and by drilling holes into the base of the plant. This results in poor stands, and plants in various stages of development can be found dying. Occasionally plants will try to recover, and sprouts will be sent out from the base of the plant, giving a distorted and stunted appearance. Infestations are often spotty throughout the field with only certain areas having serious damage.

5. GARDEN SYMPHYLANS are tiny, gray pests that disappear very rapidly when exposed to light. They have 12 pairs of legs, long antennae and a pair of short projections on the tip of the abdomen. They feed on corn roots in spring and early summer. Severely damaged plants may die or be stunted while those moderately damaged may be purplish or stunted. They follow moisture and may be found several feet deep in the soil by mid summer.

6. THE SLENDER SEEDCORN BEETLE and (7) THE SEEDCORN BEETLE injure corn seed. They can commonly be found in the spring of the year. They hollow out the seeds, and when germination is slow and the soil is cold, the damage can be severe.

7. SEEDCORN BEETLE. (For text see 6.)

8. SEEDCORN MAGGOTS destroy seeds before germination. This usually happens when the soil is cold and germinating conditions are poor. Damage apparently is more common in soils with high organic matter; the flies that lay the eggs are attracted to the decaying vegetation.

9. BLACK CUTWORMS are classed by many as the most severe soil insect problem in Illinois corn production; these worms are found most commonly in low or poorly drained spots in fields or in bottomland where they are referred to as the overflow worms. When small they feed near the surface but soon burrow into the ground and cut plants below the soil surface. Plants cut above the growing point will often recuperate, but plants cut off below the growing point die. Cutworms can usually be found near the damaged plants. When full grown (about 2 inches in length), they pupate and change into moths. Under normal conditions there is only one generation in an area.

10. WHITE GRUBS are the young of the common May beetles or June beetles. The complete life cycle may require two or three years. White grubs can commonly be found in grass sods in large numbers; when the sod is plowed, roots of the following crop will be severely eaten and the plants may die. Several species attack plants in fields under continuous cultivation. The rotation of corn and soybeans seems to be particularly attractive to some species for egg-laying. Damage is usually localized, rather than being uniform throughout the field. Small areas may be entirely destroyed, while others are not affected.

11. CORN ROOT APHIDS are most likely to cause damage in dry years. They ordinarily can be found after a grassy or weedy field has been plowed up and planted to corn. Corn plants infested by corn root aphids will grow normally until they are about 4 to 10 inches high at which time they become stunted and the leaves take on a yellowish or reddish appearance. Tiny bluish green insects that suck the plant juices may be found in clusters on the small roots. Many small ant hills are found in the area of infestation. Usually you will be able to find small brownish ants in conjunction with the aphids. These ants tend the aphids to obtain the honeydew which the aphids secrete.

12. GRAPE COLASPI are comma-shaped and about 1/4 to 1/6 inch long when full grown. They pupate in the soil, and the brown beetles that emerge deposit eggs in clover and soybean fields. The tiny grubs hatch out in the fall, overwinter and feed on the roots of corn plants the following spring. Damaged plants turn purple and become stunted. Plants ordinarily vary greatly in size throughout the infested area. The grubs cease feeding by mid- to late-June; with moisture the plants will then grow normally.

13. BILLBUGS are associated with weedy patches in fields (nut-grass particularly) or grass waterways. They may injure or sometimes kill the plants. Plants that survive have typical rows of parallel holes running across the leaves. Other insects may do similar damage.
CORN INSECTS – ABOVE GROUND

1. Corn Flea Beetle
2. Corn Rootworm Beetles
3. Southern
4. Western
5. Northern
6. Rootworm Beetle Pollination Injury
7. Thrips and Damage
8. Corn Leaf Aphid
9. Chinch Bugs
10. Stalk Borer
11. Fall Armyworm and Damage
12. European Corn Borer
13. Whorl Feeding and Mature Bore
14. Black Head Stage Egg Mass
15. White Egg Mass
16. Corn Earworm
17. Scavenger Beetles
18. Armyworm
19. Woolybear
20. Cattail Caterpillar
21. Southwestern Corn Borer
22. Grasshopper and Damage
23. Corn Blotch Leafminer
24. Hop Vine Borer and Damage
1. **CORN FLEA BEETLES** are tiny black jumping beetles that injure corn early in the season; if growing conditions are poor, plants are sometimes killed by their attack. Larger plants outgrow the damage. The importance of corn flea beetles in Illinois is in their relationship with Stewart's disease; the beetles transmit the bacteria from plant to plant, and the bacteria overwinter only in the gut of the flea beetle.

2. **CORN ROOTWORM BEETLES** of all three species can be found in cornfields. The southern corn rootworm (3) adult migrates into Illinois as early as mid-May and feeds on leaves of soybeans and corn. It rarely is a problem. Both the western (4) and northern (5) rootworm adults feed extensively on corn silks in late July, August and September. If pollination has not occurred, severe damage can result (6).

3. **SOUTHERN CORN ROOTWORM.** (For text see 2.)

4. **WESTERN CORN ROOTWORM.** (For text see 2.)

5. **NORTHERN CORN ROOTWORM.** (For text see 2.)

6. **ROOTWORM BEETLE POLLINATION INJURY.** (For text see 2.)

7. **THRIPS DAMAGE** is often noticed as white stippling or striations on the leaf surface. This damage attracts attention but is rarely a problem.

8. **CORN LEAF APHIDS** are small, soft-bodied plantlice that cluster on the tassel and upper parts of corn plants. Severely infested plants may be barren. Severe infestations prevent normal ear development, and plants produce poorly filled or shrivelled ears. Aphid infestations begin before tassel emergence; by the time the silks are dry, the aphids on many plants have begun to disappear. Early-planted corn and certain hybrids often escape most of the injury.

9. **CHINCH BUGS** are favored by long periods of dry weather. They winter in bunch grass and similar grasses, and migrate to small grain in the spring where they lay their eggs. The spring brood usually develops in thin stands of grain; as the grain dries out, the bugs migrate into cornfields. Severe infestations can practically annihilate a field. The bugs mature, fly away and locate in weak spots in cornfields where another generation is formed.

10. **COMMON STALK BORERS** are general feeders that attack small grains, clovers, weeds, corn and many kinds of plants with hollow or soft stems large enough for their body. Damage to corn is confined to marginal rows by fence rows, ditches or grass or waterways where the borers have moved in from weeds. These borers feed in the whorl, and when the leaves emerge the plants have a chewed-up ragged appearance. No-till corn can be severely damaged, particularly where grasses provided a site for egglaying the previous summer.

11. **FALL ARMYWORMS** are occasionally pests in late planted corn. The moths migrate into Illinois from the south as they do not winter in Illinois. Although they can damage an entire field of late corn, they ordinarily are found in late maturing patches in a field. The moths prefer to oviposit in this corn. The worms can be damaging to ears of corn as they near maturity. This insect is more commonly a pest of sweet corn.

12. **EUROPEAN CORN BORER** winter as mature borers, pupate in the spring, and emerge as moths in June. They lay eggs (14, 15) on the most advanced corn they can find. Young borers seek protection in midribs, behind the leaf sheaths, and in the whorls (13). As tassels emerge, the borers crawl behind the leaf sheaths and imbed in the stalk. There they mature, pupate and emerge as moths to lay eggs for a second generation on late-planted corn where the borers feed in the stalks, ear shanks and ears. A third generation may occur in the southern third of Illinois. Insecticides for first-generation corn borer control must be applied after most of the eggs have hatched but before borers imbed in the stalks. Second generation eggs are deposited over a longer period of time and upon hatching, borers immediately seek protection. Thus control with insecticides requires much more precise timing.

13. **WHORL FEEDING AND MATURE BORER.** (For text see 12.)

14. **BLACK HEAD STAGE EGG MASS.** (For text see 12.)

15. **WHITE EGG MASS.** (For text see 12.)

16. **CORN EARWORMS** winter only in the extreme southern part of Illinois. They are not serious pests of field corn but often ruin ears of sweet corn, making them unmarketable or unfit for canning. These worms also feed on soybeans, tobacco, cotton and tomatoes. Their color varies from yellow to tan to brown to green. There are several generations each year. Control on field corn is difficult and expensive and is perhaps profitable only for costly seed corn. Early planting of field corn will often avoid damage.

17. **SCAVENGER BEETLES** (picnic beetles) and **CORN SAP BEETLES** are nuisance insects which usually attack ears of corn, particularly sweet corn, after damage from other causes have occurred. Picnic beetles only attack ears corn following earworms, corn borer or other insect damage as well as weather damage. Molds and other fungi have ready access to such ears. Sap beetles are also primary invaders.

18. **ARMYWORM** outbreaks occur only when large numbers of moths migrate in from the south. They lay their eggs in luxuriant vegetation, in small grain and in timothy and other grass fields. The worms may strip the small grain, cutting off wheat heads as the grain matures. The worms then leave these areas and migrate in search of food. They may strip corn plants of their leaves but ordinarily the plants recuperate. No-till or late-planted corn on grass or grain sod is often severely attacked by worms which were in the grass. Also, moths fly northward after an outbreak and deposit eggs in weedy spots in cornfields where severe defoliation may occur in August. Consecutive generations in the same area are usually controlled by disease, insect parasites and other natural enemies. There are 2-3 generations per year.

19. **WOOLLYBEARS** are common in cornfields from just before silking until the corn nears maturity. They may be white, brown or tawny. They feed on leaves and silks. Although they feed heavily on silks, pollination usually has already occurred and no damage results.

20. **CACTAIL CATERPILLARS** (Simyra henrici Grote) feed on corn leaves but rarely are of economic importance as they are controlled naturally by a wasp parasite. The larvae are bristly black, orange and yellow caterpillars.

21. **SOUTHWESTERN CORN BORERS** are found only in southern Illinois. If they ever adapt to the Illinois winters, they will be a far worse pest than European corn borers. The mature borers winter below ground in the base of the stalk. Before wintering, they girdle the inside of the stalk about one to two nodes above the ground, and such stalks fall over in September and early October.

22. **GRASSHOPPERS** ordinarily hatch in clover or alfalfa fields as well as fence rows and ditches; when food is scarce, they begin to migrate and become serious pests of soybeans and corn. Ordinarily damage is confined to the border rows, but severe infestations may destroy entire fields.

23. **CORN BLOTCH LEAFMINERS** tunnel between the upper and lower surfaces of a corn leaf. These tunnels are quite noticeable but are of no economic importance.

24. **HOP VINE BORERS** are sporadic pests of corn in Illinois and Iowa. They are dirty white and have prominent black spots on each abdominal segment; they feed at the crown of the corn plant just above the permanent root system, much as cutworm does. Infested plants wilt and die. Damage usually occurs in late June and July in border rows near fence rows or grass waterways, although severe damage has been observed in spots throughout the field.

25. **WESTERN BEAN CUTWORM.** See color plate: CATERPILLARS in FIELD CROPS I.
1. Thrips Injury to Seedling Cotton

2. Cotton Aphid Damage to Leaves (Inset — Aphids and Predator)

3. Two-spotted Spider Mite Damage to Leaf (Inset — Color Phases of Mites)

4. Loopers and Damaged Leaf (Diseased Looper on Left)

5. Adult Boll Weevil

6. Upper — Boll Weevil Punctures Lower — Larva, Left; Pupa, Right

7. Bollworm Attacking Boll

8. Upper — Bollworm Egg Lower — Bollworm Moths

9. Typical Bollworm Damage

Prepared by the Clemson University Cooperative Extension Service’s Entomology - Plant Pathology and Agricultural Communications Sections, Federal Extension Service Cooperating
1. THrips are tiny, winged insects that injure plants in feeding on their juices. Several species attack cotton plants. They complete a generation in about two weeks and produce many generations in a year. Both larvae and adults damage cotton plants. These insects injure cotton seedlings and may also injure older plants. They attack leaves and terminal buds. Severely infested young plants may die, and the stand may be destroyed or reduced to the point where the crop must be replanted. Thrips injure leaf tissue in terminal buds results in ragged, crinkled leaves that curl upward (aphid injury would cause leaves to turn downward). The terminal buds develop, and the plant becomes distorted and excessively branched. The abundance of thrips, extent of their damage and need for their control vary greatly in different years and areas.

2. THE COTTON APHID, also called the cotton louse, occurs wherever cotton is grown. The adult cotton aphid is a soft-bodied, sucking insect that ranges in color from light yellow to dark green or almost black. They give birth to living young. Reproduction is continuous and there are no distinct generations. This insect damages cotton by sucking juices from the plants. When heavy infestation occur on seedling cotton the leaves curl or crinkle; plants become stunted and may die. Heavy infestations in mid-season make the leaves turn yellow and shed; this causes square and small bolls to shed. Late season infestation makes leaves shed, causing premature opening of bolls and immature development of fiber. Also, honeydew secretions from the aphids drop on the fibers making it sticky. Often, a fungus develops in the honeydew deposits, causing the plants to appear black or sooty. Fiber picked from such plants is stained, sticky and of low quality. In Missouri the cotton aphid is often controlled by its natural enemies. It seldom increases to damaging numbers unless its natural enemies are killed or retarded. Note: Inset shows a lady beetle larva preying on aphid colony.

3. SPIDER MITES, commonly called red spiders, attack many plants. Several species attack cotton. The mites are tiny, barely visible to the naked eye. Some are red, but many are green, orange or straw colored. Spider mites are kept under control by weather, beneficial insects that kill mites, and other species of mites that prey on them. Outbreaks are most likely to occur following application of pesticide that destroys the beneficial insects and mites. Spider mites may complete as many as 16 generations in a year. Generally, they reproduce from eggs but live birth is known to occur. They attack cotton in any stage of growth, but are usually most injurious from July 1 to early September. Infestations are most noticeable during periods of hot weather. They are detected by inspecting the undersurfaces of leaves of plants in different parts of the field, particularly in areas that were infested in previous years. Their feeding causes plant parts to become blotched or stippled and causes leaves to become discolored and drop prematurely. Heavy infestation causes cotton to open prematurely, thus a lower quality of cotton is produced.

4. SEVERAL LOOPERS are known to attack cotton. The cabbage looper and cotton leafworm are the two most commonly found in Missouri. The cabbage looper is most often reported and overwinters locally. The cotton leafworm occurs rarely and migrates from South America. It usually occurs late in the growing season. Both insects are commonly controlled by virus and fungus disease organisms. In Missouri the cotton leafworm is often controlled by natural enemies. Outbreaks are most noticeable during periods of hot weather. They are detected by inspecting the undersurfaces of leaves of plants in different parts of the field, particularly in areas that were infested in previous years. Their feeding causes plant parts to become blotched or stippled and causes leaves to become discolored and drop prematurely. Heavy infestation makes leaves shed, causing premature opening of bolls and immature development of fiber. Also, honeydew secretions from the aphids drop on the fibers making it sticky. Often, a fungus develops in the honeydew deposits, causing the plants to appear black or sooty. Fiber picked from such plants is stained, sticky and of low quality. In Missouri the cotton aphid is often controlled by its natural enemies. It seldom increases to damaging numbers unless its natural enemies are killed or retarded. Note: Inset shows a lady beetle larva preying on aphid colony.

5-6. THE BOLL WEEVIL has four stages in its life cycle: egg, larva, pupa and adult. Under favorable conditions it completes the cycle in 2 1/2 to 2 weeks. High temperatures and humidity speed the cycle; low temperatures slow down the development. As many as seven generations may develop in the extreme southern part of the Cotton Belt. The adult boll weevil is 1/8 to 1/3 inch long. It ranges in color from tan to dark gray, or sometimes to dark brown. Starting in early spring, the female lays eggs in cotton squares. Late in the season, eggs are laid both in squares and young bolls. Eggs hatch in 3 to 5 days. The larvae feed 7 to 12 days inside the squares or bolls. After feeding 3 to 7 days, and mating, females begin laying eggs. The cycle is repeated until the cotton plants are killed by cold weather. By means of jaws at the end of its snout, an adult boll weevil eats into a square or boll. Two types of punctures result: feeding punctures are made both by males and females; egg punctures are made by females as places in which to lay their eggs, and are deeper than feeding punctures. Both types of punctures cause damage. Often a square is punctured, the bracts flare, the square turns yellow and usually drops to the ground. Punctured large bolls usually remain on the plant, but if they have egg punctures, they may be damaged by the weevils developing in the holes where the eggs were laid. Weevil infested locks produce no cotton or they produce a little that is of inferior quality.

7-8-9. THE BOLLWORM feeds on cotton squares and bolls; it reduces yield and sometimes destroys the crop. In its development, it has four stages: egg, larva (caterpillar), pupa and adult (moth). Only the larvae are destructive. Between spring and early fall, this insect produces four to six generations. On cotton, moths usually lay eggs on the tender, growing tips of plants and on the top sides of leaves. Sometimes, they lay eggs on squares, bolls and stems. Eggs are white, ribbed and dome shaped; they are about half the size of a pinhead. Larvae hatch from eggs in three to five days. Color of the larvae varies; it may be pale green, rose, brown or almost black. Full grown larvae are 1 to 1 1/2 inches long. For a day or two after hatching, larvae feed on the nearest tender growth. Then, larvae on terminal buds of the cotton plant move downward; those on fruition branches move toward the center of the plant. The larvae eat out the squares and tunnel into and eat the contents of the bolls. Mature larvae enter the ground and change into pupae, from which moths emerge. There are two different bollworms on cotton: the corn earworm Heliothis zea or common bollworm pictured in the left side of Figure 8, and the Tobacco Budworm Heliothis virescens pictured on the right side of Figure 8. In Missouri the Heliothis zea is the predominate species, but a small percentage of an infestation can be tobacco budworm.
1. A Wireworm Common in MO
2. False Wireworm Common in KS
3. Greenbug
4. Greenbug (Seedling)
5. Greenbug Leaf Damage
6. Parasitized Greenbugs
7. Yellow Sugarcane Aphid
8. Yellow Sugar Cane Aphid Colony
9. Yellow Sugar Cane Aphids on Leaf
10. Corn Leaf Aphid
11. Corn Leaf Aphids in Whorl
12. Chinch Bugs Early Season Infestation
13. Chinch Bugs Mid-season Infestation
14. Chinch Bug Adults

Prepared jointly by Extension Entomologists of Kansas and Missouri.
Photo credits: No. 1, T. Riley, MO; No. 2, R. Nettleton, KS; No. 3, T.L. Harvey, KS; No. 4, 11, 12, 13, 14, L. Brooks, KS; No. 6, 10, D. Gates, KS; No. 7, J. Carnes, Mobay Chem.; No. 8, M. Roof, MO; No. 15, L. Jenkins, MO.
GRAIN SORGHUM INSECTS: I

1. **WIREWORMS** common in Missouri are hard, slick, orange colored larvae that are ½ to 1 ½ inches in length. They feed on the seed, bore into the underground portion of the stalk of the seedling, and eat the more tender roots. From two to three years are required to complete a generation, but generations overlap so that all stages are present every year. Grain sorghum following grasses or sod is most subject to attack.

2. **FALSE WIREWORMS** common in Kansas are usually found in arid locales. Larvae feed on seeds and young plants. Irrgular areas of a field may be damaged especially in the vicinity of straw stacks and weed patches. Damage is most severe in dry years.

3. **GREENBUGS** are light greenish-yellow aphids with a narrow, darker green streak down the center of the abdomen (back). The antennae, eyes, tarsi (feet) and tips of the cornicles are black. All remaining parts of the body, legs and cornicles are greenish-yellow. The greenbugs that attack sorghum differ from other aphids by their ability to reproduce at relatively high temperatures. Like all aphids, greenbugs have piercing sucking mouth parts. As they feed, a toxic substance is injected into the plant.

4. **GREENBUG** damage on seedling. Seedling grain sorghum plants are the most susceptible to damage. Planting should be delayed until soil temperatures are above 65 degrees. This not only allows for rapid seed germination, but seedlings emerge just after maximum green bug migration from small grains.

5. **GREENBUG** leaf damage is the signal for checking for economic damage. As greenbugs suck plant sap, they inject a toxin that causes characteristic reddish-yellow to reddish-purple spots around the point of feeding. Continued feeding usually results in the death of the tissue. Numerous colonies can kill entire leaves. Check Missouri’s *Insect Control Recommendations MIX 3*, and/or *UMC Guide 4349* for more information and economic thresholds for greenbug.

6. **PARASITIZED GREENBUGS.** Many beneficial insects feed on greenbugs and other aphids. The most important beneficials are several species of very small parasitic wasps. Eggs are laid within the greenbug’s body. The parasitized greenbug swells and turns tannish-brown as the larval wasp develops inside the aphid. The adult wasp emerges through a circular opening it cuts in the aphid’s back. A 10-20% rate of parasitism usually will control an infestation within a week.

