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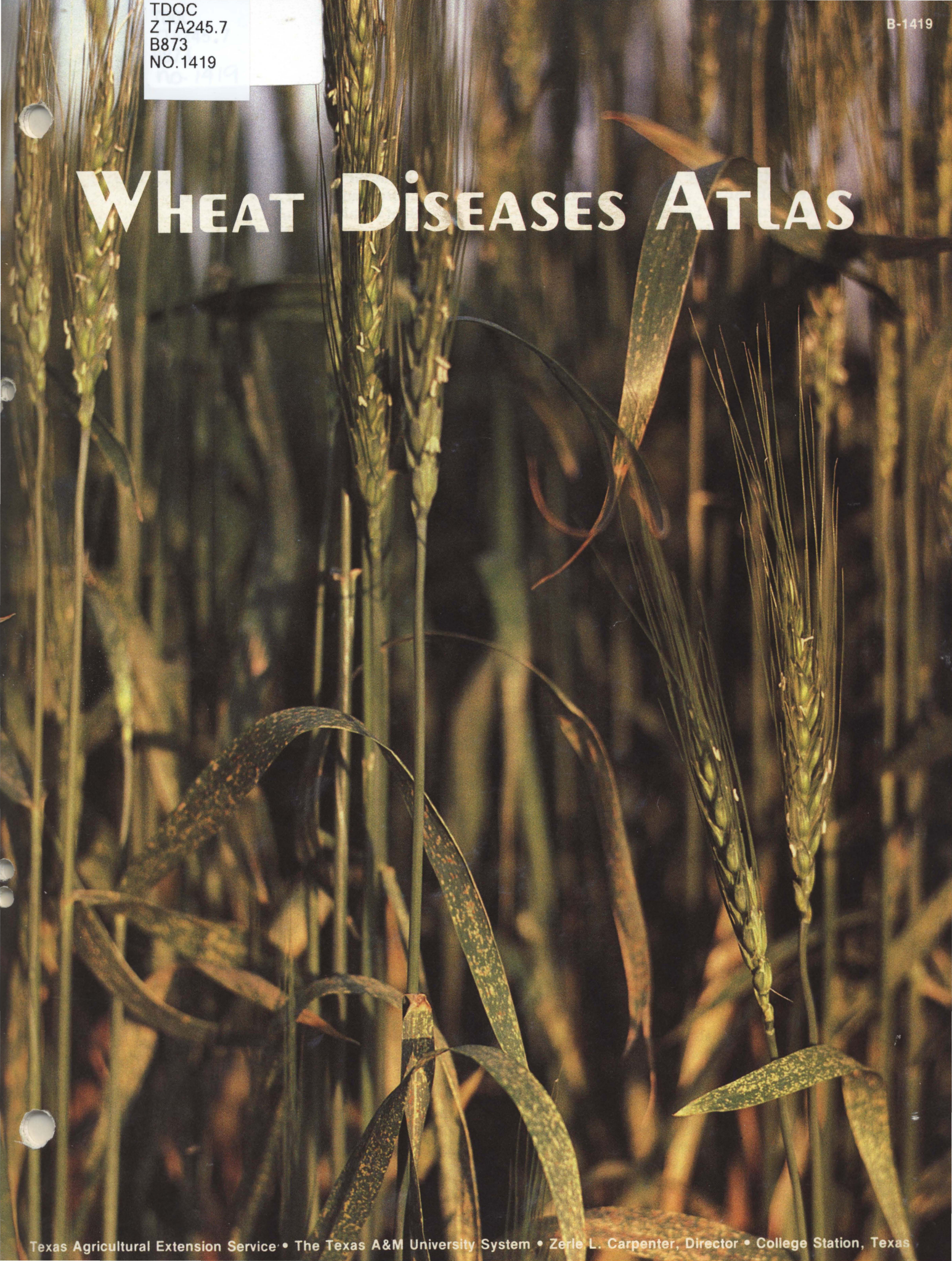
Wheat Diseases Atlas



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WHEAT DISEASES ATLAS

*Norman L. McCoy and Robert W. Berry**

INTRODUCTION

Wheat diseases have caused untold human suffering, famine and economic hardship since earliest recorded history. They were so severe that early civilizations often took dramatic steps to prevent wheat diseases. The Romans created and worshipped Robigus, the god of Rust, to appease the disease threat; others had similar unexpected and unreliable methods of disease control.

