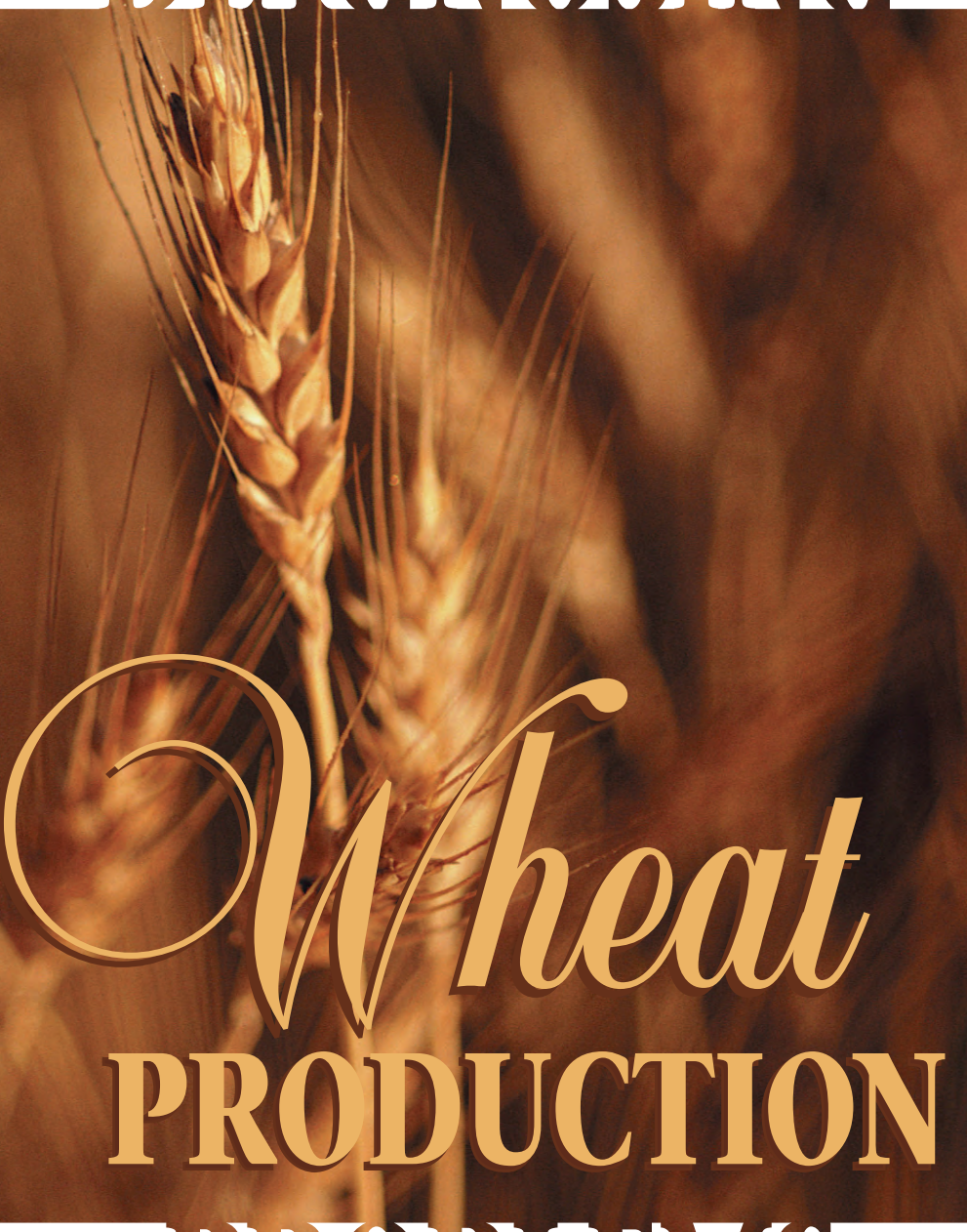
DIAGNOSING



Wheat PRODUCTION PROBLEMS

SOUTH DAKOTA
WHEAT COMMISSION
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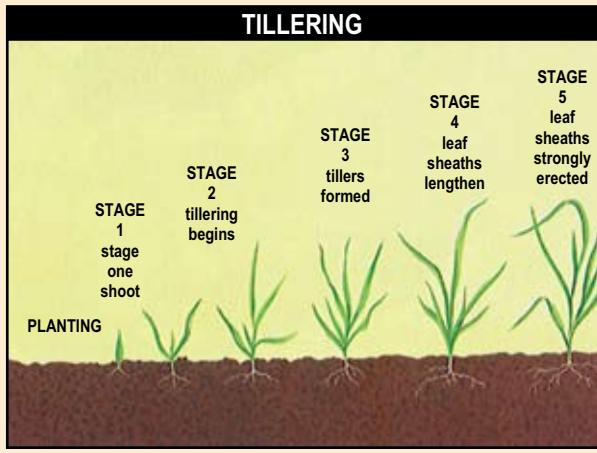
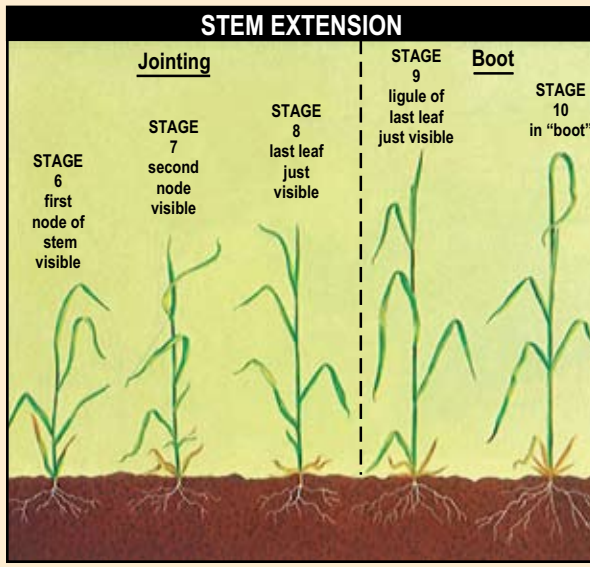
FEEKES' SCALE OF WHEAT DEVELOPMENT





Wheat, like all crops, may suffer from a number of insect, disease, weed, nutritional, and environmental stresses. This publication will help in diagnosing likely causes of slow growth, distorted appearance, off-colors, injury, and death of wheat plants from planting through harvest.