7. **YELLOW SUGAR CANE APHIDS** are lemon-yellow in color and slightly larger than greenbugs or corn leaf aphids. Their bodies are oval (nearly round) and covered with hairs with two double rows of warts on each side of the back. The yellow sugar cane aphid’s life cycle is generally similar to that of the greenbug.

8. **YELLOW SUGAR CANE APHID COLONY.** These aphids inject toxic substances into the leaves, causing yellow spots that quickly turn to a reddish color. Feeding damage is identical to greenbug.

9. **YELLOW SUGAR CANE APHIDS** on leaf. Eventually, feeding on the leaf causes the leaf to start turning brown at the outer edges and ultimately to die. See literature on greenbugs for economic thresholds and control recommendations.

10. **CORN LEAF APHIDS** are greenish blue in color. Antennae and the entire legs and cornicles are black.

11. **CORN LEAF APHIDS IN WHORL.** Typically this is the location for corn leaf aphids on grain sorghum. Unlike the two previous aphids, corn leaf aphids do not inject a toxin during feeding. Normally, there is no discoloration or leaf tissue death from prolonged feeding. Under severe drought stress, heavy infestations may cause some reddish streaking of top leaves and failure of some heads to completely emerge from the boot.

12. **CHINCH BUGS** early season infestation. Young grain sorghum is most susceptible to chinch bug injury. Avoid planting adjacent to small grains where 50 or more chinch bug nymphs are found per foot of drill row. Or, slightly delayed plantings can be protected for several weeks with an in-furrow application of a systemic insecticide.

13. **CHINCH BUGS** mid-season infestation. The more tolerant, older grain sorghum may be injured by large numbers of chinch bugs. They feed on the lower part of the plant under leaf sheaths, on the lower stalk and even underground on roots. Attempts at control may be frustrating even with the use of directed high pressure and high volume applications.

14. **CHINCH BUG ADULTS** are black insects with white wings each marked with a black triangular spot on the middle of the outer edge. The adult is the overwintering stage. There are two generations per year. **FALSE CHINCH BUG** adults are gray to brown in color.

15. **CHINCH BUG Nymphs and Adults** both give off a vile but characteristic aromatic odor when crushed. Nymphs are colored red to black with a white stripe across their backs. A true bug, they only attack members of the grass family, sucking sap from plant tissues through their piercing, sucking mouth parts. Chinch bugs are more numerous and cause greater damage in droughty years.

JAMES H. JARMAN, PEST MANAGEMENT SPECIALIST
GRAIN SORGHUM INSECTS: II

Prepared by Extension Entomologists of Kansas and Missouri.

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16. Fall Armyworm in Whorl
17. Fall Armyworm Head Capsule
18. Sorghum Midge Adult
19. Sorghum Midge Adult
20. Sorghum Midge Damage
21. Sorghum Midge Pupal Case
22. Frass on Flag Leaf Sign of Head Infestation
23. Sorghum Webworms in Head
24. Sorghum Webworm Close Up
25. Corn Earworm
26. Scouting Procedure for Insects in Heads
27. Bird Damage
28. Typical Breakage from European Corn Borer
29. Close Up of European Corn Borer
16. **FALL ARMYWORM IN WHORL.** Damaged, frass covered leaves emerging from the whorl give the plant a very raggy appearance. Later plantings of grain sorghum are usually the targets of more serious infestations. Control procedures should begin when plants under two feet tall exhibit 20-25% whorl or leaf feeding. This tropical insect migrates northward from the Gulf Coast. Its appearance in Missouri is later than the true armyworm.

17. **FALL ARMYWORM HEAD CAPSULE.** A prominent, inverted white “Y” on the front of the head is the key structure for identification. Fall armyworms have more prominent black warts with longer fine hair on the body than true armyworms.

18.-19. **SORGHUM MIDGE ADULTS.** The adult midge is a tiny, reddish-orange fly that lays its eggs in the florets of the grain sorghum head and its wild host, Johnsongrass. Only one or more midges per head signal the need for chemical control. During the adult’s life of only one day, it will lay 30 to 100 eggs. This insect is usually of importance only in the southern one-fourth of Missouri.

20. **SORGHUM MIDGE DAMAGE.** Mid to late plantings are the most seriously affected. The midge larvae hatch into gray or reddish headless maggots that consume the developing seeds. No seeds will be formed from infested florets. This pest has been of major importance in the Delta area of Missouri.

21. **SORGHUM MIDGE PUPAL** cases extend from the ends of blasted grains. The midge overwinters within the florets. Destruction of grain-sorghum residues, Johnsongrass and other related plants is an important cultural practice. The complete life cycle is only 14 to 16 days. Uneven grain sorghum development, where head emergence spreads over three to six weeks, will allow multiple generations to develop within the field, causing increased damage and making chemical control impractical.

22. **FRASS** on flag leaf sign of head infestation. Droppings from head feeding insects (frass) is a prominent sign of an infestation even when worms are not evident from a casual survey. Head feeding can result in severe economic damage by direct yield reduction.

23. **SORGHUM WEBWORMS** in head. Thresholds for this insect are a relationship of the number of larvae per head and distance between heads. When the average distance between heads is 4, 6, 8, 12 or 16 inches, the economic threshold of larvae per head is 2, 3, 4, 6 and 8, respectively. Sorghum webworms are usually most destructive on late planted sorghum in the southern third of Missouri.

24. **SORGHUM WEBWORM** close up. These are greenish-tan worms with four reddish-brown stripes down the back. They are about ½ inch in length when fully grown and are very hairy.

25. **CORN EARWORM LARVAE** may damage grain sorghum heads some years, particularly over the southern one-fourth of the state. Small larvae may hollow out grain while larger larvae devour the entire kernel. Exact economic thresholds depend on potential yield and expected prices. Still, a single half-grown larva per head is an economic infestation at expected yields of 3,500 lb. per acre. The threshold drops to ¼ of a worm per head average at yields over 4500 lb.

26. **SCOUTING PROCEDURE FOR INSECTS IN HEADS.** To help in counting insect larvae in the heads, build a light wooden frame about 8 x 10 inches and cover it with white cloth. On one side of the frame attach two wooden pegs that will slip behind the belt on trousers, holding the frame in place. Then, with both hands free, a scout can shake the sorghum heads so the dislodged worms fall onto the cloth surface. Check 20 plants in several random locations in the field to obtain an accurate infestation level.

27. **BIRD DAMAGE.** Grain sorghum kernels in the milk and soft dough stage are attacked by bird feeding. The contents of the soft grain are squeezed out and eaten. Damaged kernels are flattened and appear to be “popped” at the tip. Fields where harvest is delayed are subject to reduced yields from birds. Bird repellents are available. Control of most birds is regulated by federal and/or state and local laws. Persons should contact local agencies before attempting bird control activities.

28. **TYPICAL BREAKAGE FROM EUROPEAN CORN BORER.** Second generation and (where it occurs) third generation European corn borers may attack grain sorghum. Some grain heads will fall due to stalk breakage. Control is not recommended due to ineffective coverage from treatments and small yield losses.

29. **EUROPEAN CORN BORER.** These flesh-colored worms with inconspicuous brown spots are ¼ to 1 inch long when full-grown. Cream-colored, flat, round eggs are laid overlapping each other in small clusters on the grain sorghum plant. Young larvae feed in the leaf axils. Corn borer larvae enter the stalk when they are about half grown.
For safe and effective use of insecticides, always identify the problem correctly.
1. CEREAL LEAF BEETLE was found in eastern Missouri in 1972 and is expected to slowly spread westward, eventually throughout the state. The overwintering adult beetle is about 3/16 inch in length with metallic blue-black head and wing covers, while legs and thorax are orange. These adults fly into small grains during early spring where feeding, mating and egg laying begin. Spring seeded oats are the preferred host, but any of the small grains and several grasses may be attacked. Eggs hatch into small, hump-backed, slug-like larvae which feed by skeletonizing the leaves, giving a heavily damaged field a silvery or frosted appearance. When mature, the larvae pupate in the soil and emerge as beetles during early summer. These beetles soon become inactive and seek hibernation areas in preparation for overwintering.

2. GREENBUG is a small, light green aphid having a narrow, darker green stripe down the center of its back and with the tips of the legs, cornicles and all of the antennae black. Occasionally, greenbugs may successfully overwinter in portions of Missouri; however, the majority of our problems stem from winged females migrating with the prevailing southwesterly winds during March. Injury first appears as a yellowish ring around the feeding puncture into which toxin has been injected and plant sap withdrawn. Eventually, injured leaf tissue becomes reddish and then brown as the tissue dies. Colonies of this aphid occur on underside of leaf blades, in the crowns, and occasionally on the stems. Other aphid species, such as English grain aphid, corn leaf aphid and apple grain aphid may also be found on winter wheat, barley and oats, but their feeding does not result in discolored or dead leaf tissue.

3. THRIPS feed by rasping plant surfaces and sucking the exuding sap. Several species can be found on small grains and other pasture and meadow grasses. Rarely are they considered economic pests of small grains in Missouri.

4. HESSION FLY has two generations annually. The maggots of the late summer or early fall generation work their way under the leaf sheaths near the crowns and feed by rasping the straw and sucking the exuding sap. Such feeding weakens and stunts plants and subjects them to abnormal winter kill. This generation completes its growth and overwinters under the leaf sheaths in a brown puparia known as “flaxseed.” The very small black flies emerge in the spring and lay eggs for the second generation. Larval feeding results in poorly filled heads and lodged straws. They change into “flaxseed” before grain harvest and remain in this stage on the stubble throughout the summer. Using resistant varieties and planting after “fly-free seeding dates” are reliable means of avoiding losses from this pest.

5. ARMYWORMS have become more or less annual problems on wheat, barley and rye, particularly over southern Missouri. Moths from overwintering pupae begin emerging during late March and early April. Additional moths migrate into Missouri from the southern states. Eggs are deposited on the more rank and dense fields of small grains and grasses. It takes about three weeks for the worms to mature. These larvae prefer to feed upon green blades, and when numerous, may completely strip the grain of leaves. When growth has not been completed by the time grain ripens, they may feed on or cut off the heads or migrate by crawling to adjacent grass or corn. Cool and wet weather is more favorable for armyworm development. The spring generation is always the most severe, but second and third generation may also damage grasses or corn during July and late August.

6. GRASSHIPPERS may become a problem in the early fall along the borders of small grain fields. Several drill widths may be destroyed by adult grasshoppers feeding on seedling plants. Small grasshoppers rarely hatch from eggs early enough in the spring to cause problems in the maturing small grains.

7. CHINCH BUGS are more likely to become problems following one or more consecutive dry years. Adults overwinter in bunch grasses and migrate to small grains in the spring where the first generation is produced. These red and white immature chinch bugs suck sap from the straws near the base of the plants. Heavy feeding causes plants to appear drought stressed. Small grains usually ripens before this first generation reaches the adult stage. These immature bugs migrate into nearby corn, sorghum or other grass host fields where they become adults and produce a second generation. Thick stands with adequate fertility apparently are unfavorable for chinch bug development.

8. WHEAT STEM MAGGOTS overwinter as pale greenish larvae in the straws near the crown. Fall injury is similar to that caused by Hessian fly. Another generation occurs about the time wheat has headed. Maggots feed within the straws just above the last or next to last joint. This spring feeding results in heads drying, becoming white and producing no grain. Normally, less than 1 percent of stand is infested.

9. WHEAT STEM SAWSFLY is not known to be an economic problem in Missouri. The larval stage of this small black wasp damages the straw by boring down through the joints, girdling the stem and resulting in straw breakage similar to that caused by Hessian fly.

10. RUSSIAN WHEAT APHIDS attack small grains. Most common in western parts of winter wheat belt in Great Plains. Identified by short antennae, short cornicles and a “double tail.”

11. RUSSIAN WHEAT APHIDS inject a toxin that causes long, light-colored stripes on leaves. Leaves may curl up in onion leaf fashion. Aphids feed inside curled leaves. Occasionally, infested plants will also turn purple and tillers will lie parallel to the ground. Heads can become trapped and distorted similar to phenoxy injury symptoms.
SOYBEAN INSECTS

1. Green Cloverworm  
2. Bean Leaf Beetle  
3. Mexican Bean Beetle  
4. Cabbage Looper  
5. Thistle Caterpillar  
6. Japanese Beetle  
7. Spotted Cucumber Beetle  
8. Corn Earworm  
9. Yellow Woollybear Caterpillar  
10. Striped Blister Beetle  
11. White Grub  
12. Potato Leafhopper  
13. Grasshopper  
14. Seed Maggots  
15. Grape Colaspis Larvae  
16. Twospotted Spider Mites  
17. Yellow and Black Thrips  
18. Snails and Slugs  
19. Stink Bugs  
20. Soybean Leafminers
SOYBEAN INSECTS

1. **GREEN CLOVERWORM** moths lay eggs on undersides of leaves of soybeans, garden beans, clovers, alfalfa and some small fruits in spring. The small worms eat large irregular holes in leaves (not the pods), become fully grown in about 4 weeks and pupate in the soil. Damage occurs in August when some fields may be 30 to 50 percent defoliated. Greatest damage occurs from leaf feeding between bloom and full pod development, to late planted beans suffer most from attack. The worm in the picture has two white spots behind its head – the eggs of a parasite fly that helps keep populations low.

2. **BEAN LEAF BEETLE** adults winter in soil debris near bean fields of the preceding year. In spring, they feed on seedlings before laying eggs at the base of soybean plants. The slender, white larvae feed on nodules, roots and stems just below ground. Adults emerge in late July and August, eat irregular holes in leaves and also feed on blossoms and pods. The effect of leaf feeding is greatest when it occurs between bloom and full pod growth. Blossom feeding may reduce pod set, and pod feeding may reduce yields.

3. **MEXICAN BEAN BEETLES** are most injurious to snap beans and only occasionally to soybeans. Usually damage is restricted to small sections of a soybean field near a vegetable garden. Adults winter in debris on the ground in fence rows, roadsides and wooded areas. They migrate to snap beans in May and June. Eggs are laid on the undersides of leaves and the larvae feed there also. Injury occurs in July and August.

4. **CABBAGE LOOPERS**, minor pests in Illinois, have several generations each year. The dark brown moths lay pale yellow to white eggs on the leaves at night. Young loopers appear in about 10 days and are fully grown in 2 to 4 weeks.

5. **THISTLE CATERPILLAR**, the larva of the painted lady butterfly, commonly feeds on thistle, but will occasionally attack soybeans. The caterpillar is mottled yellow, green and black with a lateral yellow stripe and is covered with yellowish spines. The caterpillar lives singly in a nest of leaves which it has woven together. The butterfly has a mottled red, black, brown and white wings. This insect has occasionally damaged soybeans in Illinois and Indiana. Can have several generations per year. Eggs are light green and laid singly.

6. **JAPANESE BEETLE** is present only in certain localized areas in Illinois. Adults feed on soybeans, corn silks, wild grapes, smartweeds and the foliage and fruits of trees, shrubs and flowers. They have a one-year cycle and spend about 10 months as a grub in the soil feeding on the roots of grasses and cereal crops. They winter as partly grown grubs and emerge as adults in late June and July.

7. **SPOTTED CUCUMBER BEETLE**, the adult of the southern corn rootworm, does not winter in Illinois but migrates into Illinois early in the spring and can be found feeding on soybeans and corn from late May throughout the season. Northern and western corn rootworm beetles will be found from late July through September as they migrate from corn fields. All three species feed not only on blossoms and leaves of soybeans but on many other plants.

8. **CORN EARWORMS**, also called tomato fruitworms and cotton bollworms, are minor soybean pests in Illinois. Adult moths fly into Illinois during May and June, and lay eggs on fresh corn silks and tomatoes. They are general feeders, attacking cultivated crops and weeds.

9. **YELLOW WOOLLYBEAR CATERPILLARS** may be white, tawny, orange or black as well as yellow. Woollybears emerge from round, white eggs laid in clusters on leaves by a white-winged moth. These very hairy caterpillars feed on soybean leaves in the latter half of the summer. They winter as pupae in silken cocoons. There are two generations per year.

10. **STRIPED BLISTER BEETLE** adults and other blister beetles feed on the blossoms and leaves of soybeans and are of minor importance. The larvae feed in grasshopper egg pods in the soil and are most numerous the year after a heavy grasshopper population. There is probably one generation a year.

11. **WHITE GRUBS**, young of the common May or June beetles, have a life cycle of two to four years—most commonly three years. Eggs are deposited in grass stems just below ground. Adults in soybeans fields. A corn-soybean rotation it quite attractive to these beetles for egg laying. The tiny grubs feed until the first cold spell in fall when they tunnel downward. Then from the next May until October they feed heavily on roots. They again winter deep in the soil. The following May, the large, nearly mature grubs return to the surface and feed heavily. They pupate in an earthen cell in early June, and change to adults in about 4 weeks. The beetles emerge from the soil the following spring.

12. **POTATO LEAFHOPPERS** do not winter in Illinois, but are carried into the state by strong southerly winds in May and June. Primarily a pest of alfalfa and potatoes, they will attack smooth-leaved soybean varieties which are not commonly grown in Illinois. Rarely will leafhoppers damage soybeans that have a heavy pubescence. Severe yellowing of alfalfa and severe tipburn of potatoes are indicators of leafhopper abundance in the area. Leafhopper adults fly at the least disturbance. The wingless green to yellow wedge-shaped nymphs, when disturbed, run sideways. One or two generations of leafhoppers develop each year in Illinois.

13. **GRASSHOPPERS** hatch in fields, roadsides, ditch banks and fence rows in June and early July. Hot, dry conditions favor survival, but heavy rains kill them. Hoppers stay in these areas until food becomes scarce, then migrate to soybeans and corn (usually late July and August). Ordinarily, damage is confined to border rows, but severe infestations may affect the entire field.

14. **SEEN MAGGOTS** tunnel into germinating seeds, thus reducing seedling stand. Damage is usually on individual scattered plants, but occasionally stands are drastically reduced. Damage is worst during cool, wet springs when germination is slow. Soybeans planted in high organic matter soil after grass, clover or alfalfa are more likely to be injured.

15. **GRAPE COLASPIR LARVAE** feed on roots of seedlings. Leaves of affected plants turn yellow and some plants may be killed. Soybeans following soybeans or following a blow-down of clovers are most likely to be attacked. The insect winters as a small larva in the soil. It feeds on roots in spring and is full grown by about mid-June (Central Illinois) when it pupates and changes to a small, tan, oval adult.

16. **TWOSPOTTED SPIDER MITES** suck the juices from the undersides of leaves that turn yellow, then brown and drop. Mites appear as tiny moving specks that produce a fine webbing in leaves. Large numbers of mites can develop within a short time under dry conditions in July and August.

17. **YELLOW AND BLACK THRIPS** rasp the leaf tissue, leaving long white streaks. They also suck the sap from the plants. Severely damaged leaves turn silvery or gray. Some feeding occurs in every soybean field during June, July and August, but only occasionally is control required. Dry weather enhances injury by thrips.

18. **SNAILS AND SLUGS** feed on leaves of plants. They are usually most abundant in fields where there is an abundance of rotting organic material as leaves, grasses, corn stalks and weeds. The slugs are common in greenhouses. These pests are not insects but are a related group. Slimy silvery trails are a characteristic of their presence since they feed at night and hide during the day under mulch, dead leaves, rocks and similar shelter. Although rarely a serious problem, soybeans may be attacked when planted in fields that are conducive to having snail populations.

19. **STINK BUGS** suck sap from soybeans and inoculate pods with yeast spot disease organisms, causing shriveling of the bean seed. When undeveloped seeds are attacked, pods frequently are aborted. Studies indicate an average of one stink bug per foot of row reduces yields 10 percent. A few stink bugs are always present, but large numbers occur occasionally. Some stink bugs prey on insects and are beneficial.

20. **SOYBEAN LEAFMINERS** are bright orange larvae, about ¼ inch long when full grown, that mine leaves between the upper and lower epidermal surfaces. These tunnels or mines are rounded and irregular and eventually turn yellow then brown before they drop out of the leaf. There are probably two generations a year with the adults overwintering in protected areas.