The foundations of plant pathology were built upon wheat disease research. Fontana, Tillet, Prevost, Tozetti and DeBary were early researchers whose papers dealing with wheat rusts, smuts and other diseases were designated "Phytopathological Classics." In more modern times, wheat diseases have given rise to many scientific advancements in plant breeding for genetic resistance, identification of races of pathogens and the development of chemicals for controlling seedborne, soilborne and foliar-infecting wheat disease pathogens.

In spite of the long history of human concern for wheat diseases, they continue to cause economic hardship and health problems. In Texas, wheat diseases still reduce forage yields, grain production and quality in the crop. Organisms which cause wheat diseases are fungi, bacteria, mycoplasma and viruses.

This publication discusses wheat disease identification and control for the wheat producer. The most prevalent wheat diseases in Texas are included. Compare the symptoms, then consider and adopt the appropriate control strategy for maintaining wheat yields in the face of a disease threat.

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DISSEMINATION OF WHEAT DISEASES

Every organism which causes a wheat disease has one or more principal way of moving from diseased to healthy plants. Control practices often are based on measures which interrupt or eliminate the means of spreading from plant to plant and from field to field.

More diseases are dependent on seed movement for pathogen dispersal than on any other single method. Some organisms such as the loose smut fungus are found inside the planting seed, but most are found as contaminating spores or fungal fragments on the seed coat. These include the bunt organism and the fungi *Septoria, Helminthosporium, Fusarium, Alternaria, Cladosporium* and many others. Most of these fungi cause seedling blights or seed decay. They are controlled easily with good fumigating or disinfecting seed treatments. Control loose smut and other seed-inhabiting organisms with systemically active, seed treatment fungicides.

Some fields have the same disease problems each year because the disease organism is soilborne. Nematodes and root rotting fungi are the most common organisms using this method of survival, but the bunt and flag smut fungi also may be soilborne. Soilborne mosaic virus, which has not been identified in Texas, is soilborne but depends upon a fungus for movement in the soil and subsequent infection. Soilborne organisms generally survive long periods of adverse environment and use decaying plant material as food for survival. Crop rotation and clean tillage of wheat fields aid in controlling soilborne diseases.

Wind is responsible for the spread of rusts, smuts, powdery mildews and most other foliar pathogens. These pathogens may spread very rapidly over great

distances. Growing genetically resistant varieties is the most effective control of windborne wheat pathogens. Recent research shows that foliar fungicides control foliar diseases under some conditions.

Virus diseases of wheat, except for soilborne mosaic, depend on insects or mites for dispersal. Wheat streak mosaic is spread by the wheat curl mite while aphids transmit the barley yellow dwarf virus. Virus control is therefore aided by a successful insect management program.

Water moves the soilborne organisms with ease, and some are highly dependent on water for movement. Organisms which cause downy mildew, pythium root rot, bacterial diseases and soilborne mosaic virus within its fungal vector are moved easily by water to healthy plants. Control of flood waters and good soil drainage are essential for controlling diseases whose pathogens are spread in water.

ROOT DISEASES

Root, Crown and Foot Rots (Fungi - *Fusarium, Helminthosporium, Rhizoctonia solani* and others)

Symptoms of root, crown and foot rot are similar when caused by any of these fungi. These fungi also may cause seedling blights, leaf spotting and head infections, but diseases of the crown and roots are most important because of the losses they cause.