Fall Emergence and Growth

1

Poor stand establishment is the first problem producers might encounter after planting. Poor stands can be caused by a number of problems, such as a plugged drill, poor seed quality, dry soil, deep planting, soil crusting, diseases, and insects. Take time to examine the evidence. Look for field patterns. Closer examination of the situation will help determine the causes of poor stands.

2

Seed germination was initiated, as seen by the small radical or seed root that erupted from the seed, but it has now stopped. Apparently, moisture was sufficient to initiate germination, but was inadequate to sustain it. **Dry soil** has caused the germination/emergence process to stop. This is common with shallow plantings followed by several days of hot, drying winds. Seed in this condition can remain viable for a limited time, but if the seed becomes soft and spongy, the chances of it regrowing are not good.

3

Preplant herbicide injury can cause emergence problems in certain cases. Some herbicides, such as Treflan and Fargo, cause these problems if used improperly and when cold, wet conditions follow planting. Treflan can cause a short, thickened coleoptile and stunted roots when wheat is planted directly into herbicide-treated soil. It should be surface-applied or shallowly incorporated and the wheat planted below the incorporation zone.

4

The coleoptile is the embryonic leaf that penetrates the soil so the seedling can reach the surface. **Deep planting**, deeper than the coleoptile's ability to elongate, can slow emergence or cause stand establishment problems. Varieties differ in their coleoptile lengths. Semi-dwarf varieties tend to have greater problems because they have shorter coleoptiles than taller varieties. Early planting in hot soils reduces the coleoptile's ability to elongate.

5

Soil crusting limits seedling emergence. The coleoptile is unable to penetrate the crusted layer. Lift the crust to observe the yellow, crinkled first leaf. These seedlings will not emerge.

6

The seedlings on the left died soon after emergence. **Insect injury** and **seedling blight** are the two major causes of post-emergence death of seedlings. Carefully dig up plants and examine the root system and the coleoptile region between the seed and the crown.

7

These seedlings' coleoptiles have distinct brown lesions typical of **seedling blight.** Several fungi cause seedling blight, and these diseases are often worse with early planting. Although seedling diseases are common, they usually do not kill the seedlings outright. Seedling pathogens can cause other problems later in the growing season: *Cochliobolus* can lead to common root rot and crown rot, *Rhizoctonia* to sharp eyespot, and *Fusarium* to dryland root rot.

8

False wireworms are soil-inhabiting, yellowish to orange-colored worms up to 1½ inches long. A pair of short antennae are clearly visible on the front of the head and the head region does not appear flattened when viewed from the side. See wireworm in photo 77 for comparison. They commonly follow the drill row in dry soils, feeding on the seeds prior to germination.

9

If young plants are dying, with no aboveground symptoms evident, **white grubs** may be the cause. Check to see if the roots are pruned and if white “C”-shaped grubs are present in the soil near damaged plants.

10

Purple or yellow banding on the young leaves at emergence, called **color banding**, is an environmental problem caused by warm days with cool nights. Seedlings will become cold tolerant and symptoms will fade.

11

Plants with whitish streaks on the upper surfaces of leaves may have suffered **flea beetle** injury. The effects are often present along one side of the field. If streaking is severe, the plants may die. Older injuries can be confused with wind damage or dry weather.

12

Here the tiny, dark-colored **flea beetle** is shown feeding on a plant. These beetles quickly drop off or jump 2 to 3 feet from the plant when disturbed.

13

For this plant, germination and emergence were probably normal, but a few days later, signs of feeding scars appeared on individual leaves. The "window pane" feeding shown was caused by **fall armyworms**. As worms grow and demand more food, they may destroy the entire plant.

14

The larvae of **fall armyworms** appear as brownish worms crawling on the ground or hiding just under the soil surface. Symptoms include chewed leaves, missing tillers, or the entire plant being chewed off at ground level.

15

Greenbug infestation is more common after a frost, but before Christmas. Initial signs appear on the upper surface of leaves as clusters of pin-pricks that turn dark red. At the time of damage, greenbugs will be infesting the undersides of leaves. Affected leaves may turn yellow, and plant growth will slow. Parts of the field may appear yellowish. In advanced cases, plants begin to die in the fall or fail to green up in the spring.

16

Here a **greenbug** can be seen on the left and a **bird cherry-oat aphid** on the right. Greenbugs are light green and have transparent cornicles, "tailpipes." Bird cherry-oat aphids are usually dark to olive-colored with long, dark cornicles. They also have a dark red pattern that encompasses the bases of the cornicles on the abdomen.

17

Dead or injured wheat may be a result of **herbicide carry-over** from the previous crop. Herbicide carry-over often shows up where the sprayer turned or wherever there was a spray overlap that resulted in a higher rate of application. This condition is most likely to follow periods of dry weather and in soils with pH extremes.

18

Wheat planted into soils with atrazine residues emerges and then dies back from the tips of the oldest leaves first. **Atrazine carry-over** is most likely with high application rates, high soil pH, coarse textured soils, and dry weather.

19

Wheat plants that emerge and have a chlorotic or bleached appearance may be injured from **Command carry-over**. Command herbicide destroys chlorophyll in plants, thus they lose their green color. Plants often recover from early-season Command injury.

20

The plant near the center of the picture is stunted because of **Hessian fly**. Note the absence of stem elongation as compared with the normal plant on the left. Affected plants usually exhibit an unusually large, broad, greenish leaf for about a month in the fall, usually between mid-October and mid-November.

21

Hessian fly maggots are white and legless. Later, they become dark-colored, hard-shelled "flaxseeds" behind the lower leaf sheath at or just below the soil line. Symptoms are the same as those in the photo 20.

22

The **Hessian fly** adult, rarely seen in the field, is orange to brown in color. It deposits reddish eggs in grooves on the upper leaf surface.

23

Fuzzy roots are caused by dry soil conditions in the fall. Root hairs and outer plant cells are not sloughed off under dry conditions. This is a normal plant reaction to dry soil.

Spring Green Up to Heading

24

Some areas of the field may not initiate spring growth as wheat begins to green up in the spring. Look for field patterns. Plants in this terrace channel were killed by **drowning** or **standing ice**. Wheat cannot tolerate long periods of being submerged under water or ice.

25

Plants in some areas of the field may be slow or fail to green up. Look at soil conditions and location in the field. Loose, dry soil can be an indication plants died due to **winterkill**. Winterkill symptoms generally will be seen on terrace tops and north-facing slopes. Look closely at the crowns for discoloration and water-soaking.

26

The base of the plant has been split open to reveal the dark brown discoloration of **crown rot**. This plant will not survive because the connection between the roots and the tillers has been destroyed. A healthy crown is yellowish white inside. Crown rot is often initiated by **winter injury**. However, it also can be initiated by **common root rot**. Common root rot causes browning of roots, especially the subcrown internode.