21. **GARDEN WEBWORM** (not pictured) form protective webs on leaves. Larva distinguished by 3 dark dots forming a triangle on each side of each abdominal segment. Stiff hairs protrude from these dots.
1. Life Stages of the Sugarbeet Root Maggot

2. Typical Sugarbeet Root Maggot Damage (Foliage)

3. Typical Sugarbeet Root Maggot Damage (Root)

4. White Grub

5. Cutworm Damage and Mature Cutworm Sugarbeets

6. Beet Webworm Adult

7. Beet Webworm Larvae and Typical Damage to Sugarbeets

8. Wireworm

9. Flea Beetles and Damage

10. Sugarbeet Root Aphids on Beet Leaf

11. Beet Root Damaged by Root Aphids (Undamaged Root on Left)
1. **LIFE STAGES OF THE SUGARBEET ROOT MAGGOT.** The mature maggots overwinters in the previous season's beet fields 6 to 10 inches below the soil surface. During late April and early May, the maggots move to within 1-3 inches of the soil surface to pupate. In the Red River Valley, emergence generally begins during late May and continues for a period of 46 weeks. Following emergence, maturing female flies are found in sugarbeet fields depositing eggs below the soil surface at the base of sugarbeet seedlings. Eggs hatch in 3-7 days, depending on soil temperature and moisture, and the newly hatched maggots move down immediately to begin feeding on the root surface. Severe damage can occur in untreated beets planted during mid-May since young seedlings cannot withstand early season feeding pressure and heavy stand losses can result. Early planted beets, seeded in April through early May, generally are able to withstand some feeding pressure because of additional growth prior to maggot fly emergence and oviposition. In this case, stand loss is not a significant factor but yield reduction at harvest generally results. Because of the long period of adult emergence and oviposition, maggots of various sizes can be found on injured beets from early June through August. Mature maggots, after completing their feeding, move away from the beet root and deeper into the soil during August and September, where they will spend the winter.

2. **AND 3. TYPICAL SUGARBEET ROOT MAGGOT DAMAGE.** Wilted plants during June and July are a sign of root maggot damage. Digging will reveal moist feeding tunnels and maggots in the soil around the root. Damaged roots are blackened and if maggot populations are large, the tap root may be severed.

4. **WHITE GRUB.** Grubs move up in the spring of their second season to begin feeding on beet roots, cutting them off below the soil surface. Feeding continues throughout the summer with grubs again moving deeper in the soil to overwinter. Feeding activity and damage in sugarbeets are most severe during the second year of the cycle. Feeding activity resumes the spring of their third year and continues into early summer, after which the grubs migrate downward to 6-8 inches below the soil surface where they form a cell in which they pupate. In late summer they change into the adult and remain in the soil over the winter, emerging the following spring. White grubs feed on the roots, causing wilting and stand loss in sugarbeets. Typical damage in fields is wilted or dead beets in patches or areas generally close to shelterbelts. Digging will reveal the white grubs just below the soil surface in close association with the wilted plants.

5. **CUTWORM DAMAGE AND MATURE CUTWORM IN SUGARBEETS.** Cutworms feed at night just below the soil surface during dry periods. Typical damage will be areas of wilted or dead beets in the fields. Large areas can be damaged within a beet field overnight if cutworm populations are high. With sufficient moisture, cutworms will climb and feed on leaves at night, returning to the upper 1 inch of soil during the day. Daily surveillance is essential to detect damage during the early growing season, and when symptoms appear, treatment should be applied immediately.

6. **BEET WEBWORM ADULT.** Beet webworms overwinter as larvae in the soil and pupate in late spring. Adults first appear in late May and early June and the small smoky colored moths are active at night. During daylight hours the adults hide beneath beet foliage. Adult webworms are readily observed when beet foliage is disturbed, since they will make short flights within the field to find new hiding places.

7. **BEET WEBWORM LARVAE AND TYPICAL DAMAGE IN SUGARBEETS.** Early instar beet webworms are slender, active, dark green colored larvae. As they mature, they turn darker green with a black stripe down the middle of the back and wavy white lines on each side. Larvae will often migrate to sugarbeets when weed hosts are depleted. In heavy infestations total sugarbeet defoliation can occur. Hot weather increases food intake and will contribute to a rapid rise in webworm populations. A second brood is possible in late August and September.

8. **WIREWORM.** Wireworms are usually hard, smooth, wire-like worms frequently encountered in light textured soils. Wireworms attack seeds and beet seedlings, causing reduction in stand. Wireworms overwinter as larvae and adults, spending 2 to 6 years in the soil feeding on seeds and roots during spring and summer.

9. **FLEA BEETLES AND DAMAGE.** Flea beetles are small, shiny black beetles most common in sugarbeets during the early spring. Typical damage produced is small round holes in young beet leaves, giving a shot-hole appearance. With severe shot-holing, retarded plant growth and wilting are evident during hot, dry weather. Flea beetles overwinter as adults in plant trash or other suitable sites.

10. **AND 11. SUGARBEET ROOT APHID.** Sugarbeet root aphids suck the sap from beet roots. Heavy infestations will destroy rootlets, causing the plant to wilt and eventually die. Infestation and damage is most common during dry periods when cracks in the soil develop around beet roots, allowing root aphids to become established. Above ground symptoms include leaf yellowing and wilting. Roots from these plants will be covered with patches of white, mold-like material produced by the aphids. Sugarbeet root aphids overwinter in the soil or in shelterbelts, particularly poplar. Winged forms are produced in June or July and disperse into sugarbeets. Wingless generations occur on beets which produce economic damage. Winged forms produced in late fall migrate back to poplar trees to lay eggs. On poplar, wingless generations develop in galls formed as leaves open in the spring.
For safe and effective use of insecticides, always identify the problem correctly.
1. **CUTWORM AND DAMAGE.** Two species of cutworms, the dark-sided and the red backed, attack cultivated sunflowers in North Dakota and adjacent sunflower growing areas of South Dakota and Minnesota. Cutworm larvae of both species emerge in late May and early June. A well-developed climbing habit in the larvae exists in both species. Larvae feed primarily at night, cutting the sunflower seedlings at the soil surface or slightly above ground level. If there is soil crusting, the damage may occur just below the soil surface, in which case control is difficult. During the day most of the cutworms conceal themselves in the upper 1-3 inches of soil near a crop plant. When mature, the cutworms will be approximately 1½ inches long and pupation begins.

2. **AND 3. PAINTED LADY BUTTERFLY (2) AND LARVA (3) OF THE PAINTED LADY BUTTERFLY.** Larvae feed on foliage of Canada thistle, soybean, sunflower and other plants; however, infestations seldom reach levels of economic levels. Larvae normally feed in the terminal region of the plant, where one larva per leaf usually feeds under webbing in a curled leaf.

3. **AND 5. SUNFLOWER BUDWORM ADULT (4) AND FEEDING DAMAGE TO TERMINAL (5).** The presence of black frass (insect excrement) from larval entrance hole in both the stem and terminal areas of young sunflower signal the presence of the sunflower budworm. In spite of high populations, economic loss due to this insect has been minimal. The only time yield loss is noticeable is when larvae burrow into unopened buds, preventing head formation. They normally do not feed on developing seed but confine feeding activities to the fleshy part of the head. Although injury by the larva produces grotesque malformations in both the stalk and in the head, yield loss has not been economically important.

4. **ADULT BUDWORM Moths have a wingspread of about ½ to ¾ inch. Each wing has two dark transverse bands. One band extends across the middle of the wing, and the second band is located at the wing tip.

5. **IN NORTH DAKOTA, there are two generations of sunflower budworms per year. Adults from overwintering larvae emerge during the last week of May to mid-June.

6. A few days after adult emergence, eggs are laid on the terminals of immature sunflowers or on the receptacle of mature sunflowers. Eggs are also deposited in leaf axils. Upon hatching the larvae begin tunneling into the sunflower plant. The initial infestation in mid-June is characterized by an entrance hole filled with black frass.

7. Occasionally a gaping hole is formed in plants as a result of larval feeding. Damage to terminal buds increases the severity of infestations. Mature larvae pupate within the sunflower. The second generation adults appear in July and early August. Infestation by the second generation larvae is not of economic importance.

8. **APION STEM WEEVIL.** Apion stem weevil overwinters as an adult in soil, field plant trash, sod and weed clusters. Shortly after the onset of warm weather, the adults emerge. Feeding will commence with the appearance of volunteer sunflower but the adults usually remain innocuous until germination of cultivated sunflower.

   Adult feeding and egg deposition on cultivated sunflower commences at the two- to four-leaf stage. Conspicuous foliage feeding patterns (pinpoint shotholing) becomes apparent but there is little stem feeding at this time and the adults never utilize the cotyledons as a food source.

   The majority of eggs are deposited sub-epidermally in the stem and hatching occurs in about one week. The larvae feed on pith tissue and co-inhabit the lower portion of the stem with *Cylindrocopturus* stem weevil. First generation adults feed on stem tissue and foliage. This generation persists to approximately the pre-bloom stage at which time their numbers decrease markedly.

   Second generation adults feed on disk flowers and pollen, inflicting negligible, if any, damage.

9. **AND 10. CYLINDROCOPTURUS STEM WEEVIL ADULT (9) AND LARVA IN STEM (10).** The adult of *C. adspersus* is about 0.15 inches long, grayish-brown with white dots on the exterior wings (elytra) in a chevron pattern.

   Adults of *C. adspersus* spend their entire life on the foliage and upper stems of the plant, descending to the lower portion to lay eggs. Light yellow eggs (0.04 inches long) are laid individually beneath the epidermis of the lower stalk, on succulent tissues, forming straight longitudinal tunnels. Later staged larvae feed deeper into the pith tissue and migrate toward the ground. Heavy infestations of up to 25 larvae per plant are fairly common. Under these conditions the entire pith of the lower stalk may be destroyed. Loss due to this species, usually occurs in sandy areas, where plant vigor is reduced, or in mature plants where delays in harvesting occur. Lodging of infested plants is the chief economic loss.

10. **BARIS ROOT WEEVIL.** Adults of *Baris* root weevil feed on sunflower foliage in early morning and late afternoon. They are not found on the plants during most of the day. About two weeks after emergence, adults congregate in the root zone near the soil surface and feed and copulate during this period. Feeding activity results in the formation of callous tissue under which the bright yellow eggs are laid two to three at a time.

   As the fourth larval stage is reached (late August to early September), larvae chew circular tunnels in the same area from which they hatched. About this time, the plant becomes significantly dehydrated. Larvae enter the soil with subsequent encapsulation of the larvae in a soil “cocoon.” This “larval cocoon” overwinters among the remaining roots in the soil.
For safe and effective use of insecticides, always identify the problem correctly.

12. Sunflower Moths on Head
13. Sunflower Moth
14. Sunflower Moth Larva
15. Damage of Sunflower Moth Larvae
16. Head Clipping Weevil
17. Damage of Head Clipping Weevil
18. Sunflower Maggot
19. Sunflower Maggot in Head
20. Sunflower Midge Larvae
21. Sunflower Midge Damage
22. Seed Weevil Adult
23. Seed Weevil Damage
SUNFLOWER INSECTS: II

12. THROUGH 15. SUNFLOWER MOTH ADULTS (12 AND 13) AND SUNFLOWER MOTH LARVAE (14 AND 15). Adult sunflower moths are approximately ¾ inch long with a wing span of about ¾ inch. The buff to grayish wings have two small brown dots on the forewings. Since there are other moth species that are similar in appearance, the sunflower moth is often difficult to distinguish from other naturally occurring moths.

Sunflower moths begin to appear in early- to mid-July with the female moths depositing an average of 30 eggs per day among the florets on the face of the sunflower seed head. The small, white eggs are difficult to find in the florets. Each hatch within 40 to 72 hours and the newly emerged larvae feed on the florets and the developing seed. The larva has alternate dark and light colored longitudinal stripes on a light brown body. At maturity the larva is about ¾ inch long.

As larval feeding continues, the sunflower head is covered by a fine silk intertwined with insect excrement and plant debris. Research has shown that a single larva will damage at least nine seeds in a three-week period. Severe larval infestations can reach 30 to 60% seed loss, and in some cases, the entire head is destroyed.

16. AND 17. HEAD CLIPPING WEEVIL ADULT (16) AND DAMAGE (17). Weevil larvae overwinter in head debris. Pupation and emergence of the black, ¼-inch-long adults is completed in early July. Females lay eggs in the head after weakening the bud stem by feeding. This results in a feeding scar which encompasses about one-half the stem circumference approximately 4 inches below the head. As the head develops, the feeding site constitutes a weakness which ultimately breaks. The young head drops to the ground and becomes a food source for the developing larvae.

18. AND 19. SUNFLOWER MAGGOT COMPLEX (18 - ADULT) AND SUNFLOWER MAGGOT LARVA (19). Three species of flies comprise the sunflower maggot complex. All three species of maggots have one generation per season. They overwinter as either larvae or pupae in plant debris or in the soil.

Adults of all three species can be seen resting on the heads or foliage during the season. Larvae, depending on the species, will feed on the receptacle of the head or stalk. The feeding damage caused by maggots is seldom of economic significance.

20. AND 21. SUNFLOWER MIDGE LARVAE (20) AND CHARACTERISTIC HEAD DAMAGE (21). Adults are extremely small, light-tan flies with a wingspan of approximately ¼ inch. They appear in early- to mid-July and mating occurs within 24 hours emergence. Midge emergence appears to be correlated with soil moisture which must be between 40 to 60% of moisture holding capacity. When soil moisture levels are less than 40% or greater than 60% emergence does not occur.

Adults live for about three days. They prefer to lay eggs on sunflowers with buds of 2 to 3 inches. Larvae feed initially on margins of the head between the leafy bracts surrounding both heads and developing flowers. Larvae migrate to the base of developing seeds and to the center of the head as the head develops. Early infestation by midge larvae results in dead areas on the sepals. If infestations occur before the heads open, ray flowers become distorted or absent. Midge damage in moderate to severe infestation levels includes a gnarling of the head and the total absence of seeds in the center of the head. Gnarled heads may fail to open properly.

The mature midge larvae drop into the soil, pupate and overwinter in this stage.

22. AND 23. SEED WEEVIL ADULT (22) AND SEED DAMAGED BY LARVA OF SEED WEEVIL (23). There are two species of seed weevils, both of which have a long snout. The most prevalent species is reddish-brown and slightly over ¼ inch long. The other species is about ¼ inch long, and the body is gray. The larvae of both species are small, cream-colored, legless and C-shaped.

Seed weevil emergence occurs in late June and early July. The newly emerged adults feed on sunflower buds between the involucral bracts. When the sunflower matures, the adults feed on the pollen, and as the seeds begin to mature, eggs are deposited within the seed. Normally a single egg is deposited in each seed.

The small white eggs hatch in approximately one week. The larvae consume the inner meat, and it is this feeding which causes economic damage. After completion of larval development the majority of the larvae drop to the ground from mid-August to mid-September and overwinter in the soil at a depth of about 6 inches. Larvae pupate in late June and the pupal period lasts about one week. There is a single generation per year in North Dakota.
BENEFICIAL INSECTS

An aid to identification and control

1. Assassin Bug
2. Ant Lion
3. Lacewing
4. Ground Beetle
5. Syrphid Fly Larva
6. Tobacco Hornworm
   Parasitized by Braconid Wasp
   (Pupal Stage)
7. Ladybird Beetle
   Left - Larvae Feeding on Aphids
   Right - A Typical Adult
8. Predaceous Stinkbug (Top)
   Ready To Attack Immature Stinkbug
9. Praying Mantid

Prepared by the Clemson University Cooperative Extension Service's Entomology - Plant Pathology and Agricultural Communications Sections, Federal Extension Service Cooperating
1. Most members of this family of “true bugs” are predators of other insects, and some species are “blood suckers: on man and some animals. The “wheel bug,” “kissing-bug” and “thread-legged bugs” are some of the more common examples of predator species. Several other families of “true bugs” are also insect bugs, “Damsel bugs” and some few species of “Leaf or Plant bugs.” This family of true bugs ranks moderately high in importance as insect predators.

2. Ant lion is the common name given to both the larva and adult of this family of “nerved-winged insects.” Only the larval stage is predaceous. Ant lion larvae, more commonly known as “doodlebugs” are found at the bottom of conical pits in dry sand or loose pit is quickly seized by elongated, sickle-like mandibles. The ant lion withdraws the body fluids from its host. This predator is not considered of major importance in biological control.

3. The “lacewing” “golden-eye” or “aphis-lion adult” is also a member of the “nerved-winged insects.” As such, it is related to the ant lion. The delicate, gauzy winged, pale green or light brown adults are rather common during late summer and fall months. Both larvae and adults are predaceous mainly on aphids. Eggs are usually attached to foliage or stems, and each egg is at the end of a slender, slightly curved stalk. The spindle-shaped, grayish larva is equipped with a pair of elongated mandibles with which it seizes its prey and sucks the body fluids.

4. This family of beetles gets its common name of “ground beetles” from being frequently observed on the soil surface. They hide beneath objects during the day and seek their prey at night. Some species are attracted to lights. Most species of this family are predaceous; however, a few species feed on plants. Both adults and larvae are predaceous. Larvae may be found on or in the soil. Adults range in size from less than 1/4 to over 1 1/2 inches in length. Color ranges from solid black to black with metallic hues and/or spots. Ground beetles, along with the lady beetles, are considered the most important predator beetle families.

5. The slug-like, grayish-green larva of some species of Syrphid flies are predaceous. The maggot stage of some of the more common yellow-banded flies is often found living within or around colonies of aphids upon which the larva feed by removing the body fluid contents. This is a common summertime aphid predator but is of little importance upon other pests.

6. Representatives from several families of parasitic wasps serve as the most important biological control of many of the agricultural pests including many of the caterpillars (armyworms, some cutworms, etc.), weevil larvae or grubs, wood boring beetle larvae, fly particular type of species of caterpillar. Other species, such as in the illustration, are gregarious with several dozen larvae developing in a single host from only a few eggs. Most species are internal parasites although some are solitary, external feeders.

Some other Orders and Families of insects also serve as insect parasites. The Tachinid fly family also benefits mankind by parasitizing many species of caterpillars.

7. Ladybird beetles or ladybugs are a very beneficial family of predaceous beetles. Two species of this family have “gone astray” and are serious pests of beans and squash. Both adults and larvae are predators of insect eggs and small, soft-injurious pests. Overwintering adults leave hibernation during mid-spring, fly to favored host plants and lay their yellowish-orange eggs on end in small, compact masses attached to the leaves or twigs which are infested with one of their favored hosts. Upon hatching, the elongated, somewhat flattened, black or gray larva, usually with yellow or orange spots or bands, crawl over the host plant looking for prey. As they grow in size, the larval stage has been likened to a miniature alligator. The pupal stage is usually attached to the foliage or stem of the host plant. The nearly hemispherical red with yellow or black spots, or black with white, red or yellow spotted adults feed, mate and fly off in search of another plentiful food source. There are several generations each year.

8. Some species of the “stink-bug” family are predaceous, while other species will feed on both animal and vegetable fluids. Both adults and immatures (nymphs) are predaceous, usually feeding on caterpillars. These predators rank low in biological control because of a slow reproduction rate.

9. The size and distinctive praying posture make this insect a widely advertised and discussed predator. The larger nymphs and adults will attack and feed on a wide variety of insects including their own kind. Mantids overwinter in grayish egg cases attached to twigs or sides of buildings. Hatching occurs in early summer and the adult stage is reached in early fall. There is only one generation a year.

SUMMARY

These and other beneficial insects are present in widely varying numbers every year. Their occurrences ebb and flow like the tide, usually following high numbers or outbreaks of one or more species of host pests. Rarely do these beneficials eliminate a pest species, for to do so would also eliminate them. Collectively, they perform a tremendous value each year by helping to keep pest insects below the economic damaging level. Some years this may be only a small percent while in other years their impact may account for thirty or more percent reduction in pest numbers. Indiscriminate spraying, poor timing of insecticide application, and selection of insecticides highly toxic to parasites and predators all tend to reduce the effectiveness of these beneficials.

Several of these parasites and predators may be purchased and released in fields and around homes. If they are to remain near their release sites, there must be a supply of their insect pest hosts present. Repeated releases throughout the growing season are usually required for effective biological control.

GEORGE W. THOMAS, EXTENSION ENTOMOLOGIST, COLLEGE OF AGRICULTURE

CATERPILLARS ON FIELD CROPS: I

1. Corn Earworm (Dark Phase)  
4. Southwestern Corn Borer  
9. European Corn Borer

1. Corn Earworm (Light Phase)  
5. Glassy Cutworm  
10. Variegated Cutworm

2. Fall Armyworm  
6. Bronzed Cutworm  
11. Pale Western Cutworm

3. Armyworm  
7. Darksided Cutworm  
12. Western Bean Cutworm

3. Armyworm  
8. Black Cutworm  
13. Dingy Cutworm

Adapted from Service in Action Bulletins prepared by F.B. Peairs and J.L. Capinera, Department of Entomology, Colorado State University
1. **CORN EARWORM OR TOMATO FRUITWORM.** These caterpillars range in color from light green (light phase) to almost black (dark phase). Stripes also vary, but there usually is a pair of narrow dark lines down the middle of the back and broad dark bands on each side. The head is yellow or orange with a light net-like pattern. Most distinctive are the numerous microspines on the skin seen with a hand lens. This insect attacks a wide variety of field and vegetable crops. Corn earworm does not overwinter in Colorado and egg laying activity usually occurs in July.