Root rot is difficult to diagnose because diseased plants occur randomly or in irregular patches and appear stunted and lighter green. Diseased plants usually produce fewer tillers, develop shriveled grain and mature earlier than healthy plants. Diseased plants usually show a bronzed appearance with bleached, white heads. Diseased plants become brittle and break off easily near the soil line when pulled.

Infected seedlings have extensive root browning and may be killed while others may develop new roots and outpace the disease.

The foot rot phase of this disease occurs near heading time. Heads contain shriveled grain and are subject to darkening by "sooty molds."

The association of root rotting fungi with wheat roots and other plant parts is unavoidable. They are nearly always present on cereal and other grass hosts, on wheat seed, in the soil and on host debris.

These fungi are aggressive pathogens when the plants are under stress from drought, warm temperatures, nutritional deficiencies and insect damage.

Seedling infections are reduced by using clean, treated seed. Sometimes delayed planting of winter wheat in the fall decreases seedling diseases by exposure to warm soil temperatures.

It is advisable to eliminate alternate hosts such as oats and other small grains by clean cultivation and crop rotation.

Crown rot with decay at base of stalk

Plant Parasitic Nematodes (Nematodes - Cyst, Root Knot, Root Lesion, Seed Gall, Stunt and others)

Plant parasitic nematodes are nonsegmented roundworms that mostly inhabit the soil and feed on roots of wheat and other plants. However, one species, called the wheat seed gall nematode, *Anguina tritici,* is a significant pathogen of wheat. It is detected on threshed wheat by the presence of galls and hard, dark brown or black immature grain. Galls often can be mistaken for cockle seed, smut balls or other impurities. They differ from smut balls as they are hard, are not filled with a black powder and do not have the foul odor.

Young wheat leaves affected by the gall nematode usually are rolled, wrinkled, twisted or otherwise distorted.

Other nematode damage is evident by reduced plant vigor, deformed plant growth and knots on the roots. Wheat grown in nematode-infested soil usually is stunted with yellow patches occurring throughout the field.

Seedling Diseases (Fungi - *Rhizoctonia, Pythium, Fusarium* and others)

A large number of soilborne fungi, bacteria and nematodes are present in the upper few inches of soil and can cause seedling diseases. Immature seedlings are more susceptible than older plants. Three growth stages during the susceptible stage are described: 1) during the germination process, 2) when the new roots or shoots are emerging from the seed and 3) in the

Seedling disease

Leaf rust on leaves

young seedling stage. Affected plants may occur singly, in small, circular spots or in large areas in the field. Plants which survive may mature early and usually are stunted with little grain. Seedlings and young plants may be killed. Control by treating seed with fungicides and planting as shallow as possible to establish a stand.

FOLIAGE DISEASES

Rusts (Fungi - *Puccinia* spp.)

Three highly specialized species of *Puccinia* cause stem rust, leaf rust and stripe rust on wheat. Wheat rusts are of worldwide economic importance. In Texas, leaf rust and stem rust occur most commonly, while stripe rust occurs less frequently.

Wheat rust epidemics in the past have been most detrimental when infection began before or during flowering. Rust decreases the crop's foliage value and its winter hardiness.

Leaf Rust (Fungus - *Puccinia recondita).* Leaf rust, sometimes called orange rust, can occur on either side of the leaf and may sometimes occur on the stems, especially the neck (that part of a stem between the head and flag leaf). The disease first appears on older leaves, and the fungus spreads up the plant to the flag leaf as the season advances.

Wind is an important means of distributing leaf rust spores. Leaf rust can survive during the summer months on volunteer cereals and wild grasses in South Texas and northern Mexico. During the autumn months, leaf rust spores are blown northward in wind currents from northern Mexico and southern Texas. The fungus oversummers in the northern Great Plains.