27

Pink snow mold can attack wheat during cold, wet periods, or under snow cover. Initial leaf lesions are light brown with a dark brown border. Later, leaves become matted down and are bleached white as seen here. Close inspection usually reveals a pinkish orange fungus on the dead leaves. Patches of pink snow mold range from a few inches across to whole fields.

28

As wheat begins its spring green up, some plants may begin to die. Close inspection of this plant shows the crown is above the soil surface with only a few roots into the soil. **Heaving** is a common problem in soils with high clay contents. Note the cracks in the soil indicating shrinking and swelling.

29

Army cutworms cause brown patches to appear in fields soon after green up. Spots may continue to increase in size over a period of days. Close inspection may reveal brown leaves that are the old leaves from last fall, with spring growth missing. Below the soil, plants appear normal.

30

This plant shows the damage done by the **army cutworm** described in photo 29.

31

Army cutworms feed aboveground, usually more on warm days, or hide just under the soil surface. They move out of the center of damaged spots and tend to be more abundant toward the periphery of affected areas.

32

Plant death in the spring (March to April) could be due to **pale western cutworm**. Damage is often limited to spots where loose or windblown soil was present in September or October. Occasionally, damage is uniform over the whole field.

33

Pale western cutworms are transparent, gray to white larvae up to 1¼ inches long that remain below the soil surface.

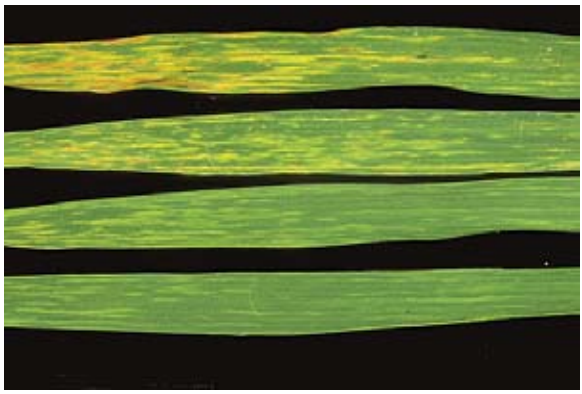
34

The lower areas of this field are turning yellow in the early spring. Possible causes might be **nitrogen deficiency**, **soilborne mosaic virus**, or **spindle streak mosaic virus**. The pattern of yellowing on individual plants must be examined in order to make a diagnosis.

35

Leaves show a mosaic pattern with green islands on a yellow background. The disease is **wheat soil-borne mosaic**. Varieties have large differences in their reaction to soilborne mosaic. Variety information can help confirm the diagnosis. Soilborne mosaic foliar symptoms fade as the weather warms up and the plants begin jointing. However, plants may remain permanently stunted.

36

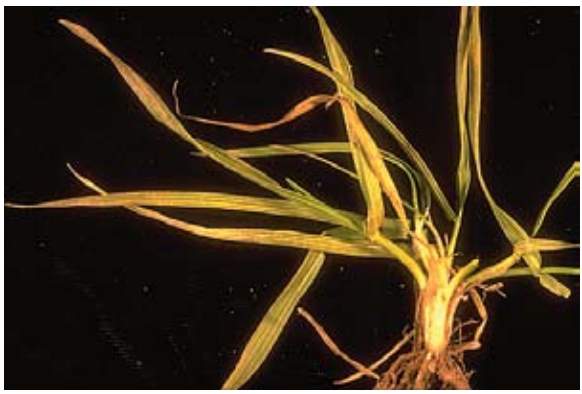


Leaves show a mosaic pattern with short spindle-shaped yellow streaks on a dark green background. These are characteristic symptoms of **wheat spindle streak mosaic**. Spindle streak symptoms fade as the weather warms up and the plants begin jointing. Infected plants usually do not suffer stunting.

37

In this field, there is a pattern that suggests two varieties were planted. There is an obvious variety difference in yellowing. The yellowing appears to be more severe on the sidehill where soil erosion has exposed lower organic matter, more calcareous subsoil. This is an example of **iron chlorosis**. Look closer at the leaves.

38



Individual plants show a yellow striping with the leaf veins remaining green. Striping is most severe on the newly emerging leaves. These symptoms are consistent with **iron chlorosis.** Soil tests would show a high pH, and more importantly, a highly calcareous soil. Iron chlorosis is rare on wheat, and as shown in the previous photo, varieties differ in their sensitivity.

39

Weeds can decrease yields, lower quality, and interfere with harvest. Fields should be scouted throughout the season for weed problems and treated as needed. **Winter annual brome grasses** such as **cheat, downy brome,** and **Japanese brome** usually emerge in the fall and are similar in appearance. They have narrow, erect leaves with a clockwise twist, red stems, and short hairs covering the leaf blades and sheaths.

40

The cheatgrasses head and mature about the same time as wheat. Pictured here are **cheat, Japanese brome,** and **downy brome** heads. Cheat and Japanese brome often are as tall or taller than wheat, while downy brome is usually shorter than wheat. Downy brome has longer awns, a drooping seedhead, and often has gray or purple colored stems. Cheat leaves and sheaths are sparsely hairy, Japanese brome leaves and sheaths are covered with dense long hairs, and downy brome leaves and sheaths are covered with dense short hairs.

41

Jointed goatgrass is a winter annual grass closely related to wheat. The easiest way to identify young jointed goatgrass seedlings is to dig up the young plant and locate the joint that contains the seeds. The joint is cylindrical shaped, about ⅜ to ½ inch long, and may contain as many as four seeds.

42

Jointed goatgrass is about the same height and matures about the same time as wheat. The seed joints are stacked in a column in the seedhead, and shatter at harvest time. The joints are similar in size to wheat kernels and are difficult to separate and clean out of harvested grain.

43

Volunteer rye is similar in appearance to wheat, but is generally taller and heads earlier.

44

Rye has longer kernels and heads than wheat, and usually is more bluish.

45

Henbit emerges in the fall and has round cotyledons about ¼ inch in diameter, square stems, and scallop-shaped leaves.

46

Henbit only grows a few inches tall. It is one of the first plants to flower in the spring with purple blossoms appearing in March.

47

Bushy wallflower or **treacle mustard** is a common weed. It usually emerges in the fall and forms rosettes with long narrow leaves and irregular leaf margins.

48

Bushy wallflower rosettes bolt in the spring and bear bright yellow flowers at the top of the plant, which only grows to about 1 to 1½ feet tall. Seeds are produced in long, narrow seed pods.