2. **FALL ARMYWORM.** This caterpillar is quite variable in color but has three yellowish-white thin lines going down the back and a darker, wider line and a broad yellowish line along each side. The setae (hairs) arise from prominent black tubercles. The most distinguishing character is the inverted white “Y” on the front of the head capsule. This pest attacks a wide variety of crops, particularly corn and sorghum. It migrates from the south into Colorado every year and usually is not a problem until the latter part of the growing season.

3. **ARMYWORM.** The head has dark net-like markings on a light brown background. Dark brown bars diverging above the mouth are present on the head capsule. Alternate light and dark stripes are present on the abdomen, and an orange stripe on each side. The armyworm prefers grass crops such as corn, small grains and sorghum. Larvae are usually found in sheltered locations or below the soil surface during daylight. Several generations occur per year with the first damage occurring very early in the growing season.

4. **SOUTHWESTERN CORN BORER.** During the growing season, this caterpillar has a white abdomen with conspicuous dark brown or black spots. It is similar in appearance to the European corn borer, but the latter has lighter spots on a browner background. During the winter, the southwestern corn borer becomes pale yellow with very faint spots. It is primarily a pest of corn, but also attacks sorghum. From one to three generations may occur per year depending on the severity of the winter.

5. **GLASSY CUTWORM.** This subterranean cutworm has an unmarked, uncolored, somewhat translucent abdomen. It is similar in appearance to the pale western cutworm but lacks vertical brown bars on the front of the head. This is an early season pest that attacks small grains, corn and alfalfa from very early spring through the end of June. Three generations per year occur in Colorado, starting in late May, with the most important damage occurring in August.

6. **BRONZED CUTWORM.** The abdomen of this large subterranean cutworm is dark bronzed-brown and has five distinct pale stripes running the entire length. It will attack turf, small grains, corn and other grasses early in the growing season. It has but one generation per year.

7. **DARKSIDED CUTWORM.** This climbing cutworm has a greyish-brown abdomen with a narrow dark band on either side. It is an early-season pest that has but one generation per year. It attacks a variety of crops, including several ornamental tree species.

8. **BLACK CUTWORM.** This subterranean cutworm is light grey to black in color. It grows to 1 1/2 to 1 1/4 inches when mature. May have three generations per year but only the first generation has the potential to damage row crops. The larvae rarely overwinters in most midwestern states. Moths overwinter in Gulf Coast states and fly north in spring.

9. **EUROPEAN CORN BORER.** This caterpillar has a cream-to-grey colored abdomen with light brown spots. The European corn borer primarily attacks field corn and damages the leaves, stalks, shanks and ears. It also has the potential to become a pest of sweet corn, potatoes, sorghum, snap beans and peppers. Egg laying for the first generation occurs during the first part of June while second generation egg laying can extend over a two- to four-week period starting in late July.

10. **VARIEGATED CUTWORM.** This climbing cutworm is best distinguished by a row of white to pale yellow dots that run along the midline of the back. There are at least four of these dots and may be as many as one per segment. The abdomen is mottled brown, sometimes with an orange stripe laterally. This insect attacks a wide variety of plants including alfalfa, corn, ornamentals and various vegetable crops. Three generations per year occur in Colorado, starting in late May, with the most important damage occurring in August.

11. **PALE WESTERN CUTWORM.** This subterranean cutworm has a greyish-white, unmarked abdomen. It is similar in appearance to the glassy cutworm but has two distinct vertical brown bars on the front of the head capsule. This is an early season pest that attacks small grains, corn and alfalfa from very early spring through the end of June. It has but one generation per year.

12. **WESTERN BEAN CUTWORM.** This small brown caterpillar is identified by faint diamond markings on the back. Mature larvae are brown to pale grey with dark brown bands behind the head. Ear tips are preferred in corn and developing pods in beans. This insect overwinters in Colorado although egg laying does not occur until late July.

13. **DINGY CUTWORM.** This is a subterranean or climbing cutworm. Its abdomen is a dull brown with a broad pale stripe down the back. When full grown, it is somewhat smaller than the other cutworms with which it might be confused. It has only one generation per year, attacking such plants as alfalfa, corn, ornamentals and several vegetable crops. Recognized by a faint V shape on the back on each abdominal segment, but positive identification requires the examination of tubercles on the side of the body segments. Eggs are laid in late summer on grass and weeds. Larvae hatch and feed in fall and in early spring.
1. Beet Webworm

2. Alfalfa Webworm

3. Celery Looper

4. Cabbage Looper

5. Bilobed Looper

6. Alfalfa Looper

7. Zebra Caterpillar

8. Beet Armyworm

9. Clover Cutworm

10. Saltmarsh Caterpillar

11. Alfalfa Caterpillar

12. Army Cutworm

Adapted from Service in Action Bulletins, Colorado State University.
1. **BEET WEBWORM.** This is a small greenish-black caterpillar with a narrow, dark stripe running down the back and long setae (hairs) that arise from distinct dark circles. It is active when disturbed. This pest will feed on the leaves of carrot, celery, pea, potato, spinach and sugarbeet. Usually three generations of caterpillars occur during the growing season, with the first appearing during June.

2. **ALFALFA WEBWORM.** This is a small greenish-black caterpillar with a broad light stripe running down the back. Long hairs arise from spots on the abdomen. It often will feed within leaves that have been webbed together. These are often connected to the ground by a silken tunnel through which it will retreat rapidly when disturbed. It feeds on alfalfa, carrots, celery, field corn and sugarbeets. The first of the two generations of caterpillars occurs during May and June.

3. **CELERY LOOPER.** This pale green caterpillar tapers from back to front. It has a distinct white stripe on either side that contains a row of white spiracles edged in black. The true legs are light green. It walks with a typical looping motion. This pest prefers celery but has attacked sugarbeets and lettuce. Two to three generations per year of this pest occur in Colorado.

4. **CABBAGE LOOPER.** This greenish caterpillar tapers from back to front and has a distinct white stripe on either side of the abdomen except immediately before pupation. It walks with a typical looping motion. The reduced nipple-like prolegs on the third and fourth segments of the abdomen help distinguish it from other looper species. This pest will attack a wide variety of horticultural crops. Two to three generations occur per year in Colorado.

5. **BILLODED LOOPER.** This is a greenish caterpillar that tapers from back to front. It walks with a typical looping motion. It can be distinguished from other loopers by a strong black line that runs around the front of the head capsule. It will feed on alfalfa, cabbage, lettuce and peas, but it rarely causes extensive damage. One to two generations occur per year.

6. **ALFALFA LOOPER.** This greenish caterpillar tapers from back to front and has a single white stripe on either side of the abdomen. The true legs and part of the head usually are black. It walks with a characteristic looping motion. It is similar in appearance to the cabbage looper but lacks the reduced prolegs on abdominal segments 3 and 4 and usually has dark thoracic legs and a dark band on the side of the head. This looper will attack alfalfa and sugarbeets as well as several horticultural crops. Usually two generations per year of this pest occur in Colorado.

7. **ZEBRA CATERPILLAR.** This insect is easily distinguished from other crop caterpillars by two bright yellow stripes running along each side of the body and separated by alternating black and white stripes running around the body. This insect can be found defoliating a variety of broadleaf field and vegetable crops, ornamental trees and flowers. It is generally not considered to be a serious pest. Damage from these insects can be expected in late May and June again in late August and September.

8. **BEET ARMYWORM.** A greenish striped caterpillar closely resembling the clover cutworm, but lacking the black markings around the abdominal spiracles. This insect will attack a variety of broadleaf and grass crops, but sugarbeet is a preferred host. The beet armyworm has two to three generations per year in Colorado.

9. **CLOVER CUTWORM.** This is a greenish or brown climbing cutworm with a broad pink or yellow stripe on either side of the body. The abdominal spiracles are surrounded by black. Elongate black spots are sometimes found on the back. This insect is mostly important as a defoliator of sugarbeets, but has damaged clover. The clover cutworm has two to three generations per year in Colorado.

10. **SALTMARSH CATERPILLAR.** These caterpillars are similar in appearance to the yellow wooly-bear caterpillar, except the saltmarsh caterpillar has a black head while the yellow woolybear has a yellow head. Both are distinguished from other crop caterpillars by their long dense hairs. Many garden crops are attacked, although bean and sugarbeet infestation are most important in Colorado. Two generations occur per year in Colorado with most important damage occurring in August.

11. **ALFALFA CATERPILLAR.** A dark green caterpillar with a white stripe on each side of its body and a red line running through the white stripe. Adult is a yellow butterfly. This insect rarely causes significant loss of crops.

12. **ARMY CUTWORM.** Body grey to brown, usually with a broad brownish band running the length of the back. Head is distinctly freckled. Mature length is 1 1/2 inches. Overwinters as half-grown larvae. One generation per year. Feeds above ground but may burrow into shallow soil surface. Attack winter wheat and alfalfa in late winter to early spring in western areas.

Adapted and modified from: Service in Action Bulletins prepared by F.B. Pears, CSU assistant professor, J.L. Capinera, CSU professor, Department of Entomology, Colorado State University (Army cutworm added by Farmland Ind.) Issued in furtherance of Cooperative Extension Work Acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture; Kenneth R. Bolen, Director of Cooperative Extension, Colorado State University. Cooperative Extension programs are available to all without discrimination. No endorsement of products names is intended nor is criticism implied of products not mentioned.
CORN ROOTWORM LIFE HISTORY
(for Western and Northern Corn Rootworms)

- **Eggs**: late summer and early fall, deposit eggs in soil near roots of corn
- **Larvae (Worms)**: feed on corn silks and pollen, overwinter in the soil, eggs hatch in spring (late May to early June)
- **Pupa (Worms)**: feed on corn roots for about 30 days
- **Adults (Beetles)**: emerge July thru April

Generations Per Year: 1

CHINCH BUG LIFE HISTORY

- **Eggs**: in spring, fly to small grain fields (wheat, barley)
- **Nymphs**: overwinter in bunch grasses
- **Adults**: early to midsummer
- **Nymphs**: lay eggs behind lower leaves
- **Eggs**: deposit eggs on corn, sorghum or grasses

Generations Per Year: 2

EUROPEAN CORN BORER LIFE HISTORY

- **Eggs**: deposit eggs on the undersides of leaves of early planted corn in June
- **Larvae**: emerge in June
- **Pupa (Moths)**: pupate May and early June
- **Eggs**: deposit eggs on the undersides of leaves of late planted corn
- **Larvae**: first feed on corn leaves, tassel, etc.
- **Pupa (Moths)**: pupate mid-July and early August
- **Eggs**: deposit eggs on the undersides of leaves of later planted corn
- **Larvae**: first feed on corn leaves, later bore into stalk
- **Pupa (Moths)**: pupate mid-July and early August
- **Adults (Moths)**: feed at dusk by sucking nectar from flowers
- **Eggs**: deposit eggs on the undersides of leaves of later planted corn
- **Larvae**: rotate 5-10 days
- **Pupa (Moths)**: pupate in soil mid-June to July
- **Adults (Moths)**: early to mid-July

Generations Per Year: 2 (in central corn belt)

BLACK CUTWORM LIFE HISTORY

- **Eggs**: deposit eggs on the undersides of leaves of early planted corn
- **Larvae**: overwinter in corn stalks
- **Eggs**: deposit eggs on corn leaves, stalks, cobs, etc.
- **Larvae**: hide during the day in the soil, feed at night on young corn plants – younger larvae, on leaves above ground – older larvae, below soil surface
- **Pupa (Moths)**: pupate mid-July and early August
- **Eggs**: deposit eggs on the undersides of leaves of later planted corn
- **Larvae**: first feed on corn leaves, later bore into stalk
- **Pupa (Moths)**: pupate in soil mid-June to July
- **Adults (Moths)**: early to mid-July

Generations Per Year: Probably 2

SOUTHWESTERN CORN BORER LIFE HISTORY

- **Eggs**: deposit eggs on corn leaves
- **Larvae**: overwinter in taproots of old corn stalks
- **Eggs**: deposit eggs on corn leaves
- **Larvae**: first, feed on corn leaves
- **Pupa (Moths)**: pupate mid-July and early August
- **Eggs**: deposit eggs on corn leaves, stalks, cobs, etc.
- **Larvae**: late, bore into stalks
- **Pupa (Moths)**: pupate in the soil mid-June to July
- **Eggs**: deposit eggs on the undersides of leaves of later planted corn
- **Larvae**: revise 5-10 days
- **Pupa (Moths)**: pupate mid-July and early August
- **Adults (Moths)**: feed at dusk by sucking nectar from flowers

Generations Per Year: 1 to 3

GREENBUG LIFE HISTORY

- **Eggs**: all stages suck plant juices and inject toxic substance
- **Nymphs**: give birth to living young
- **Adults (All Female)**: winged or wingless
- **Nymphs**: all stages feed on leaves of wheat, sorghum, or other grasses
- **Adults (All Female)**: early to midsummer

Generations Per Year: 12 to 20

Probably does not overwinter in northern states; winged adults migrate northward in early spring
INSECT LIFE HISTORY AND CYCLES

WHITE GRUB LIFE HISTORY

EGGS

LARVAE (Grubs)

ADULTS (June Beetle)

PUPAE

deposit eggs in grasslands or patches of grassy weeds in cultivated fields.

do not leave soil until following spring.

in soil

larvae

feed on roots of corn and other plants

larvae

map spend 1 or more winters as grubs

LIFE CYCLE: 1 to 4 years (depending on species)

WESTERN BEAN CUTWORM LIFE HISTORY

EGGS

LARVAE

PUPAE

ADULTS

PREPUPAE

DEPOSIT EGGS ON LEAVES OF FIELD BEANS OR CORN

EMERGE IN MID-JULY

PUPATE IN MAY AND EARLY JUNE

OVERWINTER IN THE SOIL

MID-JULY THRU SEPTEMBER: FEED IN TASSEL AND EAR OF CORN OR FEED ON BUDS, FLOWERS, FOLIAGE, AND PODS OF BEAN PLANTS

GENERATIONS PER YEAR: 1

ARMYWORM LIFE HISTORY

EGGS

LARVAE (Caterpillars)

PUPAE

ADULTS (Moths)

DEPOSIT EGGS IN GRASSY AREAS OR LODGED SMALL GRAINS

8 TO 10 DAYS

3 TO 4 WEEKS FEED ON LEAVES OF CORN, SORGHUM, SMALL GRAINS AND MANY ROW CROPS

OVERWINTER IN THE SOIL

GENERATIONS PER YEAR: 3 (DEPENDING ON LATITUDE)

STALK BORER LIFE HISTORY

EGGS

PUPAE

ADULTS

LARVAE

DEPOSIT EGGS ON COARSE GRASSES AND WEEDS, ESPECIALLY GRASSY AREAS IN FIELD MARGINS

HATCH IN EARLY SPRING

ATTACK CORE STEM PLANTS (GIANT RAGWEED, CORN, ETC.)

LATE JULY AND EARLY AUGUST

OVERWINTER

GENERATIONS PER YEAR: 1

SPIDER MITE LIFE HISTORY

EGGS

LARVAE (Six-legged)

ADULTS

DEPOSIT EGGS TO THE LEAVES OR TO THE SILK SPUN BY THE MITES

2 TO 4 DAYS

LARVAE, NYMPHS, ADULTS Suck PLANT JUICES FROM LEAVES. USUALLY OVERWINTER AS ADULTS.

Generations Per Year: Several

GRASSHOPPER LIFE HISTORY

EGGS

NYMPHS

ADULTS

DEPOSIT EGGS IN UNCULTIVATED SOIL (FIELD MARGINS, WEEDY AREAS, PASTURELAND, ETC.)

AUGUST TO OCTOBER

NYMPHS AND ADULTS FEED ON MOST CULTIVATED AND WILD PLANTS.

LATE JULY AND EARLY AUGUST

40 TO 60 DAYS

Generations Per Year: 1
ALFALFA DISEASES: I

1. Common leaf spot
2. Yellow leaf blotch
3. Leptosphaerulina leaf spot
4. Stemphylium leaf spot; R, close up of lesion
5. Summer (Cercospora) black stem and leaf spot
6. Rust
7. Downy mildew. L, upper and lower leaf surfaces; R, infected shoot tip
8. Alfalfa mosaic
9. Bacterial leaf spot
10. Spring (Phoma and Ascochyta) black stem (L) and leaf spot (R)
11. Cercospora leaf spot
1. COMMON LEAF SPOT. Caused by the fungus Psuedopeziza medicaginis, occurs worldwide reducing both yield and hay quality by early and heavy defoliation. Seeding stands under a thick cover crop can be severely infected following extended periods of cool, moist or very humid weather. Numerous small (1 to 3 mm), circular, dark brown to black spots form on the leaflets. These lesions remain distinct and develop a slight yellow halo. A tiny, light brown, cup-shaped structure (apothecuim) appears in the center of older spots on the upper leaf surface. Plants are rarely killed outright by Common Leaf Spot, but defoliation can seriously reduce plant vigor and predispose a plant to winter injury. The fungus survives in undecomposed leaves and leaf fragments on the soil surface.

2. YELLOW LEAF BLOTCH. Caused by the fungus Leptotrichiella medicaginis (synonym Pseudopeziza jonesii; imperfect stage, Sporotricha phacidioides), occurs worldwide where stands are rank and tall. Leaf symptoms start as chlorotic flecks that often enlarge to form yellow-to-orange streaks between the leaf veins. Older lesions turn an orange-yellow or brown. Numerous dark specks (pycnidia) form in the centers of older lesions on the upper leaf surface. The withered leaves may remain attached for some time. The fungus survives in undecomposed leaves on the soil surface.

3. LEPTOSPHAERULINA LEAF SPOT. Also called lepto leaf spot, halo spot, pepper spot and brown leaf spot, is most severe on young leaves, petiole and other above ground parts of recently cut stands. The disease is most prevalent in cool, moist weather. The casual fungus, Leptosphaerulina briosiana (synonyms Pseudopeziza or Pleosphaerulina briosiana), produces small, reddish-brown to black spots (“pepper spots”) that may enlarge to form oval-to-round tan spots with a darker brown border often surrounded by a yellowish area. Infected leaves and petioles die and often cling to the stem for some time. The fungus overwinters in leaves on the soil surface.

4. STEMPHYLUM LEAF SPOT. Also called target spot, is caused by the fungus Stempphyllum botryosum (perfect stage, Pleospora herbarum). The disease is often most severe in luscious dense stands following warm wet weather when harvesting is delayed. Lesions on the leaflets are oval-to-elongate, dark brown spots with lighter centers that enlarge and form concentric light and dark brown zones. A single large lesion can cause a leaflet to turn yellow and drop prematurely. Older leaf and stem lesions are covered by a sooty mold due to growth of the Stempphyllum fungus. Black, girdling lesions may develop on the petioles, pedicels and stems, causing the foliage beyond to wilt, wither and die. The fungus overwinters in old infected stems or on seed.

5. SUMMER (CERCOSPORA) BLACK STEM AND LEAF SPOT. Also called Cercospora leaf spot and Cercospora black stem, is caused by the fungus Cercospora medicaginis. The disease is common after the first cutting during warm, moist weather. Leaf lesions begin as small brown spots that enlarge to form roughly round, reddish- to smoky-brown lesions, 2 to 6 mm in diameter, with a yellow halo. If severe, leaflets are killed, causing early defoliation. Stem and petiole lesions are elliptical to elongate and reddish- to chocolate-brown. These lesions may expand to girdle and kill the stems, petioles and peduncles resulting in further defoliation and loss of seed. The fungus overwinters in crop residue and may be seed-borne.

6. RUST. Caused by the fungus Uromyces striatus, is a late-season disease that occurs worldwide. The uredial pustules are reddish-brown and dusty, forming on the lower leaf surface, petioles and stems. When severe, rusted leaves may turn yellow and fall prematurely. The near absence of the alternate hosts (Euphorbia spp.) in the USA makes the black telial stage, which forms at the season’s end, nonfunctional in the disease cycle. The fungus survives in southern states in the uredial stage in living plants. The urediospores are wind-borne northward as the season progresses.

7. DOWNY MILDEW. Caused by the fungus Peronospora trifoliorum, appears mainly in the spring and fall during cool, moist or humid weather. Symptoms disappear during warm-to-hot, dry weather. Young leaflets, especially at the shoot tips of rapidly growing plants, are often dwarfed, twisted or curled downward with light green-to-yellow blotches. A pale violet, downy growth may be visible on the underleaf surface, especially during cool, moist or very humid weather. Systemically infected plants may be stunted and yellow. Fall-infected seedlings commonly winter-kill. The fungus overwinters as thick-walled spores (oospores) in crop residue and as mycelium in systemically infected crown buds and shoots.