Early in the growing season leaf rust is recognized as small, round or oblong, raised orange pustules on the leaf surface. These pustules are most abundant on the upper surface while a few occur on the undersurface. As the season advances, rust spreads from older to younger leaves, and the pustules may become very abundant. As the wheat nears maturity, other pustules of about the same size but darker in color appear in great abundance on sheaths and leaf blades and even on the stems. Both types of pustules remain until the leaf dries, possibly before ripening if infection is severe.

New races of leaf rust fungus originate by mutation; therefore, new wheat varieties which provide resistance are being developed constantly.

Stem Rust (Fungus - *Puccinia graminis tritici).* Stem rust is one of the most destructive plant diseases known on susceptible varieties. It is *highly epidemic* and can increase at rates up to 50 percent per day. In contrast, leaf rust is much less epidemic, probably not increasing at rates above 20 percent per day. Stem rust attacks many small grains and grasses. The stem rust fungus produces two spore stages on wheat — the red and black stages. The red stage spreads during the growing season, but the black stage occurs only as wheat nears maturity. Stem rust is recognized by the

elongated, ragged pustules it produces on stems, leaf sheath, blade, chaff, beard and occasionally on young kernels. Fragments of epidermis adhere to the sides and ends of the pustules, giving a ragged appearance. The brick-red color and large elongated pustules distinguish it from leaf rust which has small, round pustules and orange-red spores.

Stem rust develops optimally near 68° F. and is seriously hampered below 59° F. and above 104° F. Delayed crop maturity especially favors the disease.

Stripe Rust (Fungus - *Puccinia striiformis)*. Stripe rust resembles leaf rust except that the pustules develop between the leaf veins as long streaks, and they are citron yellow. Mild, humid winters, cool springs and abundant rainfall permit this pathogen to spread throughout much of Texas. Stripe rust is confined to higher elevations and cooler climates, thus it is not an important disease in Texas.

Stripe rust in Texas originates from spores blown in from distant hosts. Wheat at lower elevations is sometimes infected by spores from grasses growing at higher altitudes.

Stem rust on stems

COMPARING RUST DISEASES

	Color of pustule	Size of pustule	Shape	Location
Leaf	Orange	1½ mm	Round	Scattered on leaf blades
Stem	Brick red	3 x 10 mm	Rectangular	Stems, sheaths and neck; seldom leaf blades
Stripe	Yellow	0.5 wide x long stripe	Elongated stripe	Leaves, glumes

Flag Smut (Fungus - *Urocystis tritici)*

Flag smut causes gray to grayish-black streaks on leaves in the late tillering stage of plant growth. These streaks break open later and release masses of black spores. Infected leaves become frayed and ragged looking. If the infection is heavy, plants may be severely dwarfed and usually fail to produce heads. The smut is produced in stripes that run parallel between the leaf veins; the stripes break open and expose spores which are spread at harvest time when plants are disturbed. Some contaminate grain and others fall to the soil.

When diseased wheat is threshed, spores on the straw of smutted plants spread over the threshed grain as well as throughout the straw and chaff. If contaminated grain is used for seed, flag smut fungus spores are carried into the soil where they germinate when moisture and temperature are favorable. As wheat seeds sprout, germinating smut spores infect the young sprouts. Having gained entrance to a plant, the smut organism overwinters there. In the spring it resumes growth along with the host which it dwarfs, distorts and finally kills. Flag smut spores remain alive in the soil for more than a year. To prevent flag smut damage, use seed-protectant fungicides which kill flag smut spores carried on the seed. Rotating to crops other than wheat reduces soil infestation.

Leaf Blotch (Fungus - *Septoria tritici)*

Leaf blotch is a conspicuous, early spring disease that appears as irregular, longitudinal, reddish-brown spots of various sizes scattered over the leaf surface. It is especially abundant on lower leaves. The spots may contain tiny, black specks not nearly as large as pinheads but plainly visible to the unaided eye.