49

Tansy mustard and **flixweed** are two similar mustard species. These weeds emerge in the fall and grow as a rosette with finely lobed compound leaves.

50

Tansy mustard and **flixweed** bolt in the spring and produce yellow flowers at the top of the plant, which may grow to 3 feet tall. Small orange seeds are produced in long, narrow seed pods. Seed pods of tansy mustard are usually about ½ inch long, while flixweed seed pods are generally 1 to 1½ inches long.

51

Field pennycress is a winter annual weed that usually germinates in the fall and grows as a rosette. Leaves are club-shaped and have a waxy leaf surface. Field pennycress has a strong garlicky odor, especially when the leaves are bruised.

52

Field pennycress bolts in the spring and bears white flowers at the top of the plant, which may grow from 1 to 2 feet tall. Small brown seed with a thumb print pattern on the side are produced in flattened seed pods about ½ inch in diameter.

53

Blue mustard is a winter annual that germinates in the fall and produces a rosette similar in appearance to a dandelion.

54

Blue mustard bolts in the spring and bears purple or blue flowers at the top of the plant, which may grow from 1 to 1½ feet tall. Seeds are produced in long, narrow seed pods 1 to 2 inches long.

55

Kochia, sometimes called fireweed or firebush, is a summer annual weed that germinates early in the spring, often starting in early March. Kochia seedlings have a series of long, narrow, pubescent leaves attached directly to the stem.

56

Kochia branches and produces a globe-shaped plant that will grow several feet tall. Leaves are linear and up to 2 inches long. Kochia frequently causes harvest-related problems. Plants break off at ground level in the fall and blow across the landscape, spreading seed as they go. They are frequently called tumbleweeds.

57

Russian thistle is similar to kochia, except that it has very narrow, needlelike leaves. Young seedlings emerge early in the spring and resemble a miniature pine tree.

58

Mature **Russian thistle** branches and produces a globular plant like kochia. Leaves get a sharp, spiny tip. Russian thistles break off at ground level in the fall and become tumbleweeds.

59

Wild buckwheat also is an early-spring-germinating summer annual weed. Wild buckwheat has two crescent-shaped cotyledons, red stems, heart-shaped leaves, and an alternating leaf arrangement. It begins to emerge in March and has a vining growth habit.

60

Wild buckwheat wraps around wheat plants and creates harvest problems. It often is confused with field bindweed because of the vining growth habit and similar leaf shape. However, buckwheat is an annual that grows from seed, while field bindweed is a perennial that often regrows from roots. Wild buckwheat has small inconspicuous green flowers and produces black pyramid-shaped seed.

61

Field bindweed is a perennial species that can grow from seed or established roots. Cotyledons of field bindweed seedlings are kidney-shaped, and true leaves are arrowhead-shaped. Field bindweed shoots emerging from established roots would not have cotyledons.

62

Field bindweed has a vining growth habit and alternating leaves. It produces white or pink flowers about 1 inch in diameter. Field bindweed seeds have a roughened appearance with two flattened sides and one rounded side.

63

In this field, a dry fertilizer spreader with the spreader fan not operating properly appears to have caused streaks. Wheat is very responsive to nitrogen fertilization, and on fields low in available nitrogen, poor **fertilizer spread patterns** can be quite obvious. The pale color and lack of vigorous growth of the plants outside the streak suggest **nitrogen deficiency**.

64

The bottom leaf of this plant is showing a symptom of **nitrogen deficiency** with yellowing starting at the tip and extending back along the midrib forming an inverted V. This characteristic dieback is not frequently observed on wheat as bottom leaves often die from shading and diseases before symptoms appear. Plant analysis and fertilization history would help to confirm this diagnosis.

65

Grazed wheat fields that have **not** been **adequately fertilized** (nitrogen deficiency) with nitrogen will commonly show spots with a pronounced greener color and more vigorous growth reflecting the added nitrogen supplied through animals' urine. Close inspection of plants in the spots would likely reveal an increased tiller number.

66

Sometimes mistaken for soilborne mosaic, early spring **greenbug** infestation is characterized by yellowish spots in fields, usually worse in one corner or one portion of the field, but not apt to be confined to low areas. Symptoms are more pronounced on the lower leaves. Where severe, the plants may be stunted or dying.

67

Pictured is a **greenbug** colony. Either the insects or their parasitized remains should be visible if yellowing, as previously described, is due to greenbugs.

68

Good early growth appears to be taking place at the left, but a strip to the right appears either void of plants or has plants of poor vigor. Judging from the pattern of the symptoms, plants in the strip are showing a **lack of starter fertilizer** because the applicator chain broke.

69

This is a close-up of the two strips from the previous picture. Plants without the starter fertilizer show a lack of vigor and poor tillering, a symptom of **phosphorous deficiency**. Although these plants do not show any purpling, you may see purpling of leaves with phosphorus deficiency. Collect a soil sample to confirm the diagnosis and plan next year's fertility program.

70

This stand is thin and lacks vigor. Plants do not show any insect feeding or disease symptoms. Herbicides have not been used for many years on the field. The color and poor tillering might suggest a phosphorus deficiency, but soil tests show an adequate level. Examination of the roots finds discolored tips (see photo 71). A soil test reveals a pH of less than 5 and KCl-extractable aluminum of greater than 25 ppm. These plants exhibit **aluminum toxicity** caused by a very low soil pH. Varietal differences do exist.

71

A close-up of the root system of plants with **aluminum toxicity** from a low-pH soil shows poor root development (length and number). Roots are frequently discolored (brownish), and plants may actually die in some cases, hence the thin stand. You would need to soil test to confirm the diagnosis and plan a lime application to correct the problem.

72

Misapplied **2,4-D** can inhibit tillering and reduce plant vigor (foreground) if applied before wheat is fully tillered. 2,4-D should not be applied in the fall or until wheat is fully tillered in the spring.

73

This is a field that has developed a brownish cast suddenly in early spring. There appears to be a definite pattern, and if you look closer you see **leaf burning** on the upper leaves. The wheel tracks suggest liquid **nitrogen fertilizer** has been applied recently and caused burning. Symptoms should disappear as new leaves develop, and no detrimental effect on yields should result.

74

Wheat loses its cold hardiness as it greens up in the spring. Low temperatures may cause leaf tip burning, which is a symptom of mild **freeze damage**. These symptoms may be confused with leaf burning caused by liquid nitrogen fertilizer. This damage will have little or no effect on yields. A more severe freeze can kill tillers.