8. ALFALFA MOSAIC. Caused by a virus of many strains transmitted to seed through pollen and ovules from infected plants and by aphids after feeding on infected plants. Typically, a yellow or light green interveinal mottling and yellow streaks parallel to the leaf veins appear in young developing leaves during cool weather. Infected leaves or entire plants often become distorted and stunted. Mosaic-infected plants may die within several weeks to several years. Symptom expression is often masked in hot weather; many infected plants may never show symptoms. The virus is seed-borne and also overseasons in living alfalfa and other plants (some 220 species in 73 genera).

9. BACTERIAL LEAF SPOT. Caused by the bacterium Xanthomonas alfaliae, may occur worldwide following warm-to-hot, moist weather. Small round-to-irregular, water-soaked leaf spots expand up to 3 mm in diameter, become irregular and brown or black, often with a lighter center that may glisten due to dried bacterial exudate on the surface. Infected leaves usually wither and drop prematurely. Stem lesions are “greasy” before enlarging and turning light-to-dark brown. Infected seedlings are often stunted or killed. The bacterium overseasons in crop residue and in soil.

10. SPRING BLACK STEM. Or Ascochyta leaf spot, is similar to Summer (Cercospora) Black Stem (5), but disease development is favored by cool, moist weather in spring and fall. Usually the first cutting is most damaged. The causal fungus, Phoma medicaginis var. medicaginis (synonym Ascochyta imperfecta), primarily infects the stems, but attacks all above-ground plant parts. Dark green, water-soaked, girdling lesions develop in the stems and petioles, turning dark brown to black with age. The lesions may enlarge and merge until most of the lower parts of stems are blackened. Young shoots may be girdled, turn yellow-to-brown and die. Numerous small, irregular, dark brown or black spots form on the lower leaves. The lesions enlarge and may merge to cover most of the leaflet. If severe, the leaves turn yellow, wither and drop prematurely. A crown and root rot may also develop. The fungus overseasons in diseased plant tissue and may be seed-borne.

11. CERCOSPORA LEAF SPOT. A minor foliar disease in warm, moist weather caused by the fungus Cercospora zebrina. The fungus is closely related to the one that incites Summer Black Stem (5); however, C. zebrina also attacks various clovers. The brown leaf lesions are oval to irregular in shape, expanding into dark, target-shaped spots surrounded of the fungus on the diseased tissue. The fungus overwinters in plant residue and may also be seed-borne.

For chemical control suggestions, a listing of resistant varieties and other control measures, consult the Extension Plant Pathologist at your land-grant university or your county extension office.
ALFALFA DISEASES: II

1. Bacterial wilt
2. Phytophthora root rot. L, dead and dying plants; R, typical root symptoms
3. Anthracnose. L, external and R, internal symptoms
4. Fusarium crown rot
5. Mycoleptodiscus crown rot
6. Sclerotinia crown and stem rot
7. Fusarium wilt
8. Rhizoctonia stem canker
9. Violet root rot
10. Crown wart
11. Dodder
1. **BACTERIAL WILT.** Caused by the bacterium *Corynebacterium insidiosum*, is a major disease that occurs worldwide, especially in poorly drained wet areas. The bacterium is easily spread in the field by mowing and tillage equipment, surface water and animal life in the soil. Symptoms first appear as the dying of scattered plants throughout a field, usually starting in the second or third year after seeding. Severely infected plants are stunted to dwarfed, bunchy and yellow-green to bleached. Such plants are more susceptible to winter-killed. Under moisture stress, young succulent growth wilts and dies. A cut through a diseased tap root or crown reveals a yellow-to-brown discoloration in the central cylinder. The bacterium overseasons in crop debris in the soil and infects plants through a variety of wounds.

2. **PHYTOPHTHORA ROOT ROT.** Is a serious worldwide, soil-borne disease caused by the fungus *Phytophthora megasperma*. Like Bacterial Wilt (1), it occurs primarily in low-lying, poorly drained soils following periods of excessive rainfall or flood irrigations. Losses are most severe to seedling stands. Infected plants are stunted; the leaves turn yellow or reddish, wilt and die. Regrowth is slow and greatly reduced after a cutting. The tap roots and rootlets are rotted with yellow-to-brown lesions that later turn black. In the southern half of the USA during warm, moist or humid weather.

3. **ANTHRACNOSE.** Caused by the fungus *Colletotrichum trifolii*, occurs in the southern half of the USA during warm, moist or humid weather. Infected shoots wilt and die, turn straw-colored to white and are scattered through a field. Newly killed shoot tips often have a “shepherd’s crook” appearance. Lesions on the lower parts of these shoots are oval to diamond-shaped with a straw-colored center and a brown border. Black fruiting structures (acervuli) form in the centers of older lesions and on crop debris. The fungus may grow downward from infected shoots into the crown tissue which appears bluish-black. Diseased crowns produce weak, less vigorous shoots or entire plants infected with the fungus. The fungus overseasons as thick-walled, dormant spores in soil and as a saprophyte in crop debris.

4. **FUSARIUM CROWN ROT.** And root rot, like Fusarium Wilt (7), is a widespread, soil-borne disease caused by several species of *Fusarium*. These fungi enter through a variety of wounds caused by machinery, cold temperatures, nematodes, insects and other animals. Infected plants are usually stunted with bleached, yellow leaves that wilt under a moisture stress. Light brown-to-black streaks develop in the vascular tissue of diseased plants. Leaves on these plants often curl slightly and wither. The disease progresses slowly, rarely killing a plant in a single growing season. The stand is gradually thinned from year to year. Seedlings may wilt, wither and die (postemergence damping-off), especially during warm, wet weather. These fungi survive as chlamydospores in soil or plant debris.

5. **MYCOLEPTODISCUS CROWN ROT.** Caused by the fungus *Mycoleptodiscus terrestris*, is only found in the USA and is most severe in warm, humid weather. The fungus causes damping-off of seedlings, but is more prevalent as a black rot of the lateral roots that later spreads into the tap root and crown. Infected crowns have numerous wilted and dead stems. Small brown leaf spots and reddish-brown stem lesions are occasionally seen. As with Sclerotinia Crown and Stem Rot (6), fungal mycelium and numerous, small, round to spindle-shaped black sclerotia may be found in decayed crown tissue. The fungus probably overwinters as sclerotia in crop residue and soil.

6. **SCLEROTINIA CROWN AND STEM ROT.** Caused by the fungus *Sclerotinia trifoliorum* (synonym *S. sclerotiorum*), is a cool, wet weather disease that infects plants of all ages. Small, more or less circular patches of dying and dead seedling plants are common. On older plants, infected leaves and stems become yellow and finally collapse. A white, cottony mass of fungus mycelium grows over dead plants or the soil surface in wet weather. Dark brown to black sclerotia later form in the fluffy growth. Affected plants may die with the fungus invading the crown area. The crown turns soft and grayish-green, causing the shoots to wilt and turn yellow. The fungus overseasons as dormant, hard, round-to-irregular sclerotia, up to 8 to 20 mm in diameter, in soil and crop debris.

7. **FUSARIUM WILT.** Normally caused by the soil-borne fungus *Fusarium oxysporum* f. sp. *medicaginis* occurs in irregular areas in a field. Scattered plants within these areas wilt, sometimes starting on one side, with leaves turning light green-to-yellow. Affected plants are commonly stunted or dwarfed and die slowly over a period of several weeks or months during warm-to-hot weather. Dark or reddish-brown streaks within the vascular cylinder are visible in a tap root that has been split or cut across. The fungus, like those cause Fusarium Crown Rot (4), survives in soil for years as chlamydospores or as mycelium in living or dead plants.

8. **RHIZOCTONIA STEM CANKER.** Or blight is caused by the cosmopolitan soil fungus *Rhizoctonia solani*. Scattered, round to irregular areas of affected plants are evident in a field. Elliptical to circular, somewhat sunken, tan to reddish- or brown lesions (cankers) form on the lower stems, crown and tap root. If severe, stems and roots are girdled causing the leaves and shoots to turn yellow, wilt and die. Seedlings are killed before or after emergence. In hot, humid weather the leaves and shoots, especially on lush plants in thick stands may appear water-soaked. Affected parts soon wilt, wither and die. The fungus survives for years in the soil as minute, irregular dark brown-to-black sclerotia or as a saprophyte in plant debris.

9. **VIOLET ROOT ROT.** Caused by the fungus *Rhizoctonia crocorum* (sexual stage, *Helicobasidium purpureum*), is usually of minor importance. The disease is most prevalent in older stands after midsummer, killing plants in enlarging, circular to irregular patches. The plants turn yellow, then brown, wither and die. Infected roots decay, turn brown to dark violet and are covered with a thick, bright violet-to-cinnamon, feltlike mat of hyphae. The fungus survives as dark violet-brown, velvety sclerotia in soil and as a saprophyte in plant debris.

10. **CROWN WART.** A common disease in excessively wet fields, mostly in the western USA, is caused by the fungus *Physoderma* (Urophycis) *alfaldae*. Irregular shaped white galls, up to 5 cm in diameter, form on the crown at or slightly below the soil surface. Older galls turn gray-to-brown as they dry and decay. The fungus survives as resting spores in gall tissue and in the soil.

11. **DODDER.** Also known as strawgleeweed, goldthread and lovevine, is caused by several species of *Cuscuta*. Dodder is a slender, twining, orange-to-yellow, annual vine that is parasitic on a wide range of plants. It occurs in tangled, yellowish patches that enlarge up to an acre or more in diameter if left uncontrolled. This “leafless” seed plant entwines alfalfa stems, grows over the tops of plants and mats them down, slowly reducing their vigor. Infected areas are difficult to harvest. Dodder seed can remain dormant in soil up to 20 years.

For chemical control suggestions, a listing of resistant varieties and other control measures, consult the Extension Plant Pathologist at your land-grant university, or your county extension office.
1. Stewart's bacterial wilt, L, leaf blight; C, seedling stalk rot; R, flea beetle
2. Goss' wilt, L, leaf and R, stalk symptoms
3. Holcus leaf spot
4. Eyespot
5. Yellow leaf blight, L, leaf spots; R, lesion with pycnidia
6. Southern leaf blight
7. Northern leaf blight
8. Helminthosporium leaf spot (blight) and ear rot
9. Physoderma brown spot
10. Zonate leaf spot
11. Sorghum downy mildew
12. Crazy top
13. Common rust
14. Gray leaf spot
15. Corn viruses. L, wheat streak mosaic; R, maize dwarf mosaic
16. Genetic leaf spot
1. STEWART’S BACTERIAL WILT. Caused by the bacterium *Erwinia stewartii*, is most severe following mild winters. Long, pale green to yellow or tan streaks with wavy margins form in the leaves. The streaks soon turn dry and brown, starting at feeding scratches made by the corn flea beetle (*Chlaenomela pucilia*). Dark brown cankers may form in the lower stalk pith. Infected plants sometimes produce premature, bleached and dead tassels. The bacterium overwinters in the corn flea beetle.

2. GOSS’ WILT. Caused by the bacterium *Corynebacterium nebraskense*, occurs in Nebraska and areas of bordering states. Water-soaked streaks, parallel to the leaf veins, occur on the leaves. Dark, angular, water-soaked spots (flecks) form next to the leaf veins. The fibrovascular bundles in systemically-infected stalks are discolored. Affected plants may be stunted. Plants can be infected, wilt and die at any stage. The bacterium overwinters in corn debris near the soil surface and in seed.

3. HOLCUS LEAF SPOT. Caused by the bacterium *Pseudomonas syringae*, appears as round-to-elliptical spots, up to 1 cm in diameter, on the lower leaves. The dark green and water-soaked spots dry to a creamy-white to tan with a brown or reddish margin; some are surrounded by a yellowish halo. The bacterium survives in corn, grass and sorghum debris.

4. EYESPOT. Caused by the fungus *Kabatiella zeae* (perfect stage, *Aureobasidium zeae-* *maydis*), occurs in the northern USA during cool, wet weather. Numerous, round-to-oval spots, up to ½ cm in diameter, with a tan-to-cREAM center, brown to purple margin and surrounded by a yellowish halo, form on the leaves. The upper leaves may wither and die prematurely, late in the season. The fungus overwinters in corn debris on or near the soil surface.

5. YELLOW LEAF BLIGHT. Caused by the fungus *Phylllosticta maydis* (perfect stage, *Mycosphaerella zeae-* *maydis*), is most prevalent in northern areas of the USA after extended cool, moist weather. Rectangular to oval, yellow-to-tan spots, often surrounded by a red and purple margin and a broad yellowish area, form on the leaves. Black specks (pycnidia) form in older lesions. If severe early, the lower leaves turn yellow, wither and die. The fungus overwinters in corn, foxtail and Sudangrass debris on the soil surface.

6. SOUTHERN CORN LEAF BLIGHT. Caused by the fungus *Helminthosporium maydis* (perfect stage, *Cochliobolus heterotrophicus*), is most prevalent in the southern half of the USA following warm, moist weather. Leaf lesions are tan with buff-to-brown borders, elongated between the veins, generally parallel-sided, and up to 1 by 3 cm. Two races of the fungus exist, Race 0 and Race T, which devastated the corn crop in much of the USA during 1970, but has been practically eliminated by planting resistant hybrids. The fungus survives on corn refuse on or close to the soil surface.

7. NORTHERN CORN LEAF BLIGHT. Caused by the fungus *Helminthosporium turcica* (perfect stage *Trichometasporiella*), is most prevalent in the northern half of the USA following warm, moist weather and heavy dews. Long, elliptical, greyish-green and tan lesions on the leaves may be up to 4 by 15 cm. They usually appear first on the lower leaves. When severe, a plant may turn greyish-green and die early. The fungus overwinters on corn debris.

8. HELMINTHOSPORIUM LEAF SPOT (BLIGHT). Caused by the fungus *Helminthosporium carboneum* (perfect stage, *Cochliobolus carboneum*), appears as round-to-oval or linear tan spots up to 1 by 3 cm. The lesions sometimes develop concentric zones and brown margins. Leaf sheaths, husks and ears are also infected by certain races. The fungus overwinters in corn debris.

9. PHYSODERMA BROWN SPOT. Caused by the fungus *Physoderma maydis*, occurs chiefly in the Southeastern states following hot, moist weather. Very small, round to oblong yellowish spots often occur in bands on leaves, sheaths and stalks below the ear. The yellowish lesions turn chocolate- to reddish-brown and may merge to form angular or irregular blotches. Infected stalks may break at the nodes. The fungus overwinters in corn debris and soil.

10. ZONATE LEAF SPOT. Caused by the fungus *Gloeocercospora sorghi*, is found mostly in the Gulf states. Lesions, which occur mainly on older leaves, are reddish-brown, water-soaked and may enlarge up to 2.5 to 5 cm in diameter. Aging lesions develop a targetlike pattern. Other hosts include sorghum, Sudan grass, Johnsongrass and sugarcane. The fungus overwinters in crop debris.

11. SORGHUM DOWNY MILDEW. Caused by the fungus *Peronosclerospora (Sclerospora) sorghi*, is found as far north as extreme southern Indiana and Illinois where it is more important on sorghum and sorghum-Sudangrass hybrids. Plants are often stunted and yellow, sometimes with chlorotic to white-striped leaves. A whitish downy growth may appear on either leaf surface in damp weather. Barrenness and poor ear fill accompany severe infection. The fungus survives in the soil and is spread by sowing infected seed.

12. CRAZY TOP. Caused by the widespread soil-borne fungus *Sclerotophora (Sclerospora) macropora*, infects plants when the soil is waterlogged sometime before the seedlings are 10 to 15 cm tall. The tiller is partially or completely replaced by a plumy mass of small leaves. Diseased plants may be quite stunted and tiller excessively with lighter green, often narrow, straplike and leathery leaves. Ear shoots may be numerous, elongated, leafy and barren. The fungus survives the refuse of many grasses and soil.

13. COMMON RUST. Caused by the fungus *Puccinia sorghi*, often appears after silking following warm, moist weather. Small, round to elongated, golden- to cinnamon-brown pustules form on both leaf surfaces and other above ground plant parts. The pustules turn chocolate-brown to black as the plant matures. When severe, the leaves may turn yellow, wither and die early. The fungus overwinters on living plants in southern states and spreads northward by wind-borne spores.

14. GRAY LEAF SPOT. Caused by the fungi *Cercospora zeae-maydis*, and *C. sorghi var. maydis*, occurs in warm-to-hot humid areas, especially where minimum tillage is practiced. Long, narrow, parallel-sided, tan or gray-to-tan or yellow spots, up to ½ by 2 to 5 cm, may merge forming large gray blotches with irregular margins that kill the leaves. The fungus overwinters in corn debris on or near the soil surface.

15. CORN VIRUSES. A. WHEAT STREAK MOSAIC VIRUS, transmitted by feeding of the wheat curl mite (*Aceria tulipae*), infects many grasses including wheat and corn. If severe, corn plants may be stunted and yellowed. Small, oval to elliptical yellowish spots and streaks form on young leaves. The streaks elongate and develop parallel to the veins. Severely affected plants form small ears with a poor seed set. The virus and its mite vector require living cereal, grass or corn plants to survive.

B. MAIZE DWARF MOSAIC VIRUS, caused by several strains of the sugarcane mosaic virus, is transmitted by the feeding of over 20 species of aphids. Angular, light and dark green mottling on young leaves develops into narrow, light-green or yellowish streaks along the veins. Early-infected plants are stunted and yellow-green with a poor seed set. Plants infected after silking time may appear nearly normal. The virus infects over 200 species of wild and cultivated grasses. Johnsongrass is the only important overwintering host in most of the USA.

16. GENETIC LEAF SPOT. Is one of many white-to-yellow flecks, spots and streaks that develop on corn leaves; not necessarily uniformly on a plant. Often only a few scattered plants in a field are affected.

For chemical control suggestions, a listing of resistant varieties, and other control measures, consult the Extension Plant Pathologist at your land-grant university, or your county extension office.
CORN DISEASES: II

1. Seedling blight
2. Common smut
3. Nemotode damage. L, to roots; R, damaged area in a field
4. Charcoal stalk rot
5. Diplodia stalk rot
6. Gibberella stalk rot
7. Anthracnose. L, stalk rot; C, top-dieback; R, leaf blight
8. Kernel red streak
9. Trichoderma ear rot
10. Fusarium kernel or ear rot
11. Gibberella ear rot
12. Diplodia ear rot
13. Nigrospora ear rot
14. Aspergillus ear rot and storage mold
1. SEEDLING BLIGHT may be caused by numerous fungi, several in the genus Pythium. Seeds may decay in the soil or seedlings rot before emergence. Seedlings that do emerge lack vigor, are yellow, stunted, wilt and die from a tan to dark-brown decay below the soil line that results in a poor, uneven stand. Damage is more severe in cold, wet soil than in warm soil. The causal fungi survive in soil, crop debris and seed.

2. COMMON SMUT OR BOIL SMUT, caused by the fungus Ustilago maydis is widely distributed over the world. Small to large galls form on any actively growing, above ground plant part. The galls are covered with a glistening white membrane that later ruptures to release masses of black smut spores. Large galls on the ear and above are more destructive than galls below the ear. Initial infections to young plants come from spores in corn debris, soil or manure. Secondary infections occur in the field.

3. NEMATODE DAMAGE to corn roots may be caused by a number of different species of plant-parasitic nematodes including awl, burrowing, dagger, lance, needle, ring, root-knot, root-leision, spiral, sting, stubby-root, stunt and probably others. Damaged plants are stunted and uneven in height, often chlorotic, may wilt during midday and lack vigor in oval to irregular areas of fields. Roots that form are usually shallow, stubby and “nubbed off,” or develop indistinct swellings to knot-like galls, and may branch excessively with few or no feeder rootlets. The roots often have dark, discolored areas and may be rotted. Weakened plants produce smaller and fewer ears that are poorly filled. The nematodes may survive in soil indefinitely by infecting a wide range of other host plants.

4. CHARCOAL STALK ROT is caused by the fungus Macrophomina phaseolina. Pith tissue in the lower stalk may shread. Black specks (sclerotia) form in large numbers on the fibrovascular bundles, giving rotted pith tissue a charcoal-like appearance. Affected stalks may break over (lodge). The disease is most common in the southern half of the USA, especially in the eastern Great Plains. The fungus survives as sclerotia in soil and debris of many crops, including corn.

5. DIPLODIA STALK ROT is caused by the fungus Diplodia maydis. Affected plants often die early with the leaves suddenly turning a dull grayish-green similar to frost injury. The lower parts of the green stalk turn tan to dark brown and the pith disintegrates. Diseased stalks are weakened and break readily. In the fall, raised black specks (pycnidia), that can not be scraped off with the thumbnail, are clustered near the nodes in dead stalks. The fungus survives in corn debris and seed.