Disease symptoms vary with the season. If a late fall infection occurs, it may be recognized by the circular-

Flag smut on a leaf

Leaf blotch

to-oval, speckled spots on the blades of seedling leaves. Centers of the spots are first light green, changing into the natural green of the leaf. In the spring when the spots gradually elongate as the fungus grows in the leaf tissue, they turn reddish-brown, and the leaves have a yellowish cast and may die prematurely. Lower leaves usually are the most severely diseased. Sometimes a spot extends entirely across a leaf where the blade is attached to the sheath, killing the leaf distal to that point. This disease progresses from the lower leaves upward and may eventually infect the flag leaf. Flag leaf infection is the most damaging part of the disease cycle. If protective fungicides are used, apply them before infection of the flag leaf.

In some years, leaf blotch kills as many as 50 percent of the tillers. This damage often is confused with winter injury. Small, black fruiting bodies over a large part of the dead leaves and dead tillers give a positive indication of the disease.

After the wheat crop is harvested, the leaf blotch fungus lives through the summer on volunteer wheat as well as in leaf fragments from the previous wheat crop. Spores, shed from infected plants, can always infect susceptible grains and other grasses, and the spores can remain alive for as long as a year. The fungal growth within the leaf tissue remains alive for long periods even under conditions unfavorable to the fungus. When winter wheat seedlings appear above ground in the fall, leaf blotch infection occurs on them. Since the fungus is adapted to cool weather the infections grow and spread until stopped by severe cold. Overwintering in wheat leaves, the fungus resumes activity in the spring, and successive crops of spores are produced in wet weather until the wheat matures.

The wheat grower has several general control measures considered under good farming practices. The first of these is sanitation. Plow crop residue under as soon after the harvest as possible to hasten decomposition before fall seeding time. Where this disease is severe use crop rotation with at least 1 year between wheat crops. Thoroughly clean and sow fall wheat as early as possible to allow good growth before cool weather.

Powdery Mildew (Fungus - *Erysiphe graminis tritici)*

Powdery mildew may infect all aerial parts of the plant but is usually most prevalent on the upper surface of lower leaves. Symptoms can appear anytime after seedlings emerge. Wheat plants affected by powdery mildew usually are found where growth is dense and the air is moist. This disease reduces the amount of leaf area available for food manufacturing. In severe cases, wheat plants lodge and kernels shrivel.

Powdery mildew is first noticeable as small, irregular or circular, light gray spots on the upper surface of a leaf. Spots enlarge as the fungus grows and often involve large parts of the leaf. As the spots age, the fungus takes on a flowery appearance due to the production of an enormous number of spores. Often, the lower surface of the leaf beneath the diseased spots turns yellow and older parts of the spots turn brown. Affected leaves become deformed and crinkled, especially those attacked when young. In severe cases, leaves become brittle or may die prematurely. As

Powdery mildew

Tan spot

affected wheat approaches maturity, small, black fruiting bodies seen as black specks may be scattered throughout the fungal growth on infected spots. On the glumes, the fungus appears as a grayish-white mold.

New chemicals under current investigation may be a practical approach for controlling this disease. Crop rotation and early destruction of crop residue after harvesting minimize the chances of a heavy infection. Close grazing to reduce rank growth allows air and sunlight to dry the plant and reduce damage.

Bacterial Leaf Blight
(Bacterium - *Pseudomonas syringae)*

This bacterial disease causes necrosis (dead tissue) at the boot to early heading stage. There usually are numerous, small, water-soaked spots on the flag leaf and the first and second leaves below the flag leaf. Within 2 to 3 days these spots expand and often form into large, grayish-green, desiccated areas. These areas become necrotic and bleach to a light tan or white within a week of initial symptom development. Often 75 to 100 percent of the leaf blade is destroyed. Quite often a chlorotic yellow halo appears around some of the lesions.

This disease has been observed in Texas but has not been identified as causing economic loss.