75

The premature death of individual tillers, usually prior to heading, may indicate the presence of **wireworms**.

76

Carefully examine the underground portion of affected tillers by looking for a circular hole cut by the **wireworm larva** to gain entrance. The growing point is usually destroyed by the larva as it tunnels within the stem.

77

Wireworms are hard-shelled, plainly segmented, yellow to orange larvae. Unlike false wireworms (see photo 8), their antennae are not readily visible, and the head area often appears flattened from top to bottom.

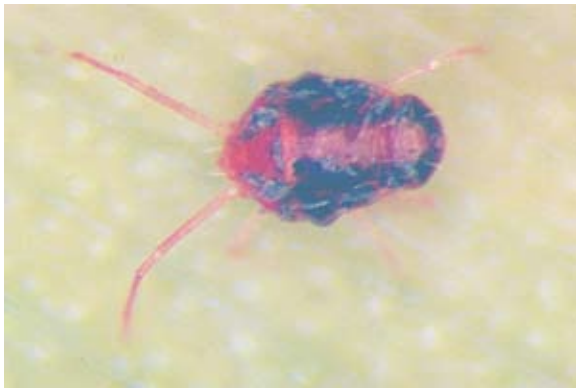
78

Brown wheat mites may cause fields or spots in fields to turn brown or bronze. This is more common during dry periods of fall, winter, or early spring and more often in fields where wheat follows wheat or where volunteer wheat was present during the previous spring.

79

Examine leaves for a faint pattern of white pin-pricks. The dark-colored brown wheat mites also are visible in this photo. Frequently, **brown wheat mites** concentrate their feeding near the end of the leaf causing the tips to become noticeably brown.

80

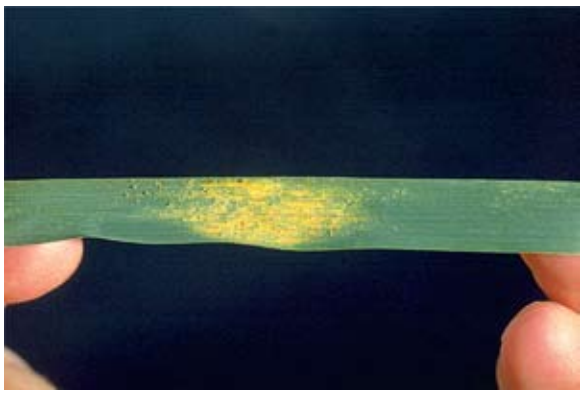


Brown wheat mites, about the size of a period in newsprint, may be seen on the surface of leaves when plants are viewed from a few feet away. They drop from leaves when disturbed. The front legs are at least twice as long as the remaining legs. This mite is easily confused with the winter grain mite (photo 85).

81

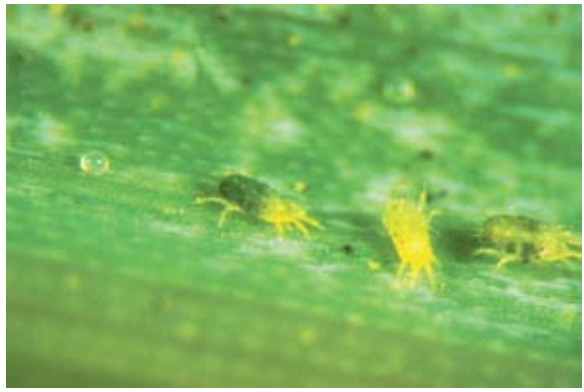
Here wheat is either showing stress or disappearing in spots along one side of the field adjacent to wheat stubble. Affected areas may be small at first, but gradually enlarge during mild weather in the fall or early spring. At greenup in the spring, these spots may appear to be winterkill where the condition was not observed earlier. This could be **Banks grass mite** that moved from nearby infestations on volunteer wheat, grasses or other crops.

82



This leaf has a yellowish spot composed of numerous tiny, yellow pin-pricks. Severely affected leaves may be dead or dying. Affected areas are seldom as distinct as the yellowish spot on this leaf appears. Look on the undersides of affected leaves for slight webbing and presence of **Banks grass mites**.

83



Banks grass mites are very small and best seen with a hand lens. Their bodies are nearly transparent or brownish and often have a couple of spots visible between the mid and rear sections of the body. If mites are visible on leaves from a distance, check for brown wheat mites or winter grain mites.

84

Winter grain mite infestations cause wheat to have a silver-gray appearance, sometimes with stunting, rolled leaves, and death of leaves beginning at the tip. Note the symptoms of the left leaf compared to the healthy leaf on the right.

85

The **winter grain mite** may be of concern in either fall or spring. Mites often hide at the base of plants during the day and feed at night. Mites are brown, globe-shaped, and have bright orange legs.

86

Stunted, dying, or stressed plants could be the result of **chinch bug** damage. Chinch bugs prefer thin wheat, usually in drier parts of the field.

87

Where damage is due to **chinch bugs**, the black-and-silver-winged adults or reddish nymphs will be apparent in the soil, in the crown region, and around the base of affected plants. Sometimes they will appear behind the lower leaf sheaths.

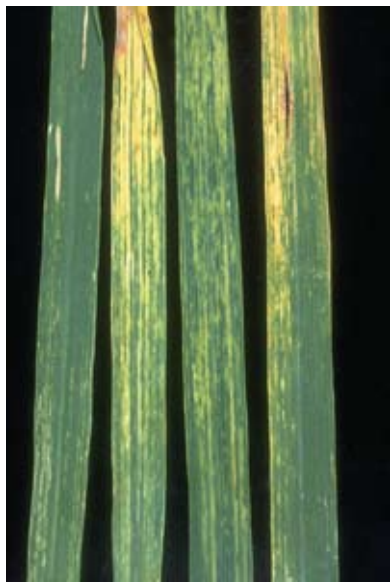
88

This field has **wheat streak mosaic**. Plants in the foreground are stunted and yellow. A stubble field with volunteer wheat is visible on the left side of the affected field. The field pattern suggests some pest or disease is coming out of the volunteer wheat. Take a close look at the affected plants for disease symptoms.