6. GIBBERELLA STALK ROT is caused by the fungus Gibberella zeae (asexual stage, Fusarium roseum f. sp. cerealis ‘Graminearum’). The disease is widely distributed in the northern half of the Corn Belt. External symptoms are much like those of Diplodia Stalk Rot (5). A pink to reddish rot disintegrates the pith. Superficial black specks (perithecia), that are easily scraped off with the thumbnail, form on dead stalks. The fungus survives in corn and cereal debris and rarely on seed.

7. ANTHRACNOSE is caused by the fungus Collectotrichum graminicola. Enlarging, oval to spindle-shaped, yellow-to-brown lesions with distinct borders form in the leaves. Entire leaves may turn yellow-to-brown and die. Leafl lesions appear mostly on young plants and frequently on the upper leaves after silking. Black streaks appear on the lower stalk late in the season, with the pith dark brown and shredded. The tops of affected plants may turn yellow or red prematurely or the upper or lower stalk may break over. Numerous, black, spiny fruiting bodies (acervuli) form on the surface of the dead tissue. The fungus survives in corn debris and seed.

8. KERNEL RED STREAK is caused by a toxin secreted by the wheat curl mite (Aceria tulipae). Red streaks form on the sides of the kernels and often extended over the caps. Originally this disorder was believed to be a symptom of the wheat streak mosaic virus. The condition is usually most pronounced on kernels near the tip of the ear. Striking differences occur among inbred lines and hybrids in the amount and intensity of red streaking. White corn hybrids generally show less red streaking than most yellow corns.

9. TRICHODERMA EAR ROT is caused by the fungus Trichoderma viride. A white mold growth that later turns green and powdery forms on and between the kernels and husks. It commonly follows damage by other leaf or ear infections. Trichoderma appears when rainfall is above average the month before harvest.

10. FUSARIUM KERNEL OR EAR ROT, caused by the fungi Fusarium moniliforme and F. m. var. subglutinans, is probably the most widespread disease attacking corn ears. The caps of individual kernels or groups of kernels scattered over the ear develop a salmon-pink to reddish-brown discoloration. A powdery, cottony-pink mold forms later. Infection commonly follows some sort of injury. The same fungi may cause a stalk rot that is difficult to tell from Gibberella Stalk Rot (6). The fungi survive in corn debris and seed.

11. GIBBERELLA EAR ROT, sometimes called red ear rot, is caused by the same fungus that produces Gibberella Stalk Rot (6). It is found most frequently in the cooler and more humid areas of the USA when the weather during the month or six weeks prior to harvest is unusually wet. A pink-to-reddish mold, often starting at the ear tip, grows on and between the kernels and tightly stuck husks. Infected ears are toxic to swine, dogs and man.

12. DIPLODIA EAR ROT or dry rot is caused by the same fungus that induces Diplodia Stalk Rot (5) and seedling blight. Husks of early-infected ears appear bleached or straw-colored in contrast to the green of healthy ears. The entire ear may rot, turn grayish-brown, shrunk and remain upright with the husks stuck tightly together. Part or all of the ear is rotted with a white mold growing between the kernels. Black specks (pycnidia) may form at base of the husks and/or on the sides of the kernels. Infections usually begin at the base of the ear and progress toward the tip.

13. NIGROSPORA EAR ROT is caused by the fungus Nigrospora oryzae (perfect stage, Khuskia oryzae). Symptoms are not conspicuous until harvest. Ears are lightweight with the cob shredding easily, usually at the butt end. Kernels are loose on the cob, slightly bleached, with numerous round, black specks (spores) forming at the tip end. Affected ears are lightweight and the kernels are poorly finished. The disease occurs when growth is checked by drought, poor soil, frost, insects or other diseases. The fungus survives in corn debris.

14. ASPERGILLUS EAR ROT AND STORAGE MOLD may be caused by a number of species of fungi in the genus Aspergillus. The powdery mold growing on and between or within the kernels is usually black, greenish-yellow, or tan. The germ is discolored or dead. The disease is most common in the field when the weather is unusually wet for the month prior to harvest. Affected corn kernels may “cage” together in storage to form a crust, usually at the center and top of a bin. Some strains of the common fungus Aspergillus flavus, occasionally produce mycotoxins ( aflatoxins) that are harmful if fed to poultry, swine, beef and dairy cattle, or if consumed by humans.

For chemical control suggestions, a listing of resistant varieties, and other control measures, consult the Extension Plant Pathologist at your land-grant university, or your county extension office.
COTTON DISEASES
An Aid to Identification and Control

1. Postemergence dying of cotton seedlings
2. Ascochyta seedling blight
3. Ascochyta wet weather blight
4. Bacterial angular leaf spot
5. Fusarium wilt of cotton with cross section of diseased stem
6. Verticillium wilt damage to cotton stem
7. Sting nematode and wilt damage to cotton
8. Sting nematode damage to roots of cotton
9. Typical boll rot damage to cotton
1. **POSTEMERGENCE DYING.** Caused mostly by the fungus *Rhizoctonia solani*. The fungi *Pythium* and *Fusarium* cause similar killing of cotton seedlings. The surviving plants may be injured to some extent and yet survive. The above-mentioned fungi are present and persist in most cultivated soils in the state and cause greatest cotton seedling damage when soils are wet and cool for a prolonged interval after cotton seed germination.

2. **ASCOCYTA SEEDLING BLIGHT.** Caused by the fungus *Ascochyta gossypii*. Grayish white, circular to irregularly circular spots occur on seedling leaves and occasionally on the stem. The tiny, black fruiting bodies of the fungus are sometimes visible in these spots. Heavy leaf spotting can retard seedling growth and sometimes kill young seedlings. The fungus can survive 1 to 2 years in the soil and on seed. It also causes wet weather blight of cotton leaves (see photo 3) and boll rot.

3. **ASCOCYTA WET WEATHER BLIGHT.** Caused by the fungus *Ascochyta gossypii*. In addition to leaf blight damage, elongated lesions, often with gray centers, may develop in the crotch of lateral branches and leaf stems in midseason or later. Cool, rainy weather seems to promote this occurrence. The damage is seldom significant and warrants no control, except the use of clean seed and rotation. Boll rot damage, on the other hand, can be serious.

4. **BACTERIAL ANGULAR LEAF SPOT.** Caused by the bacterium *Xanthomonas malvacearum*. Angular, water-soaked spots cause most damage to leaves, stems, and bolls. Leaves may turn yellow and drop. The bacteria survive on infested seed and for 1 or 2 years on undecayed crop debris in the soil. Seedling damage often occurs when the seed are infested with the bacteria at planting.

5. **FUSARIUM WILT OF COTTON.** Caused by the fungus *Fusarium oxysporum f. vasinfectum*. Symptoms are stunting, wilting and yellowing of leaves. The plants die slowly. A dark brown discoloration of vascular tissue underneath the surface of the stem is good evidence of *Fusarium* wilt and can be found by cutting across any part of the main stem of severely affected plants. There are many resistant cotton varieties, but this resistance is often broken by certain nematodes feeding on the roots.

6. **VERTICILLIUM WILT.** Caused by the fungus *Verticillium alboatrum*. Only a few incidences of this wilt have been found in South Carolina and these mostly in the upper Piedmont. The brown vascular discoloration that is present with *Fusarium* wilt is not present with this wilt. Instead, brown flecks and streaks are usually present in the pith and can be seen by slicing the stem at an angle. The fungus can survive several years in the soil and is favored by cool growing seasons.

7. **STING NEMATODE AND WILT DAMAGE.** Caused by nematodes of the genus *Belonolaimus*. This pest is a problem mainly in sandy soils of the Coastal Plains. It has not been reported in the Piedmont. Damage to roots is usually very severe and plants which survive are stunted and unthrifty. *Fusarium* wilt often follows sting nematode damage and the two are often found together. The nematode survives in the soil and feeds on the roots of many different crops and weeds. Damage from lance nematode, *Hoplolaimus spp.*, is similar, but it usually occurs later in the season. Lance nematode inhabits sandy and sandy loam soils and also causes greatest damage to cotton in the Coastal Plains of the state.

8. **NEMATODE DAMAGE TO COTTON ROOTS.** Caused by sting or lance nematode (see 7 above). The taproot has not developed and most of the lateral roots are heavily damaged. This type of damage is sometimes confused with poor growth of roots over hardpans in the soil. In some instances both affect root growth.

9. **COTTON BOLL ROT.** Caused in this example by the fungus *Fusarium moniliforme*. Several different fungi and bacteria cause boll rots. The greatest damage occurs when high moisture exists around the bolls for extended periods. The causal organisms are very common. Many of the fungus spores are airborne and the organisms live over on crop debris or are brought into the field on contaminated seed. Many times boll rot develops following damage from insects or hail. Tight lock is a common symptom of diseased bolls.
1. Black Sheath Rot. L, Early; R, Advanced

2. Blast. L, Leaf; R, Neck and Collar

3. Brown Spot. Resistant

4. Kernel Smut. L, Typical; R, Severe

5. Narrow Brown Leaf Spot. L, Leaf; R, Neck and Collar

6. Sheath Blight. L, Early; R, Advanced

7. Sheath Spot. L, Aggregate; R, Bordered

8. Leaf Smut

9. Stem Rot. L, Early; R, Advanced
**1. BLACK SHEATH ROT** is caused by *Gaeumannomyces graminis*. Plants are most susceptible during internode elongation. Dark brown-black discoloration from the crown up the stem. Leaves of heavily infected sheaths die. Tillering and yield may be reduced. Usually only a problem in fields during the first few years rice is grown. Some cultivars are more susceptible than others.

2. **BLAST** is caused by *Pyricularia grisea*. Blast overwinters in rice seeds and infected rice stubble. The fungus can spread from these two sources to new rice plants during the next growing season and initiate new infections. Blast symptoms can occur on leaves, leaf collars, nodes and panicles. Leaf spots are typically elliptical (football shaped), with gray-white centers and brown to red-brown margins. Fully developed leaf lesions are usually 0.4 to 0.7 inch long and 0.1 to 0.2 inch wide. Both the shape and the color vary depending on the environment, age of the lesion and rice variety. Infected nodes and panicles are darkened. When panicle infection occurs, heads will be white. The panicle may collapse. Worse when rains occur frequently and temperatures are slightly cooler than normal.

3. **BROWN LEAF SPOT** is caused by *Cochliobolus miyabeanus*. The primary source of inoculum for brown leaf spot is infected seed. In addition, the fungus can overwinter in crop debris. Small oval to circular, brown leaf lesions. Occurs on plants stressed by low temperature, cold water, herbicide injury, other diseases and nitrogen addition. The fungus grows upward inside the plant and on the plant's surface, causing new lesions. The fungus also can spread to nearby plants. Severely damaged plants may lodge. These patches of lodged plants are easily seen from a combine at harvest. Damage can range from partial infection of the lower leaves with little effect on grain development to premature plant death. Sheath blight is more prevalent during periods of warm moist weather and in thick, lush stands, due to the high humidity which develops in the canopy.

4. **KERNEL SMUT** is caused by *Tilletia barclayana*. Spores released from smutted grains before or during harvest overwinter in other kernels, crop debris and soil. After planting in the spring, the spores float to the surface and germinate to form primary sporidia. Secondary sporidia are disseminated to rice panicles through the air. Minute, black masses of spores inside the hull burst and are then visible. Hands are blackened by the spores when the kernels are handled. Worse during warm, rainy weather at bloom. Apply recommended rates of nitrogen since high nitrogen rates strongly favor kernel smut.

5. **NARROW BROWN LEAF SPOT** is caused by *Cercospora oryzae*. Narrow brown leaf spot enters through the stomata and grows in host tissue cells. Symptoms may not be seen for up to 30 days after infection. Symptoms are most commonly seen in late growth stages and consist of short, elliptical to linear brown lesions on the leaf blades. Lesions are darker and smaller on resistant cultivars, and wider and lighter brown with gray necrotic centers on susceptible cultivars. Similar symptoms may be seen on leaf sheaths, pedicels and glumes.

6. **SHEATH BLIGHT** is caused by *Rhizoctonia solani*. Sheath blight symptoms may sometimes appear on seedling rice, but symptoms are more likely to develop after jointing begins. The first symptom is an oblong, water-soaked lesion on leaf sheaths at or near the water line. In two or three days the lesion will have a grayish-white center surrounded by a dark purplish- or reddish-brown margin and may be up to 1 inch long. Lesions may be small at internode elongation and later extend up the stem. This lesion interrupts the flow of water and nutrients to the leaf tip and the tip may die. Tissue below the lesion may remain green. As the plant grows and the canopy closes, the humidity inside the canopy increases. In this humid environment, the fungus grows upward inside the plant and on the plant’s surface, causing new lesions. The fungus also can spread to nearby plants. Severely damaged plants may lodge. These patches of lodged plants are easily seen from a combine at harvest. Damage can range from partial infection of the lower leaves with little effect on grain development to premature plant death. Sheath blight is more prevalent during periods of warm moist weather and in thick, lush stands, due to the high humidity which develops in the canopy.

7. **BORDERED SHEATH SPOT** is caused by *Rhizoctonia oryzae*. Similar to sheath blight, but symptoms are confined to the sheaths. Occurs in patches a few feet in diameter. Lesions are usually found on leaf sheaths halfway up the tiller and rarely on the leaf blades. Lesions are oval, 0.5 cm. to 2 cm. long and 0.5 cm. to 1 cm. wide. They are pale green, cream or white, with a broad dark margin. As lesions mature, they often become darker and margins are less defined. Sheath spot lesions usually do not coalesce to form the large area of infection typical of sheath blight, which it closely resembles.

8. **LEAF SMUT** is caused by *Entyloma oryzae* and *E. dactylidis*. Leaf smut produces small, slightly raised black spots or streaks under the epidermis of leaves and occasionally on leaf sheaths. In a heavy infestation, the leaves turn yellow, the tips dry out and die, and the leaves split lengthwise. Infection normally occurs in late season. High plant nitrogen levels, especially in later growth stages, favor the disease.

9. **STEM ROT** is caused by *Sclerotium oryzae*. Small black, blocky lesions on leaf sheath near water line. Stems can be rotted and lodge. Dark gray mold and small black particles that resemble powdered charcoal can be seen inside stems. Fields with low potassium levels are most likely to be damaged.

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SORGHUM DISEASES: I

1. Zonate leaf spot
2. Rough spot
3. Sooty stripe
4. Northern leaf blight
5. Red dot
6. Rust
7. Bacterial spot
8. Bacterial stripe
9. Bacterial streak
10. Physiologic leaf spot
11. Anthracnose and red rot
12. Maize dwarf mosaic
13. Sorghum downy mildew
14. Crazy top
1. **ZONATE LEAF SPOT**, caused by the fungus *Gloeosporium sorghi*, is common in the humid Southeast. Circular, reddish-purple bands, alternating with tan- or straw-colored areas, form concentric pustules (semicircular along the leaf margins) on the leaves and sheaths arid may enlarge to cover the width of the leaf. Pink to salmon-colored gelatinous spore masses develop over the stomates. When severe, destruction and premature defoliation of leaves and poorly filled seed may occur. The fungus overwinters as small, raised bodies (sclerotia) that form in lines parallel to the veins within dead leaf tissue. The fungus may also be seed-borne.

2. **ROUGH SPOT**, caused by the fungus *Ascochyta sorghina*, is prevalent throughout the humid Southeast. Small, round-to-oblong, light-colored lesions with well-defined margins form near the ends of leaves, later enlarging and merging to form large blotches. Numerous minute black fruiting bodies (pycnidia) develop on the lesions and may later fall away, leaving large areas of dead tissue. Disease spread takes place when spores (conidia) ooze out of the pycnidia in wet weather and are dispersed by wind and rain. Overwintering occurs on crop residue.

3. **SOOTY STRIPE**, caused by the fungus *Ramulispora sorghi*, appears as small, water-soaked, reddish-brown areas on the leaves that develop into long, elongate-elliptical lesions with straw-colored centers and purple small, water-soaked, reddish-brown areas on the leaves that develop into dispersed by wind and rain. Overwintering occurs on crop residue.

4. **NORTHERN LEAF BLIGHT** is caused by the fungus *Helminthosporium (Exserohilum) turcicum* (*Drechslera turcica*). Small, reddish-purple to yellow-tan spots develop on the leaves. Lesions gradually enlarge into grayish or tan elliptical spots several inches long with reddish-purple or tan borders that resemble those of sooty stripe. Sporulation, which appears as a dark gray mold, occurs in the centers of older lesions. The absence of the “sooty” appearance differentiates leaf blight from sooty stripe. The fungus spreads by wind and rain and overwinters on diseased plant refuse.

5. **RED DOT**, caused by the fungus *Helminthosporium (Exserohilum) rostratum* (*Drechslera rostrata*), is a minor disease of older plants. Small, red or purple lesions develop on the leaves and are limited laterally by the veins. Spread and overwintering is as for northern leaf blight.

6. **RUST**, caused by the fungus *Puccinia purpurea*, does not usually appear in northern sorghum-growing areas until plants near maturity. Minute purple, red or tan spots appear first. Later, the raised, reddish-brown pustules are prominent, especially on mature leaves. When severe, rusted leaves turn brown. RED DOT may be 3 to 5 inches long and 1/4 inch across. The centers become grayish when the fungus sporulates and “sooty” when numerous, minute black sclerotia are produced. Broad yellow margins distinguish sooty stripe from leaf blight. Sooty stripe is favored by warm, humid weather. The fungus overwinters as sclerotia on crop residue.

7. **BOTRYTIS SPOT**, caused by *Pseudomonas syringae pv. syringae*, is more common than bacterial streak, but is not as widespread as bacterial stripe. Spot is favored by cool-to-warm, moist and windy weather. Leaf lesions, which appear first on the lower leaves, are round to elliptical, dark green, water-soaked, and 1/25 to 1/4 inch in diameter. The spots turn red in a few hours, then light tan with red or dark brown borders. The lesions may enlarge and merge to form irregular blotches that kill the whole leaf. Bacterial spot can be distinguished from bacterial streak by the absence of streaks and bacterial exudate. The bacteria that cause spot, stripe and streak overwinter on seed and infected plant residue in the soil or on Johnsongrass. All three bacteria are spread by wind, rain, insects when the foliage is wet.

8. **BACTERIAL STRIPE**, caused by *Pseudomonas andropogonis*, occurs wherever sorghums are grown. Long, narrow (1/4 inch by 9 inches or more), water-soaked and irregular stripes, bounded by the veins, form on the lower leaves. The lesions soon dry and turn a solid brick red, dark purplish-red, reddish-brown, or tan-to-dark brown, depending on the sorghum and genetic factors that condition pigmentation. The stripes later elongate and fuse to form irregular blotches that cover a large part of the leaf and extend into the sheath. Bacterial exudate, the same color as the stripe, in droplets mostly on the underleaf surface and along the margins and dries to form reddish crusts or scales. The disease is favored by warm-to-hot, moist and windy weather.

9. **BACTERIAL STREAK**, caused by *Xanthomonas campesstris pv. holcicola*, is the most prevalent bacterial disease. The streaks are first narrow, water-soaked and translucent, 1/4" wide and 1"-6" inches long, with red or brown borders and irregular blotches of color interrupting the streaks. Parts of the streak may broaden into elongated oval blotches with tan centers and narrow red or brown margins. When numerous, the streaks may merge to form long, irregular lesions covering much of the leaf. Abundant light-yellow droplets of exudate form on young lesions, drying to thin scales that are lighter than those of leaf stripe. When severe, leaves may wither and drop early. Bacterial streak is favored by warm-to-hot, wet and windy weather.

10. **PHYSIOLOGIC LEAF SPOT**. Sorghum leaves may be affected with intensely covered leaf spots or stripes without evidence of bacterial exudate or scales or the presence of fungal mycelium and fruiting bodies. This nonparasitic spotting may be due to genetic factors, certain environmental conditions, a variety of mechanical injuries or a physiological breakdown of leaf tissues. The spots or stripes may be a solid color or develop various concentric or irregular patterns. Physiologic leaf spotting is minimal in sorghum near the former.

11. **ANTHRACNOSE AND RED ROT** are two phases of a destructive disease caused by the fungus *Colletotrichum graminicola*. Anthracnose is most serious where humid and relatively dry periods alternate. Small, well-defined, circular-to-elliptical spots that are tan, orange, red, or blackish-purple appear on the leaves. When humid, the spots increase in size and number to cover much of the leaf area. Short, stiff black hairs (setae) are evident in older lesions. The interior of stalks is rotted and marbled red and white (red rot). Diseased stalks frequently break over. The fungus is seed-borne. Overwintering also occurs in the soil, on plant residue, Johnsongrass and other susceptible weeds.