Tan Spot (Fungus - *Pyrenophora trichostoma)*

Tan spot first appears on wheat leaves as small, dark, oval lesions with light to dark brown centers. The lesions soon develop into large tan to light brown blotches often surrounded by a distinct yellow border. When the spots are abundant leaves may turn yellow. As the spots increase in size leaves may die from the tip toward the base. The lowest plant leaves are infected first in the early spring, and the fungus spreads to upper leaves as the season progresses.

As wheat is nearing maturity the tan spot fungus invades the stem and overwinters on the straw that remains above or on the soil surface. Tiny, raised, black fruiting bodies form on the infected straw. During rainy periods in the spring and early summer fruiting bodies discharge spore forms that infect new wheat plants.

The tan spot fungus survives on wheat residue on the soil surface, but it is destroyed when the residue is worked into the soil. To obtain the most effective control of tan spot till all wheat stubble under so rapid decay of the straw occurs. Any tillage practice that minimizes straw on the soil surface is beneficial in controlling tan spot. When tan spot becomes a problem under minimum tillage practices, growers must decide between working residue into the soil or chemical controls.

Fungicides such as the Mancozeb are cleared for foliage disease control on wheat, and timely applications reduce the incidence of tan spot.

Spot Blotch (Fungus - *Helminthosporium sativum)*

Several names have been used to describe the various symptoms produced by this fungal organism.

Spot blotch

Barley yellow dwarf (virus)

It appears as seedling blight, crown rot, root rot, spot blotch (leaf spot), node canker, head blight and black joint. Wheat and barley are most susceptible, while rye is slightly susceptible and oats and corn are practically immune.

As a seedling blight, the fungus attacks young shoots, producing dark brown or black lesions that may spread into the roots. Seedlings attacked at or above the ground line usually die.

The most striking form of this disease is produced by infected crowns, roots and basal parts of the stem which produce a distinct rotting of affected parts. Sometimes plants are attacked by this organism individually or through several feet of drill row.

In the root rot phase of the disease, roots of an affected plant may be covered with small, irregular, brown spots or diseased roots may show a general browning.

The disease on the leaves is called spot blotch or leaf spot. These spots range in color from light brown to dark brown and have definite margins.

Head blight can occur when the fungus attacks the spikelets after heading. On the kernels the disease is called black point and is characterized by a black discoloration at the base or embryo end of the infected kernel. Thus the fungus overwinters in the soil in diseased crop residue, in wild grasses, on the seed or beneath the seed coat.

Seed treatment results in good stands of vigorous plants. Clean seed, good cultural practices, good soil fertility and crop rotation all help control the disease.

Barley Yellow Dwarf (Virus)

Barley yellow dwarf virus (BYDV) occurs on most cereals and numerous grasses but not on broadleaved plants. Barley yellow dwarf damage to wheat varies with variety, time of infection and environmental conditions. Infected crops typically produce 5 to 20 percent less grains. The BYDV may seriously affect winter survival.

Barley yellow dwarf is diagnosed by the yellow, stunted plants, singly or in small groups, among normal plants. BYDV is transmitted by several species of aphids, and recovery and transmission of the virus by aphids may be required for a positive diagnosis.

Development of symptoms depends on the time of infection. Leaf discoloration in shades of yellow, red or purple from tip to base and from margin to midrib is typical. Seedling infections, if not lethal, slow plant growth and cause prominent or brilliant yellowing of older leaves. Yellow or red flag leaves on otherwise normal plants indicate post-seedling infections. Diseased plants have stiff leaves and underdeveloped root systems.

Barley yellow dwarf symptoms may include a response of wheat varieties to aphid feeding apart from any influence of the virus.

BYDV is not transmissible through seed, soil sap or insects other than aphids. Aphids acquire BYDV by feeding on infected plants for periods as short as 30 minutes but more typically for 12 to 30 hours. Virus-containing aphids remain infectious through successive molts, but the virus is not passed through eggs.