89

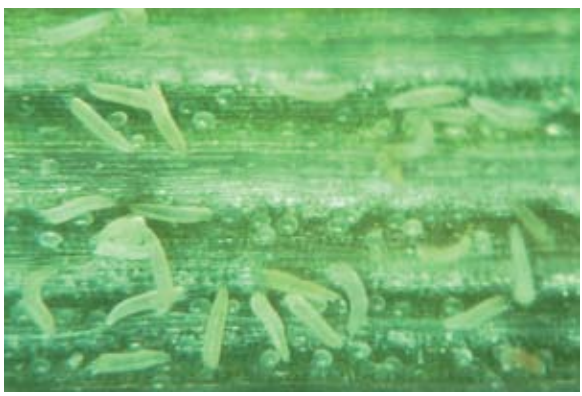
Wheat streak mosaic symptoms are quite variable, depending on variety, environment, and strain of the virus. Typically, symptoms consist of long yellow streaks that are concentrated at the leaf tips. As leaves become progressively more yellow with time, the leaf veins often remain green. Wheat streak mosaic symptoms could be confused with nutrient deficiency problems such as iron chlorosis.

90



A new disease was found recently that is similar to wheat streak mosaic. It is provisionally being called **High Plains mosaic**. Symptoms are similar to wheat streak mosaic, but they tend to be spottier. The life cycle of the High Plains mosaic pathogen is similar to wheat streak mosaic virus, and they are frequently found together.

91



This is a close up view of **wheat curl mites**. You need about a 20X magnifier to see their white, cigar-shaped bodies. The round, white structures are eggs. These mites can carry both wheat streak mosaic virus and the High Plains mosaic pathogen. Wheat curl mites often cause the edge of wheat leaves to roll inwards. The mites congregate in the protected area under the rolled edge.

92

Early symptoms of **American wheat striate mosaic** are thin, white striations parallel to the leaf veins. They are most prominent on the leaf's underside. This viral disease is carried by leafhoppers and tends to be randomly scattered through the field. Many varieties are highly resistant. American wheat striate mosaic could be confused with mite or thrips damage. See photo 129 for symptoms later in the season.

93

Barley yellow dwarf often occurs in patches in the field. Plants are stunted and have yellow or purple leaf tips. Barley yellow dwarf is carried by several species of aphids including the greenbug and bird cherry-oat aphid. Fall infections seem to cause the most damage.

94

These are symptoms of **barley yellow dwarf**. Notice that the leaf tips are yellow or purple, but the leaf bases tend to remain green. The midrib stays green longer than the leaf blade. Normally, barley yellow dwarf symptoms first appear at the boot stage.

95

Infestation by **Russian wheat aphids** may occur any time of the year. Look for purple to pink discoloration on rolled-up leaves. Long, white streaks, usually on the upper leaf surface, are common on infested leaves.

96

Similar in color to greenbugs, **Russian wheat aphids** are light green, with cigar-shaped bodies. Their cornicles are absent, but they have a forked tail process visible with a hand lens when viewed from the side. Winged or wingless forms may be present in rolled leaves, within the boot, or in emerging (and usually trapped) heads.

Heading to Maturity

97

This thin stand of wheat appears to be the result of factors existing early in the growth cycle. Plant and soil samples from the poor-growth area and normal-growth areas would be quite helpful in assessing the reason for this thin stand. Samples from this area would show a **low soil pH**, less than 5, with greater than 25 ppm KCl-extractable aluminum. Liming would correct this problem.

98

Patches of **white heads** in the field may indicate problems at the crown or below the soil line. Examine the roots and the lower stems of the plants. Possible causes of white heads include drowning, take-all root rot, dryland root rot, wheat stem maggot, sharp eyespot, freeze damage, scab, and Cephalosporium stripe. The pattern in the field is often useful in diagnosing the problem. This picture shows the patchy field pattern of **take-all root rot**.

99

Take-all root rot causes the roots and lower stems to turn dark, shiny, black. The disease usually occurs in large patches in the field, and all tillers on affected plants are diseased. Plants are often stunted, have white heads, and pull up easily because the roots have rotted. Take-all is most likely to occur in continuous wheat fields with moderate to high residue levels and is favored by moisture.

100

Dryland root rot, also known as **dryland foot rot,** is another disease that causes white heads. It is caused by a fungus called *Fusarium*. Often the stem base turns pink. The inside of the culm is filled with cottony pink or pinkish-white fungal mycelium. All tillers on the plant are usually affected. The disease occurs in low rainfall areas and is favored by drought stress. The disease is easily mistaken for drought stress or take-all.

101

Sharp eyespot causes lesions with light tan centers and dark brown margins on the lower stems. The ends of the lesions are typically pointed. If stems are girdled, the tiller may be stunted and mature prematurely, resulting in a white head symptom. Each tiller can be affected differently. It rarely causes significant yield loss. When sharp eyespot attacks young seedlings, it can cause seedling blight. See photo 7.

102

White heads can be a sign of damage by **wheat stem maggots**. Common in most fields, damage is limited to individual, scattered heads. White heads can easily be removed by lightly pulling them. Chewing damage is apparent at the base of the stem just above the uppermost node. If most of the tillers on a plant have white heads, the damage is more likely due to other causes. Wheat stem maggots are pale green.

103

These leaves each have one or two broad yellow stripes running the length of the leaf. In the center of the yellow stripes are some brown leaf veins. You can follow these discolored veins down into the leaf sheath and even into the lower nodes. The yellow stripes with brown veins are diagnostic for **Cephalosporium stripe**. This vascular disease causes an uneven stunting of tillers and can cause white heads.

104

Close-up of the vascular browning in the nodes caused by **Cephalosporium stripe**.

105

The **cereal leaf beetle** larvae feed on the upper epidermal layer of the leaf causing long, whitish streaks. The damaged area is transparent. Primary damage is on the flag leaf, but damage may occur on other leaves and the head. While all small grains may be a host, this insect prefers oats.

106

The **cereal leaf beetle** larva is responsible for the "window-pane" damage to the leaf. Eggs placed on the leaf surface hatch into tiny larvae that cause longitudinal streaks. Larvae may be overlooked since they tend to remain hidden beneath a protective, brown grass-like camouflage. Exposed larvae are about ¼ inch long at maturity, yellowish, and somewhat grub-shaped, resembling an immature Colorado potato beetle.

107

The adult **cereal leaf beetle** is about 3⁄16 inch long with a reddish thorax and a metallic, blue-black abdomen. Adults hibernate soon after small-grain harvest and do not become active again until the following spring when mating and egg laying begins.

108

There are several different kinds of leaf spots on wheat. This is an example of **tan spot**. It is most likely to occur in continuous wheat fields with moderate to high residue levels.

109

This is a close-up of **tan spot**. Lesions are tan and usually have a yellow border. There is often a small dark spot in the center of the lesions. Varieties differ greatly in their response to tan spot.