12. **MAIZE DWARF MOSAIC (MDM)** is a widespread disease caused by certain strains of the MDM virus. Young leaves develop an irregular dark- and light-green mosaic that often turns into elongated red blotches or stripes with dead centers and redish margins. Plant growth is often stunted, flowering is delayed, and early-infected plants may not head or set seed. Several species of aphids transmit the virus to sorghum from overwintering grass hosts, especially Johnsongrass.

13. **SORGHUM DOWNY MILDEW**, caused by the fungus *Peronosclerospora sorghi* is a serious disease of susceptible varieties. Soil-borne resting spores (oospores) germinate, systemically infect seedlings and produce a striped chlorotic mottle and a white down on the underleaves when free moisture is present. Sporangia are later released from the white down and spread by air currents to nearby plants where small, rectangular chlorotic spots are formed that rapidly become pigmented and dead. Young plants develop chlorotic, green and white striped leaves which eventually shrivel. Oospores formed between the veins of shredded leaves fall to the ground, permitting the disease to reappear if a susceptible crop is planted within the next several years.

14. **CRAY TOP**, caused by the downy mildew fungus *Sclerophthora* (*Sclerospora*) *macrospera*, is generally rare except in certain fields or areas within fields that are waterlogged shortly after planting. The oospore germinate under these conditions and produce sporangia which release motile zoospores that infect germinating seedlings before they emerge. Young plants may exhibit a yellow mottling of the upper leaves. Diseased plants eventually develop thick, stiff, twisted or curled leaves with puckered surfaces that may develop long yellow, tan or brown stripes that usually do not shred. Infected plants fail to head or produce heads that are barren with a proliferation of floral structures (crazy top). Oospores formed in deformed leaves or heads of more than 140 grass and cereal hosts serve to perpetuate the disease.

For cultural and chemical control suggestions, a listing of resistant varieties and other control measures, consult the Extension Plant Pathologist at your land-grant university, or your county Extension office.
1. Green ear  
2. Covered kernel smut  
3. Head smut  
4. Loose kernel smut  
5. Head mold  
6. Fusarium head blight  
7. Seedling blight  
8. Fusarium stalk rot  
9. Charcoal rot  
10. Pythium stalk rot  
11. Milo disease or Periconia root and crown rot  
12. Acremonium wilt  
13. Nematode damage  
14. Pokka boeng or twisted top  
15. Drought stress  
16. Iron chlorosis  
17. Bird damage
1. **GREEN EAR**, caused by the fungus *Sclerotinia graminicola*, occurs only during prolonged periods of light rains and heavy dew. This minor disease of grain sorghum is occasionally severe on sweet sorghum and broomcorn. The head (panicle) is partially or completely transformed into a mass of small twisted leaves. In moist weather the fungus produces a white “down” on leaves similar to the sorghum downy mildew fungus. Overwintering occurs in soil as thick-walled oospores.

2. **COVERED KERNEL SMUT**, caused by the fungus *Spelacotheca sorghi*, is rare where seed is treated and resistant types are grown. Usually kernels in a head are replaced by enlarged smut galls (sori) that are white, gray or brown. Gall are covered with a light-gray membrane which often ruptures and releases its mass of black smut spores (teliospores) at harvest. Covered and loose smut fungi are seed-borne and soil-borne spores are NOT considered important in their disease cycles.

3. **HEAD SMUT**, caused by the soil-borne *Sphaerotheca reiliana*, may cause serious losses since it cannot be controlled by seed treatment. Part or all of the head is transformed into a single smut gall or sorus. Parts not included in the sorus are usually blasted or individual florets are proliferated. The smut sorus is covered with a whitish membrane that ruptures soon after head emergence. The black smut spores (teliospores) gradually blow or wash away. Disease is favored by planting in cool dry soil and continuous cropping to susceptible sorghums. All sorghum smut fungi infect seedlings before they emerge.

4. **LOOSE KERNEL SMUT** is caused by *Sphaerotheca cucurbitae*. Diseased plants are often stunted with smutted heads that emerge several days earlier than heads on healthy plants. The membrane covered the smut gall ruptures soon after the head emerges, releasing masses of black teliospores which soon blow or wash away leaving remains of the deformed florets. Overwintering is as covered kernel smut.

5. **HEAD MOLD** is common when weather during the late stages of seed development is humid and wet. Air-borne fungi (species of Alternaria, Chaetomium, Cladosporium, Colletotrichum, Curvularia, Fusarium, Helminthosporium, Nigrospora, Penicillium and Trichothecium) discolor glumes and kernels and may cover them with mold growth. Head molds damage the seed allowing invasion by other fungi. Damaged or immature kernels and soft-seeded varieties are most susceptible.

6. **FUSARIUM HEAD BLIGHT**, caused by the fungus *Fusarium moniliforme* (perfect state *Gibberella moniliformis*), is most serious in the humid South. Several or even all florets in a head may die and covered with a cream to pinkish-tan mold in humid weather. If the panicle is split lengthwise, a red-brown-black discoloration is evident in the upper portion of the peduncle which extends into the branches and even upper portions of the stalk. Infection by air-borne spores probably occurs through cracks or insect wounds.

7. **SEEDLING BLIGHT**, caused by species of *Fusarium* (mostly *F. moniliforme*), Helminthosporium, Penicillium, Pythium and Rhizoctonia occurs where germination and seedling growth are checked by adverse soil and weather conditions. Short-lived primary roots and early-formed adventitious roots are very vulnerable. *Fusarium moniliforme* may rot seed and seedlings near the soil line, causing them to collapse (damp-off) from a reddish decay of the primary roots. Seedling blight fungi are commonly both seed- and soil-borne.

8. **FUSARIUM STALK ROT**, caused by *F. moniliforme*, attacks any time from seed germination to plant maturity producing a root-stalk rot, especially when sorghum is grown under adverse conditions. The disease is most damaging during cool, wet weather following a period of hot, dry weather. Fusarium stalk rot can be distinguished from charcoal rot by the lack of small black sclerotia, a slower disintegration of pith tissues and being a dry disease resistance was incorporated. Seedlings may wilt and die from a brown or reddish, water-soaked decay. Mildly affected plants are stunted with somewhat underdeveloped seeds. When more severe, leaves often wilt, roll, turn yellow, and dry. Plants may die before heading. Tissues within the lower internodes of the stalk, crown and large buttress roots develop a chocolate-brown to dark red decay. The fungus survives in soil and crop debris as thick-walled chlamydospores.

9. **ACREMONIUM WILT**, caused by the fungus *Acremonium strictum*, is a new disease of the High Plains that first appears as a drying of leaves and a discoloration of the midrib and leaf veins. Large patches of dead tissue often develop along one side of the midrib. Later, whole leaves die and symptoms progress to younger leaves. The top of the plant eventually dies. Vascular bundles within diseased stalks are discolored and plugged. The fungus overwinters in crop debris and soil.

10. **ACREMONIUM WILT**, caused by the fungus *Acremonium strictum*, is a new disease of the High Plains that first appears as a drying of leaves and a discoloration of the midrib and leaf veins. Large patches of dead tissue often develop along one side of the midrib. Later, whole leaves die and symptoms progress to younger leaves. The top of the plant eventually dies. Vascular bundles within diseased stalks are discolored and plugged. The fungus overwinters in crop debris and soil.

11. **MILO DISEASE OR PERICONIA ROOT AND CROWN ROT**, caused by the fungus *Periconia circinata*, was a major disease of milo sorghums before disease resistance was incorporated. Seedlings may wilt and die from a brown or reddish, water-soaked decay. Mildly affected plants are stunted with somewhat underdeveloped seeds. When more severe, leaves often wilt, roll, turn yellow, and dry. Plants may die before heading. Tissues within the lower internodes of the stalk, crown and large buttress roots develop a chocolate-brown to dark red decay. The fungus survives in soil and crop debris as thick-walled chlamydospores.

12. **ACREMONIUM WILT**, caused by the fungus *Acremonium strictum*, is a new disease of the High Plains that first appears as a drying of leaves and a discoloration of the midrib and leaf veins. Large patches of dead tissue often develop along one side of the midrib. Later, whole leaves die and symptoms progress to younger leaves. The top of the plant eventually dies. Vascular bundles within diseased stalks are discolored and plugged. The fungus overwinters in crop debris and soil.

13. **NEMATODE DAMAGE**, caused by numerous genera and species of microscopic, transparent roundworms feeding on the roots, reduces plant vigor and root growth, and lowers the plant’s natural resistance to other pathogens. When severe, a field appears “ragged” with areas of stunted, chlorotic plants that may wilt on sunny days and recover slowly at night. Root systems are commonly reduced in size with dark discolored areas (root lesions), knoblike swellings at the root tips, nodulelike galls throughout the root system, excessive production of branch roots, stubbed-off roots in clutters, or coarse roots with few branch roots and feeder roots. Nematode overwinter in plant residue and soil and are spread by any agency that moves infested soil.

14. **POCHKA BOENG OR TWISTED TOP**, caused by the fungus *Fusarium moniliforme var. subglutinans*, occurs where high humidity is prevalent. Leaves near the tops of plants do not unfold properly, resulting in a ladderlike appearance. When severe, infection may move from the leaves and sheaths into the stalk causing death to the upper plant parts. Sometimes the stalk is bent or develops uniform narrow, “knife-cut” lesions in the rind. Diseased stalks may break over at these lesions during storms. The fungus may grow on the outside of the stalk, behind the leaf sheath or in the whorl, during prolonged wet weather.

15. **DROUGHT STRESS** causes the upper leaves to roll upward and inward. On young plants with sufficient nitrogen (N) but lack moisture, the leaves roll and become dull but do not yellow. In older plants, drought may produce N deficiency symptoms even if sufficient N was applied. Seedlings may wilt and die, particularly in a loose seedbed. Drought stress is often most severe in plants attacked by root-stalk rot fungi.

16. **IRON CHLOROSIS** is common in areas west of the Mississippi River where the soil is alkaline, wet, poorly aerated or compacted. Slightly affected plants develop yellow striped leaves while the leaves on severely affected plants are mostly yellow with white margins and tips.

17. **BIRD DAMAGE** is common and grain losses may be severe in areas where populations of sparrows, blackbirds, doves, crows, weavers and buntings are high. Birds are not attracted to bitter grain types of sorghum. Vastities with pendent heads (goose-neck) have less of a loss to birds than stiff, upright types. Infection by head molds and other fungi commonly follows damage to the heads and grain.

For cultural and chemical control suggestions, a listing of resistant varieties and other control measures, consult the Extension Plant Pathologist at your land-grant university, or your county Extension office.
SOYBEAN DISEASES: I

1. Pythium seedling rot
2. Rhizoctonia root rot
3. Soybean cyst nematode. L, field damage; R, cysts on roots
4. Phytophthora root and stem rot
5. Brown stem rot
6. Charcoal rot
7. Purple seed stain
8. Powdery mildew
9. Septoria brown spot
10. Anthracnose
11. Stem canker
12. Pod and stem blight. L, pycnidia on stems and pod; R, infected seed
13. Downy mildew. L, upper and C, lower leaf surface; R, infected seed
1. **PYTHIUM SEEDLING ROT** is caused by several species of soil-borne fungi in the genus *Pythium*. Diseased plants may occur singly, in small circular patches – especially in low areas in the field – or uniformly over an entire field following a rainy period. Seedlings may rot before emergence. Plants that do emerge may wilt later, then turn brown and die. Pythium causes a soft watery rot. Damage is most severe in cold, wet soil. The fungi survive in seed and crop debris as oospores and mycelium.

2. **RHIZOCTONIA ROOT ROT** is caused by the common soil-borne fungus *Rhizoctonia solani*. Seedlings or somewhat older plants wilt and may die from a firm, dry, brown to reddish-brown decay of the roots and stem below or near the soil line. The fungus also causes pre- and postemergence damping-off. Damage is most severe in heavy, poorly-drained soils where groups of affected plants commonly wilt and die in areas 4 to 10 feet in diameter. The *Rhizoctonia* fungus survives in soil as mycelium and sclerotia.

3. **SOYBEAN CYST NEMATODE**, caused by *Heterodera glycines*, is a serious pest and major threat to soybean production. Severely infected plants are stunted and yellowed (chlorotic) and may die in areas of fields. Lightly infected plants appear normal, especially when growing conditions for soybeans are favorable. Pinhead-sized, shiny, white to yellow females or brown cysts (dead female bodies) are attached to the roots. The cysts are much smaller than the larger and loosely attached bacterial nodules. The dark brown cysts persist for years in the soil. The cysts are easily spread in even small bits of soil.

4. **PHYTOPHTHORA ROOT AND STEM ROT** is caused by the soil-borne fungus *Phytophthora megasperma var. sojae*. Affected plants turn yellow, wilt, wither and die at any age, leaving short to long gaps in rows. Seedlings may be affected and die before or after emergence. A dark brown root rot can be found on older plants, with the dull brown discoloration extending up the stem into the lower branches. The *Phytophthora* rot is most severe in low, poorly-drained, clay soils following cool and rainy weather. The *Phytophthora* fungus survives in soil and buried crop debris as oospores or mycelium.

5. **BROWN STEM ROT** is caused by the soil-borne fungus *Phialophora gregata* (synonym *Cephalosporium gregatum*). The disease usually becomes apparent about midseason by a dark reddish-brown discoloration inside the lower stem when the stem is split. The browning can be confused with that caused by other pathogens and should not be considered as diagnostic. Certain fungal strains cause the leaves to scorch between the veins, wither and drop early. External symptoms are not observed on infected plants until pod set. The causal fungus survives in soybean debris as mycelium.

6. **CHARCOAL ROT** is caused by the fungus *Macrophomina phaseolina*. The disease appears in dry, hot weather or when plant growth is limited by some factor. Affected plants lack vigor and die early. Numerous black specks (sclerotia) appear when the “bark” is peeled from the stem base by some factor. Affected plants lack vigor and die early. Numerous black specks (sclerotia) appear when the “bark” is peeled from the stem base by some factor. Diseased seed are often dull, cracked and rough. Small, inconspicuous, angular, reddish-brown spots form on the leaves, stems and pods. Infected seeds may reduce the stand or often produce diseased seedlings. The fungus survives in seed and crop debris as mycelium with infection favored by prolonged moist weather from pod set to harvest.

8. **POWDERY MILDEW** is caused by the fungus *Microsphaera diffusa*. Superficial, white to pale gray powdery patches form on the leaves. The soybean tissue underneath is reddened. Where the disease is severe, affected leaves wither and drop early. The mildew fungus is believed to survive in living leaves in the southern states. The disease is favored by warm dry days and cool nights.

9. **SEPTORIA BROWN SPOT** or brown spot is caused by the fungus *Septoria glycines*. Small, angular to irregular, chocolate- to reddish-brown spots form on both surfaces of the leaves. The lower and older leaves gradually turn yellow and drop early. Black specks (pycnidia) form in the older lesions. In wet weather, infections progress from the lower to the upper leaves. Late in the growing season, infected leaves turn rusty-brown and drop early. The fungus survives as mycelium in crop debris and seed.

10. **ANTHRACNOSE** may be caused by two fungi, *Colletotrichum dematium* var. *truncata* and *Gloeophyllum glycines*. The former fungus is much more common in the Midwest, infecting plants of all ages. *G. glycines* only infects older plants. Both fungi produce similar symptoms. Indefinite, enlarging, reddish- or dark-brown areas develop on the stems and pods. Later, these areas are covered with black fungal fruits (acervuli) that resemble tiny pin cushions containing black spines (setae) that are easily seen with a hand lens. Infected seed may be shriveled and mortal, or near normal in appearance. The anthracnose fungus survives as mycelium in crop debris and in seed.

11. **STEM CANKER** is caused by the fungus *Diaporthe phaseolorum* var. *caulivora*. Dark, reddish-brown then tan, girdling cankers form in the stem at the base of a branch or leaf petiole, usually at the 4th or 5th nodes, starting about the beginning of pod set. Affected plants, which are usually scattered in a field, commonly wilt, wither and die early with the dead, dried leaves remaining attached. Small, reddish-brown lesions on the cotyledons may cause infected seedlings to wither and die. The fungus survives in crop debris and seed as mycelium.

12. **POD AND STEM BLIGHT** is caused by the fungus *Diaporthe phaseolorum* var. *sojae*. Plants when near maturity develop large numbers of black specks, fungal fruiting bodies (pycnidia), in straight rows along the stems and scattered on dry, poorly developed pods. Heavily infected seed are dull, badly cracked, shriveled and often covered partially or completely with a white mold growth. Sowing diseased seed commonly results in seed decay, seedling blights and often a poor stand in the field. The fungus survives as mycelium in crop residues and seed.

13. **DONNY MILDEW** is caused by the fungus *Peronospora manihurica*. Indefinite, yellowish-green areas appear on the upper leaf surface. The lesions enlarge and turn a grayish-brown to dark brown surrounded by a yellow-green margin. The disease gets its name from the grayish to pale purple tufts of mold that form directly on the undersides of the lesions in damp weather. If severe, some leaves wither and drop early. A whitish crust, composed of mycelium and oospores of the fungus, may form on infected seed. The fungus survives as thick-walled oospores in infected leaves and on the seed.

14. **SUDDEN DEATH SYNDROME (SDS)** (not pictured*) SDS is caused by an interaction of environment, fungi (*fusarium solani* f.sp. *glycines*), *Rhizoctonia* cyst nematode and other stresses. Occurs most frequently on low, wet soils as circular or oval patches. Scattered plants are possible. Leaf symptoms begin as small yellow blotches in the interveinal tissue that later merge to leave only the veins green. Upper trifoliate turn brown, dry out and curl upward. Symptom is similar to brown stem rot (see leaf symptom #5) but the stem pith is not discolored.

*SDS added by Winfield Solutions, LLC.*
SOYBEAN DISEASES: II

1. Bacterial blight
2. Bacterial pustule. R, close up of pustule
3. Wildfire
4. Alternaria leaf spot
5. Frogeye leaf spot
6. Phyllosticta leaf spot
7. Sclerotinia stem rot. L, cottony mycelium; R, sclerotia on stems
8. Soybean mosaic. L, and C, leaf symptoms; R, mottling of seed coats
9. Yellow mosaic
10. Bud blight. L, necrosis of terminal buds; R, blotches on pods
11. Lightning damage
12. Hail injury
13. Frost damage
14. Iron deficiency
15. Potassium deficiency
1. BACTERIAL BLIGHT is caused by the bacterium *Pseudomonas glycinea* (synonym *Pseudomonas syringae*). Leaf spots are small, angular and yellow, later turning dark brown to black, commonly with water-soaked margins, and bordered by a yellowish-green halo. The enlarging lesions may merge to form large, irregular dead areas. In windy and rainy weather, the centers of older lesions drop out or tear away with the leaves appearing ragged and shredded. The disease is common following cool wet weather up to about midseason. The bacterium survives in crop debris on or above the soil surface and in seed.

2. BACTERIAL PUSTULE, caused by the bacterium *Xanthomonas phaseoli* var. *sojensis*, develops during warm, wet weather. Small, angular, yellowish-green spots with dark, reddish-brown centers, without water-soaked margins, form on the leaves. The center of each lesion has a minute, raised pustule, especially on the lower surface. Tissue lesions may merge to produce large, irregular dead areas. The dead tissue may rupture and tear away during windy and rainy weather. The bacterium survives in crop debris and seed.

3. WILDFIRE is caused by the bacterium *Pseudomonas tabaci*. The same organism causes a worldwide disease of tobacco. Light brown to dark brown or black spots with a broad yellow halo, up to 1.25 cm wide, appear on soybean leaves. The lesions may enlarge in damp weather and merge to kill large irregular areas that become dry and tear away. If severe, almost complete defoliation can occur. Wildfire almost always is found associated with Bacterial Pustule (2). The bacterium survives in crop debris and seed.

4. ALTERNARIA LEAF SPOT is caused by one or more species of fungi in the genus *Alternaria*. Dark brown, concentrically-ringed spots 0.8 to 2.5 cm in diameter, form on the leaves of plants as they near maturity. The lesions often enlarge and merge to kill large areas of leaves. Infected seed may show a dull brown discoloration. The *Alternaria* fungus survives as mycelium in crop residues and seed.

5. FROGEYE LEAF SPOT, caused by the fungus *Cercospora sojina*, is most common in the southern half of the USA in warm humid weather. The disease appears as small, irregular to angular, light gray to tan spots on the leaves with narrow, dark reddish-brown borders. Several lesions may merge to form large, irregular spots. Where severe, infected leaves may wither and drop early. Lesions also develop on the stems pods and seed. The fungus overwinters as mycelium in crop refuse and seed.