Controlling aphids in the field with insecticides reduces the incidence of barley yellow dwarf and

Wheat streak mosaic (virus)

Wheat (soilborne) mosaic (virus)

increases yields, especially when autumn infections are reduced. However, since an aphid can inoculate each plant it visits, BYDV may be spread by insects that escape treatment or that migrate from untreated areas.

Early autumn plantings are most subject to infection and should be avoided.

Wheat Streak Mosaic (Virus)

The wheat streak mosaic virus is spread by the wheat curl mite, a four-legged, cigar-shaped, microscopic mite. This disease is very prevalent in the Texas Panhandle wheat growing area where it destroys a significant percentage of the winter wheat crop annually. Affected areas may cover hundreds of acres or may be localized in a few fields.

Although most infection occurs in the fall, the characteristic yellowish streaking and mottling of the leaves usually are first observed after the arrival of warm spring weather. If the warm weather continues, these leaf symptoms become more pronounced, leaves turn yellow and plants are stunted. As plants approach maturity mottling disappears and the leaves turn brown and die. Wheat streak mosaic is most severe in warm, dry weather.

The mite vector feeds on the upper surface and near the margin of leaves causing them to curl upward and inward toward the mid-vein. Mites frequently are found within the rolled leaves.

The wheat curl mite is the natural means of spreading the wheat streak mosaic. It thrives on lush, young growth of wheat and many grasses. Mites develop from eggs to adulthood within 8 to 10 days, so their numbers can increase rapidly during short periods of favorable environment. Crops of wheat and irrigated corn overlapping in spring and autumn in Texas perpetuate mites and wheat streak mosaic virus.

Wheat streak mosaic virus is controlled by cultural practices that minimize sources of virus and mites when new wheat crops emerge in autumn. Thus, destroying volunteer wheat coupled with late planting controls the disease. Late autumn planting insures development of new crops after summer crops have matured and mite populations have declined or after frost has killed summer host plants. Through late planting, infections are postponed, and mites and wheat streak mosaic virus are given less time to reach damaging proportions.

Wheat varieties resistant to wheat streak mosaic virus or to mite feeding have been identified, but they are not adapted for commercial use. Many currently grown varieties differ in tolerance.

Wheat (Soilborne) Mosaic (Virus)

Wheat soilborne mosaic virus (WSBMV) is common in Kansas and Oklahoma but has never been identified in Texas.

Symptoms of WSBMV disease appear early in the spring, usually when weather is cool and damp, but are rarely seen in the fall or winter. Wheat fields observed from a distance have irregular patches of light green or yellow color compared to healthy wheat. Upon close examination, symptoms on the infected

Loose smut or head smut

wheat plant leaves range from mild green to yellow mottling and striping, giving the mosaic appearance.

Stunting varies from moderate to severe and may be accomplished by rosetting. Symptoms favor temperatures below 68° F. and gradually disappear before harvest time if normal temperatures persist.

A fungus, *Polymyxa graminis*, which is a parasite of roots of many grass plants, is the vector that transmits WSBMV. This root parasite transmits the virus from plant to plant. Virus particles are either inside spores of the fungus or are attached to the spores. The fungus invades the roots in the fall, when soils are cool and wet, carrying the virus particles with it.

Growing resistant varieties is the only practical control method although high nitrogen rates reduce the severity of symptoms and improve yields.

STEM AND HEAD DISEASES

Glume Blotch (Fungus - *Septoria nodorum)*

Glume blotch, also called glume spot, is one of several diseases in Texas that attack the chaff or glumes of wheat heads. It is a warm weather disease and does not develop extensively until the crop nears maturity. In most years glume blotch is one of the relatively unimportant wheat diseases in Texas. Grain in infected heads shrivel and is lost with the chaff at harvest time.