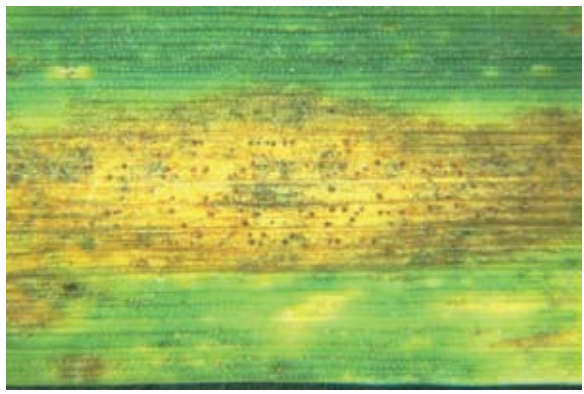
110

Chloride deficiency can cause leaf spotting that resembles tan spot (see photo 108). Symptoms appear uniformly and suddenly after flag leaf emergence. Symptoms occur on soils that have low chloride levels.

111

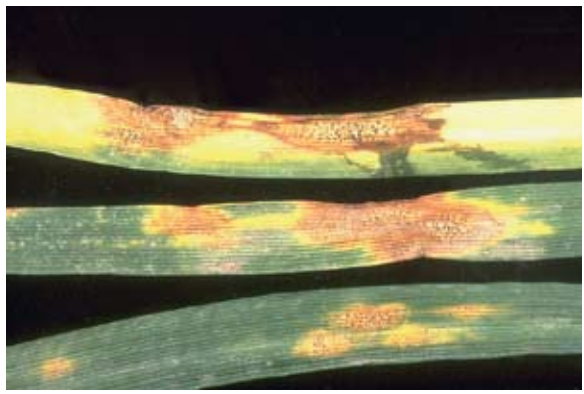
Stagonospora nodorum blotch is very similar to tan spot. The lesions tend to be longer and more variable in shape than tan spot. However, it is often impossible to distinguish these two diseases without close examination (photo 112).

112



One way to identify **Stagonospora nodorum blotch** is to look for the small, caramel-colored fungal structures in the lesions. These are usually difficult to see and will require a 10X hand lens.

113



Septoria blotch, also known as **speckled leaf blotch**, has tan lesions with distinct black fungal structures easily seen with the naked eye. It is possible to confuse this disease with Stagonospora nodorum blotch, but tan spot lacks the speckles.

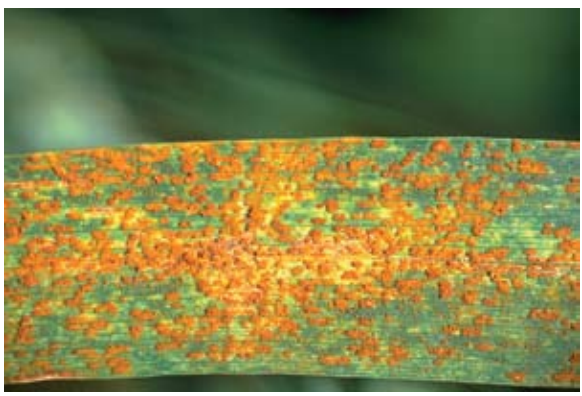
114

The initial symptoms of **bacterial streak** are water-soaked dots as seen next to the thumb. These water-soaked areas expand into narrow, yellowish, water-soaked streaks confined by the veins as seen near the top of the leaf. A key diagnostic symptom is that the lesions appear translucent when viewed with back lighting. As lesions age, they become dark brown and are no longer translucent. When the disease attacks the glumes, it is called **black chaff**.

115

Bacterial leaf blight causes greenish-gray, water-soaked spots or large blotches that later dry and turn white. It occurs when several days of cool, rainy weather coincide with flag leaf emergence. Usually, symptoms are first seen on the flag leaf at boot stage. In severe cases, the entire leaf dies.

116



The bright orange pustules containing dusty orange spores are characteristic of **leaf rust**. Pustules occur primarily on the upper leaf surface. Infection requires moisture, so this disease is more common in areas with higher rainfall. There are large differences in susceptibility among varieties.

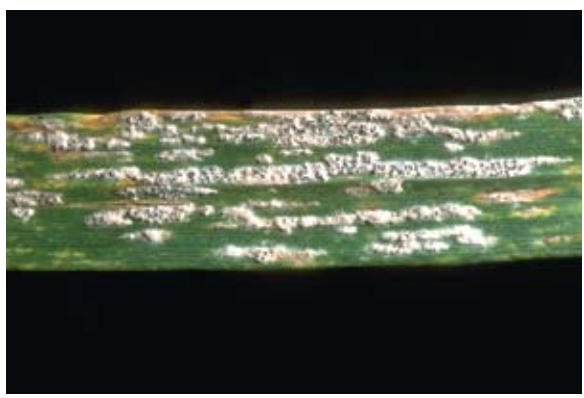
117

Unlike leaf rust, **stripe rust** pustules tend to occur in long stripes. Also, the pustules of stripe rust tend to be yellower than leaf rust. Stripe rust requires cool temperatures, so it is more commonly seen in the early spring in the Great Plains.

118

Stem rust attacks the leaves, stems, and heads of wheat. It is the only kind of rust that attacks the stems, so this is diagnostic. Pustules of stem rust tend to be longer, more ragged, and darker brown than leaf rust. As pustules age, they turn dark (see stem on left), therefore this disease is sometimes called black stem rust. Stem rust requires higher temperatures than the other rusts, so it is more commonly seen at the end of the season.

119



Powdery mildew is one of the easiest diseases to diagnose. It looks like small pieces of white cotton on the leaves. The small, black dots on the mildew pustules are fungal overwintering structures. On highly susceptible varieties, it can attack the heads and cause significant yield loss.

120

Loose smut is most noticeable soon after heading. The floral parts of the wheat head are replaced by loose masses of brownish-black, powdery fungal spores. These spores are easily blown off or washed off by rain. After a few days, only a bare rachis remains, and the affected tillers become less noticeable. Loose smut is seedborne and usually affects all the tillers on a plant.

121

Lodging can be caused by many factors. Heavy winds and rains at the heading stage are responsible for most lodging problems. Knowing the variety, nitrogen rate, field location, and incidence of diseases or insects will help determine the reason for lodging. Lodging tends to occur on bottomland, or when high nitrogen rates, tall varieties, and high seeding rates are used.

122

Any time stem breakage or lodging occurs just above the first or second node, suspect **Hessian fly**.

123

You can verify **Hessian fly** infestation by using a pocket knife to carefully remove the leaf sheath from the node nearest the point of the break and looking for maggots or flaxseeds just above the node. See photo 21 for another close-up of flaxseeds.