6. PHYLOSTICTA LEAF SPOT is caused by the fungus *Phyllosticta sojae*. This minor disease commonly appears as pale-green, round to oval or V-shaped areas at the margins of the first few trifoliate leaves of young plants. The lesions soon dry, turn tan or a dull gray with a narrow, dark brown or purplish border. The lesions later tear and fall away. Numerous black specks, fungal fruiting bodies (pycnidia), form in the older lesions. The fungus survives as mycelium in crop refuse and seed.

7. SCLEROTINIA STEM ROT or white mold is caused by the soil-borne fungus *Sclerotinia* (or *Whetzelinia*) *sclerotiorum* var. *sojae*. The lower stems of affected plants are covered with a white cottony mold in prolonged moist weather. Small to large, black, round to irregular, fungal bodies (sclerotia) form in the cottony mold both outside and inside the stems, and occasionally within the pods. Diseased plants may die early with the wilted then withered leaves remaining attached for some time. The fungus may also cause a pre- and postemergence damping-off of soybean seedlings. The fungus survives for long periods as sclerotia in the soil and with the seed.

8. SOYBEAN MOSAIC, caused by the soybean mosaic virus, produces variable symptoms depending on the soybean cultivar and strain of the virus. Diseased plants are usually somewhat stunted with distorted (crinkled, puckered, ruffled, narrow, stunted) leaves. The symptoms are largely masked at temperatures above 85° to 88°F. The pods are often stunted, flattened or curved and contain fewer and smaller seed. Certain virus strains cause a dark brown to black mottling of the seed coat. Infected seeds fail to germinate, or they produce diseased seedlings. The virus overseasons in living plants and is spread by the feeding of aphids and other insects and by sowing virus-infected seed.

9. YELLOW MOSAIC is caused by the bean yellow mosaic virus. Mixed infections of the virus with the soybean mosaic virus are not uncommon. Initial symptoms of both viruses are essentially the same. Characteristic of yellow mosaic is a conspicuous yellow mottling of the leaves. The yellow areas are scattered over the leaf blade or occur in indefinite bands along the major veins. Rusty spots later form in the yellowed areas. Veinal necrosis often occurs. Some virus strains produce severe mottling or crinkling in the leaves. Infected plants are not noticeably stunted. The virus infects a wide range of weed and crop plants. It is transmitted by several species of aphids. Seed transmission in soybean has not been reported.

10. BUD BLIGHT, caused mostly by the tobacco ringspot virus, produces a variety of symptoms. The tip (terminal) bud on young plants turns brown, dies, and curves downward to form a “shepherd’s crook.” Later, other buds turn brown, die and become very brittle. Diseased plants are often stunted to dwarfed, produce few or no pods, and remain green until frost. The pods that do form may drop early or develop dark blotches. Bud blight usually starts at a field margin and progresses inward. The causal virus infects many weed and crop plants and is transmitted by young thrips, grasshoppers, probably other insects, as well as daggar nematodes. The few seeds produced by systemically infected plants give rise to diseased seedlings.

11. LIGHTNING DAMAGE causes soybean plants to be killed in generally circular spots, up to about 50 feet in diameter, with a border of damaged plants. Lower parts of the stems may be blackened with numerous dead, attached leaves. Lightning can be distinguished from root rot by the sudden death of both soybeans and weeds in the affected area, the clearly defined margins, no evidence of a pathogen and that the spot does not increase in size.

12. HAIL INJURY is easy to recognize. Leaves are ragged and torn. Stems may be “cut off,” broken, or show sunken dark areas on one side. Hail injuries may be colonized later by pathogenic organisms and result in girdling cankers and/or weakened stems.

13. FROST DAMAGE is most common on early-planted soybeans. Often only the upper parts of the plants in low-lying areas of fields are killed or damaged. Regrowth soon appears at a nondamaged node. If such growth is vigorous, and the number of severely damaged plants is small, replanting is not needed.

14. IRON DEFICIENCY appears as a yellowing of the interveinal areas on the younger leaves. Later, even the veins may turn yellow with the whole leaf finally turning ivory-colored to almost white. Brown dead spots may form near the leaf margins. Iron deficiency, which closely resembles manganese deficiency, is common in alkaline soils, usually well above pH 7.0.

15. POTASSIUM DEFICIENCY appears as a yellowing of the interveinal areas on the younger leaves. Later, even the veins may turn yellow with the whole leaf finally turning ivory-colored to almost white. Brown dead spots may form near the leaf margins. Iron deficiency, which closely resembles manganese deficiency, is common in alkaline soils, usually well above pH 7.0.
WHEAT DISEASES: I

1. Black head mold
2. Botrytis head mold
3. Common bunt or stinking smut
4. Loose smut. R, healthy head
5. White heads (Fusarium)
6. Foot rot (Fusarium culmorum)
7. Scab or head blight
8. Black chaff. L, leaf and R, glume symptoms
9. Septoria leaf blotch. R, pycnidia of Septoria tritici in leaf lesion
10. Stem rust. L, telial stage; C, uredial stage; R, aecial stage on barberry leaf
11. Leaf rust
12. Septoria leaf and glume blotch (S. nodorum). L, leaf and R, glume symptoms
13. Tan or yellow leaf spot. R, pseudothecia of Pyrenophora trichostoma on straw
14. Powdery mildew. L, black specks (cleistothecia) in older colonies
15. Cephalosporium stripe. L, leaf and R, culm symptoms (leaf culm is healthy)
1. BLACK HEAD MOLD. Caused by species Cladosporium and Alternaria and to a lesser extent Stemphylium, Epicoccum, and Sporobolomyces. These fungi, often called “sooty molds,” give an olive-brown to black weather at or near grain maturity, and are most severe when harvest is delayed. Plants predisposed to other diseases, shading, nutrient deficiency and lodging are most susceptible. The fungi survive mostly in plant refuse.

2. BOTRYTIS HEAD MOLD. Caused by the fungus Botrytis cinerea, is a minor, late season disease. Warm, wet weather at or near harvest increases the incidence of this disease. Infected glumes and kernels are disease or other disorders are most susceptible. The fungus has a wide host range and survives on plant debris.

3. COMMON BUNT OR STINKING SMUT. Caused by two closely related fungi, Tilletia caries and T. foetida. The fungi produce plump “smut balls” that replace the kernels and cause the blumes to spread apart. These balls have a fishy odor and crush at harvest to release a cloud of dark spores (teliospores or chlamydospores). Infected plants are slightly stunted and the heads usually remain green longer than those on healthy plants. Cool soil temperatures favor seedling infection. The fungus overwinters as teliospores on seed and in soil.

4. LOOSE SMUT. Caused by the fungus Ustilago tritici. Unlike Common Bunt (3), Loose Smut does not affect seed quality. The smutted heads, with the kernels replaced by black masses of spores, are clearly visible shortly after they emerge. At harvest, only a naked rachis remains of a smutted head. Wheat plants are only susceptible to infection for about a week at flowering time. The fungus invades the embryo of the developing seed, remains dormant until the kernel germinates and then colonizes the terminal growing point.

5. WHITE HEADS. The blasting and killing of inflorescences — is a symptom common to many disorders including Fusarium Foot Rot (6), Cephalosporium Stripe (15), Eyespot, Rhizoctonia Sharp Eyespot, Take-all, symptom common to many disorders including Fusarium Foot Rot (6), 5. WHITE HEADS.

6. FOOT ROT. Caused by the soil-borne fungus Fusarium culmorum, is economically important in many areas of the USA, especially in warmer soils. Plants under moisture or nutritional stress or insect injury are very susceptible. Light-brown to reddish-brown lesions develop on subcrown internodes, coleoptiles and primary roots. Above ground plant parts can become infected from stubble-produced spores which infect irregular tan blotsches on the leaves or White Heads (5). The greatest yield loss comes from stands thinned by foot and crown infections which are often lethal to seedlings. The fungus overwinters on plant refuse, seed and in soil.

7. SCAB OR HEAD BLIGHT. Caused by species Fusarium, primarily F. roseum f. sp. cerealis (perfect stage, Gibberella zeae). One or more spiklets per head turn prematurely straw-colored when glumes on healthy spiklets are still green. Infected spiklets are usually sterile or contain bleached to grayish-brown, shriveled and rough kernels. A pink orange mold often grows at the base of diseased spikelets. Black perithecia of the fungus often grows at the base of diseased spikelets. Black perithecia of the fungus often grows at the base of diseased spikelets.

8. BLACK CHAFF. Caused by the bacterium Xanthomonas translucens f. sp. undulosa, appears as dark brown to black or olive-green, interveinal blotches and streaks on the glumes, awns, leaves, sheaths, necks, and stems. Slime or tiny droplets appear on the lesions in wet weather and dry into minute yellow scales. Diseased heads mature late, may be sterile if infected before flowering, or produce kernels that are shriveled at their bases. The bacterium overwinters in soil, living and dead plants and soil.

9. SEPTORIA LEAF BLOTCH. Caused by the fungus Septoria tritici. Small, light green-to-yellow spots on the leaves and sheaths enlarge and merge to form irregular, tan-to-reddish-brown blotches with gray-brown to ash-colored centers often partially surrounded by a yellow margin. Black specks (pycnidia) form in older lesions or at stem nodes. Affected leaves often turn yellow, wither and die early. The fungus survives in living and dead wheat plants and in seed.

10. STEM RUST. Caused by the long-cycled rust fungus Puccinia graminis f. sp. tritici, occurs on stems, leaves, sheath, and heads. When severe, grain may be shrunken and light weight. The oblong, reddish-brown ureidospores are tattered with fragments of plain wheat epidermis. The pustules release masses of dusty ureidospores that infect wheat. As the wheat matures, the pustules gradually turn black when telia and teliospores develop. To complete its life cycle an alternate host, common barberry (Berberis vulgaris, B. canadensis, B. fendleri) or species of Mahonia, is required. The teliospores germinate in early spring to produce basidiospores which infect nearby alternate hosts and form orange-to-yellow leaf spots called pycnia. Later, on the opposite side of the same leaf, aecial “cluster cups” develop containing golden aeciospores. These spores infect nearby wheat plants completing the disease cycle. The fungus overwinters on wheat stubble and in the uredial stage on living plants in the southern USA and Mexico. The wind-borne ureidospores spread northward as the season progresses.

11. LEAF RUST. Caused by the fungus Puccinia recondita f. sp. tritici, appears as small, round-to-oval, orange-yellow dusty pustules (uredia) on the leaves and sheaths, sometimes the stems, and occasionally the glumes and awns. On a resistant wheat only small yellow flecks or spots without uredia develop. As wheat matures, glossy, dark gray-to-black covered telia are produced. The alternate host, species of meadow rue (Thalictrum) is infected in Europe but this is rare in the USA. The rust fungus overwinters in the uredial stage living wheat plants in the southern USA and Mexico. The wind-borne ureidospores spread northward as the season progresses.

12. SEPTORIA LEAF AND GLUME BLOTCH. Caused by Septoria nodorum (perfect stage, Leptosphaeria nodorum), closely related to the Septoria Leaf Blotch fungus (9). S. nodorum infects the leaves, sheaths and stems producing symptoms very similar to S. tritici. Enlarging, grayish or brownish blotsches, which later turn chocolate-brown, form on the glumes. The centers turn grayish-white and are studded with black pycnidia. The fungus overwinters in living and dead plants and in seed.

13. TAN OR YELLOW LEAF SPOT. Caused by the fungus Pyrenophora trichostoma (imperfect stage, Helminthosporium tritici-repentis), can be serious where no-till is practiced. Diseased leaves often turn yellow, wither and die early. Small, yellow-to-tan-brown flecks enlarge to shaped brown lesions, up to 12 mm long, with a yellow border. In the fall, raised, black pustules form on wheat stubble. These structures mature in winter and spring to produce asciiospores that infect the next wheat crop.

14. POWDERY MILDEW. Caused by the fungus Erysiphe graminis f. sp. tritici. White-to-light gray, powdery patches form on the leaves, sheaths, stems and floral bracts. Black, speck-sized cleistotheca form on wheat stubble. These structures mature in winter and spring to produce ascospores that infect the next wheat crop.

15. CEPHALOSPORIUM STRIPE. caused by the fungus Cephalosporium gramineum (imperfect stage, Hymenula cerelas) is associated with wet soils and more or less continuous cultivation of winter wheat. Yellow then brown stripes develop on the stems and often continue the length of the leaf. Older leaves gradually turn yellow and die. Diseased plants are stunted and produce white, poorly filled heads with shriveled kernels. The fungus overwinters in crop debris and soil near the surface.

For chemical control suggestions, a listing of resistant varieties, and other control measures, consult the Extension Plant Pathologist at your land-grant university, or your county extension office.
1. Foot rot or eyespot. L, lodging in a field; C, and R, Lesions on culms

2. Rhizoctonia bare patch, L; sharp eyespot lesion on culms, R

3. Take-all. L, in the field; C, darkened culm bases; R, white heads

4. Helminthosporium root and crown (foot) rot. L, field; R, decayed crowns

5. Frost injury

6. Winter injury

7. Fusarium root and crown (foot) rot

8. Typhula blight or speckled snow mold. L, infected plants; R, sclerotia

9. Soil-borne mosaic. L, in a low-lying field; R, leaf symptoms

10. Barley yellow dwarf

11. Wheat streak mosaic

12. Herbicide (Trifluralin) injury
Evidence of water-soaked, translucent blisters on the stem base of plants, indicative of the fungal infection known as **Eyespot or Eyespot**. Symptoms include pale green to bronzy-yellow or light purple patches on the leaves, particularly in cool, wet conditions. 

**Foot Rot or Eyespot**, also known as strawbreaker, is caused by the soil-borne fungus *Pseudocercosporella* (Cercosporella) herpotrichoides. Maturing plants lean or break over (lodge) and in all directions from a basal stem or foot rot that develops during wet weather in autumn, winter and early spring. Leakage of white to light-yellow lesions with dark brown margins and up to 4 cm long, form vertically on the stems and lower leaf sheaths near the soil line. Diseased plants are often yellowish and mature early with white, sterile heads or with poorly filled kernels. The fungus overseas in cereal and grass debris.

**Rhizoctonia Bare Patch or Sharp Eyespot** is caused by the cosmopolitan soil-borne fungus *Rhizoctonia solani*. Unlike Foot Rot or Eyespot (1), both roots and stems of winter and spring wheats are infected with a brownish decay. Rare or thin patches of stunted seedlings and older plants, having a purplish cast to the lower stems and leaves, are scattered throughout a field, and are characteristic of root attack. Sharply defined, lens-shaped, light tan to straw-colored spots with deep brown margins form vertically on the leaf sheaths up to ten inches or more above the soil line. These eye-shaped lesions closely resemble those of Eyespot (1). When roots are infected, plants may lodge and produce white heads. The fungus survives as small, brown-black sclerotia in soil and as mycelium in the debris of many kinds of plants.

**Take-All**, caused by the fungus *Gaumannomyces* (Ophiobolus) *graminis var. tritici*, is most serious in sandy, alkali, infertile soils where cereals, especially wheat, and grasses are grown intensively. Winter wheat is more seriously damaged than spring wheat. Affected plants are stunted to severely dwarfed (uneven in height) in localized areas. Such plants have a reduced number of tillers, somewhat yellowed leaves, ripen early, may lodge in all directions, and develop white heads that are sterile or poorly filled and later darkened by “sooty molds.” Roots, crowns and stem bases develop a brittle, dry, brown-to-black rot. A superficial, coal-black mycelial mat forms under the lower leaf sheaths. The fungus overseas in soil as well as cereal and grass debris.

**Helminthosporium Root and Crown (Foot) Rot**, also called dry land foot rot, is caused by the fungus *Helminthosporium sativum* or *H. sorokinianum* (perfect stage, *Cochliobolus sativus*). A reddish-brown to dark brown decay develops in the coleoptil and subcrown internodes and later in the crowns and roots. Seedlings may be killed before or after emergence. Plants that survive are stunted, lack vigor, produce few tillers, mature early and form heads that are bronzed to a bleached-white. Such heads have shriveled seed. The disease occurs in random patches and is most severe in plants under stress from drought, high temperatures, nutrient deficiencies or insect injury. The same fungus incites another disease known as spot blotch. Oval to elongated dark brown spots with a definite margin form on the leaves. The spots may merge to form large blotches that girdle and kill the leaves. The fungus survives in crop and grass debris, soil, and on or in seed.

**Frost Injury** often occurs to winter wheat plants in low-lying areas in the spring. Affected leaves may have a bronzed appearance or the leaf tips are bleached. Heads that emerge are often variably distorted, bleached, at least partially sterile, and susceptible to attack by various “sooty molds.” Early spring frosts can kill plants to the soil line. Frost injury often predisposes surviving plants to root and crown rotting fungi.

**Winter Injury** is more serious to winter wheat than frost damage since much larger areas are usually affected. Plants may be heaved out of the soil from repeated freezing and thawing. Heaved plants, with sheared-off roots, are vulnerable to desiccation by sun and wind. Many new roots are regenerated in the spring, such plants turn yellow, wither and die. Small patches to large areas of weak or dead plants are evident in early spring.

**Fusarium Root and Crown (Foot) Rot**, caused primarily by the fungus *Fusarium graminearum* (synonym *R. roseum* f.sp. cereale ‘Graminearum’), which incites Scab or Head Blight, invades injured root and stem (crown) tissues in cool, wet weather, but damage is most evident in warm-hot weather when plants are under stress. Other species of *Fusarium* common in wheat roots include *F.avenaceum* and *F. culmorum*. Seedlings may wither and die while older plants mature early, producing fewer tillers and white heads with mostly shriveled seed. Dry, light-brown to reddish-brown lesions develop in invadied coleoptile, crown (foot) and root tissue. The greatest yield loss occurs when infection of the crown or foot reduces the stand in random or irregular patches. Surviving diseased plants are brittle, stunted and a lighter green than normal plants. The fungi overseas in plant refuse, seed and in soil.

**TYPHULA BIGHT OR SPECKLED SNOW MOLD** is caused by two closely related fungi, *Typhula incarnata* and *T. idahoensis*. Disease symptoms appear when the snow melts in northern winter wheat growing regions. Under snow cover, a dense, white-to-gray mold (mycelium) grows over moist plant parts. Numerous small brown sclerotia amongst the mycelia growth gives the characteristic speckled appearance. Dead, withered leaves are common but diseased plants usually recover in warm, dry weather unless the crown is seriously infected. In this case, plants may be killed over extensive areas. The *Typhula* fungus overseasons as sclerotia in soil or as mycelium in plant residue.

**Soil-Borne Mosaic** is a virus disease transmitted from healthy plants by a soil-borne fungus, *Polymyxa graminis*. Winter wheat plants growing in poorly drained, low-lying areas of fields appear light green to bronzy-yellow or light purple, patchy or uneven during prolonged, cool spring weather. The disease is sometimes mistaken for Winter Injury (6). Leaves and leaf sheaths are irregularly mottled and striped light and dark green to lemon-yellow. The stunted to dwarfed and yellowish plants tend to recover and appear normal when the weather turns warm. Kernels in affected heads are often shriveled and light weight. The virus and its fungus vector overseason in soil and crop residues.

**Barley Yellow Dwarf** is a prevalent virus disease of wheat and other cereals. Disease outbreaks coincide with flights of aphids that transmit the virus when they feed on a diseased plant and then a healthy one. Plants may be stunted to dwarfed and yellowish. Leaves are stiffer and more erect than normal. Early-infected plants are flattened and may winter-kill due to poor root development. Tillerling is reduced, maturity is slowed and spikelets may be bleached. Kernels in affected heads are often shriveled and light weight. In tolerant wheats the symptoms can be nondescript and easily confused with nutrient deficiencies, winter injury, root rot or other virus disease. The yellow dwarf virus overseasons in living grass and cereal plants and is transmitted by about a dozen species of aphids, which are blown northward as the season progresses.

**Wheat Streak Mosaic** is a virus disease transmitted up to 1 1/2 miles by the wheat curl mite (Aceria tulipae) and from plant-to-plant by leaf contact. The disease is worst in early-seeded, autumn-infected fields. Light green to faint yellow blotches, dashes and streaks, parallel to the veins, develop in wheat leaves during mid to late spring. Infected plants become stunted with golden-yellow, mottled and streaked leaves. Plants tend to spread more than normal and to tiller excessively. Early-infected plants fail to head or may produce only a few shriveled kernels. When severe, plants may die before maturity. The virus overseasons in living cereal, grass and corn plants.

**Herbicide (Trifluralin) Injury** is most common in turning areas at the edge of a field that receive an excessive amount of chemical. In old cases, misapplication is the problem. Where wheat is grown in rotation with a legume crop, carryover of the herbicide may injure wheat seedlings. The leaves on such plants may have reddish margins. The roots appear pruned and “stubby.”

For chemical control suggestions, resistant varieties and other control measures, consult the Extension Plant Pathologist at your land-grant university, or your county extension office.

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