124

Strawbreaker, or foot rot, causes lodging with stems buckling near the base. Dark, eye-shaped lesions appear on lower stems just above the soil. Later, these lesions appear charred. The symptoms on the lower stem could be confused with take-all, but there are differences: strawbreaker lesions are not shiny black (see photo 99); the roots do not rot, so plants are not easily pulled up; and stems break just above the soil line.

125

True armyworms are head-attacking insects associated with lodged wheat. Watch for them in rainy periods in May to early June. They strip the leaves prematurely and may clip the awns. They rarely cut wheat heads or damage the kernels, but head-clipping in barley is a problem. True armyworms can be yellow, green, or black. They always have various-colored stripes; at least one thin, yellow band is visible. The armyworm's head is prominent and shiny, light brown.

126

Wheat head armyworm often is found in conjunction with true armyworm outbreaks. It spends more time during the day feeding on developing heads, and with longer mandibles, it is able to damage kernels prior to hard dough stage. This worm has green and white stripes. Its body tapers distinctly from head to tail.

127

Initial symptoms of **glume blotch** are small brown spots on the glumes or awns. These expand to dark blotches, darkening the head. As lesions age, they may bleach white and contain very small caramel-colored round fungal structures. Glume blotch can be caused by the same fungus that causes Stagonospora nodorum blotch (photos 111 and 112) or the fungus that causes speckled leaf blotch (photo 113).

128

Basal glume rot is a bacterial disease that attacks the heads when rainy weather coincides with head emergence. It is similar to glume blotch, but is less common. Dark brown lesions start at the base of the glumes and may extend into the rachis. Whole spikelets may die and turn white, but the discoloration at the base of the glumes remains visible. Often, only one or a few spikelets per head are affected.

129

American wheat striate mosaic can cause dark brown stripes or blotches on the glumes of some varieties of wheat. Symptoms tend to be more uniform than with glume blotch. Usually the stem below the head is also darkened. Leaves have a mosaic symptom of fine white, green, or yellow lengthwise striations. All of the tillers on an infected plant are usually affected, but adjacent plants can be symptomless. See photo 92 for early symptoms.

130

Trapped heads, **missing florets**, and **twisted awns** can be caused by misapplied 2,4-D, MCPA, Banvel, or Tordon. This type of injury usually results from application at the wrong growth stage for these herbicides. The safest time to apply 2,4-D, MCPA, or Banvel is when the wheat is fully tillered, but prior to jointing.

131

Downy mildew may occur in low, wet areas of fields. Plants are stunted and have yellow, thickened, leathery leaves. Heads are often distorted, causing a symptom called **crazy-top**, which may resemble herbicide injury, see photo 130.

132

Shredded leaves and broken stems are typical symptoms of **hail damage**. Damage can range from slight leaf damage to a total crop failure by breaking stems near the soil surface. A silage smell is often detectable soon after hail.

133

Hail damage at the boot stage may cause the head to be entrapped in the boot, not allowing it to emerge normally, which results in a gnarled or misshaped head. Hail may cause damage to the whole head or only slight damage to areas where the hail stones struck.

134

Freeze damage at the late boot and heading stages causes the head to have a yellowish-white, water-soaked appearance. The awns will be bleached.

135

A close look inside the florets will help assess the extent of **freeze damage**. The pollen-shedding anthers will become shriveled and turn whitish-brown instead of having a normal turgid, green appearance as in photo 136. The feathery, whitish stigmas will not open and they will become whitish-brown and water-soaked.

136

A **healthy wheat** head has green anthers and white stigmas as in the lower left floret. The yellow anthers of the middle floret indicate pollen has recently been shed and the developing kernel in the upper floret indicates there has been no freeze damage.

137

Tordon applied prior to wheat planting for field bindweed control can cause head sterility, especially if applied too late, at excessive rates, and if dry conditions prevail following herbicide application. The dark areas in this wheat field are related to spot treatments of field bindweed with Tordon prior to planting the wheat. Wheat appeared normal until grain filling.

138

Nodes of the wheat plants shown in the previous picture are swollen and dark green. Swollen nodes are a symptom of misapplied 2,4-D, Banvel or **Tordon**. The stems turn red due to an accumulation of photosynthates that could not be translocated to the heads because they were sterilized by Tordon.

139

As wheat begins to mature, plants in some areas of the field may have an off-white color resembling take-all, instead of the normal golden color. This is **premature ripening** due to **hot, dry weather**. Patterns follow the different soil types in the field that are lighter or shallower. The grain will be shriveled and have low test weights.

140

Scab, also called **Fusarium head blight**, causes white heads when periods of rainy weather coincide with flowering. Commonly, only the upper portion of the head is blighted. Close inspection may reveal masses of pinkish-orange fungal spores on the spikelets or on the rachis. Scab causes seed to be discolored (photo 141).

141

Scab causes wheat seed to become pink or white and chalky in texture. It is lighter in test weight and may contain certain mycotoxins injurious to nonruminant livestock. Scab-infected grain is often difficult to market.

142

Delayed harvest and continual moist conditions after the grain is mature may cause the grain to germinate resulting in **head sprouting**. Varieties differ in susceptibility to sprouting. White wheat varieties tend to have more sprouting problems than red wheats.

143

Bunt is a type of smut that replaces the contents of wheat kernels with brown spores that have a fishy odor. The outer hull of the wheat kernel may remain intact and such seeds are called bunt balls. During harvest and handling, these bunt balls break open and contaminate healthy seed with the spores. Formerly common, bunt is now controlled with seed certification programs and seed treatments.

144

Ergot sclerotia are large (¼ to ½ inch long) purple-black fungal structures that replace the developing grain and protrude from the head. They could be confused with bunt balls, but ergots are larger than bunt. Ergot sclerotia are hard with a solid white or gray interior, while bunt balls are fragile and filled with smelly, dark spores. Ergot is rare in wheat but fairly common in triticale and rye.

145

This mature head is covered with a dark fungus called **sooty mold**. Sooty mold fungi are opportunistic invaders of dead tissue. They are favored by periods of rain after the wheat has matured. After long periods of rain, sooty mold may penetrate the glumes and cause black point on kernels (see photo 146).

146

Black point or **black tip fungus** is a dark, discoloration of the embryo end of the kernel. This may result in a discount if the grain is graded as damaged. The germination rate of the affected grain may be reduced. Black point is caused by the same fungi that cause sooty mold and is favored by rainy weather after wheat has matured.

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