The disease is first evident on the chaff and may be seen as small, irregular, grayish or brownish spots or blotches which later enlarge and become chocolate brown. As the spots age, their centers often turn grayish-white, and in these regions tiny, black, pimple-like, spore-bearing bodies usually can be seen. Occasionally infection occurs at the base of a glume and cannot be distinguished from basal glume rot unless the fruiting bodies are found. Ordinarily only a few glumes in a head become infected, but in severe cases the entire head is attacked and turns dark brown.

The fungus can be seedborne and is undoubtedly the source of contamination. Seed treatment is an economical approach to control. Foliar fungicides have given good control; however, repeated applications usually are necessary, and the economics of this practice may not be practical for the wheat producer.

Loose Smut (Fungus - *Ustilago tritici)*

Loose smut is the most easily recognized of all wheat smut diseases because of the characteristic dusty black appearance of diseased heads, an appearance that has given it such common names as smut, blackhead and black smut. An important difference between this and other smut diseases of wheat is that infection is carried from one season to another within the seed and not as spores on the seed surface.

The term "loose smut" is very descriptive since fungal spores, which make up each blackhead, adhere loosely and are knocked off easily, leaving only the bare stalk. Loose smut is recognized as soon as the affected head emerges from the boot.

Spores of the loose smut fungus are approximately the size of a pollen grain. When healthy wheat is in bloom, the smut spore is blown to the healthy bloom and infection occurs. The fungus becomes established inside the developing kernel. It becomes inactive and dormant for a year or more. When an infected seed is sown and sprouts, the fungus actively grows into the young shoot to the growing point, keeping pace with plant development. As wheat heads form, the fungus begins its own reproduction process and replaces the spikelets with a new crop of dusty, black spores which are ready to infect flowers of healthy plants.

Plant seed from smut-free fields; they do not have loose smut in them. Treat with a fungicide. Chemicals with systemic activity are the only ones effective against loose smut.

Bunt (Stinking smut) (Fungus - *Tilletia foetida)*

Wheat bunt, sometimes called stinking smut or covered smut, gets its name from the characteristic fishy odor given off by infected heads. Two types of losses result from bunt infection in wheat: (1) smutted heads are a total loss and reduce yield in proportion to their number and (2) the presence of bunt in threshed wheat gives the grain the foul, fishy odor which makes the wheat unfit for milling and subject to dockage when sold. The prevalence of bunt varies from year to year. It depends partially on soil conditions following

planting and the extent to which preventative measures are used.

In the field, bunted heads usually stand more erect than healthy heads because of their lighter weight. The offensive odor indicates heavy infestations in fields and the presence of smut galls in grain being shipped or stored.

Many smut galls are crushed during threshing and spores are released, lodging on healthy kernels, especially at the brush end and in the grooves. Planted in the soil with the wheat, the spores germinate when soil conditions are favorable; by the time a wheat sprout emerges, the smut fungus has produced spores of another type which infect young wheat plants. After entering a young shoot, the fungus continues to grow as an internal parasite eventually transforming wheat kernels into smut galls.

Chemical seed protectants are effective in killing smut spores carried on kernels.

Bunt or stinking smut

COMPARING SMUT DISEASES

	Loose	Bunt	Flag
Plant parts affected	Seed	Seed	Leaf, sheath, stem
Seedborne	Internal	External	External
Soilborne	No	Yes	No
Type control	Systemic fungicide	Protectant fungicide	Protectant fungicide

Sooty Molds (Fungi - *Alternaria, Cladosporium, Epicoccum* and *Stemphylium)*

The most prevalent molds are mildly parasitic species of *Alternaria* and *Cladosporium,* but other species may be involved occasionally. The "sooty" appearance of molded plants is caused by the superficial growth of fungi which produce a heavy growth of greenish-black spores and mold on plant surfaces.

These dark spored fungi often develop on maturing wheat plants when wet weather and high humidity cause delayed harvest. Mold sometimes develops on leaves and causes "black point" symptoms on the kernels. Heads that are shaded, weakened, undersized or prematurely ripe for other reasons are affected more often. Plants that are nutritionally deficient, lodged or damaged by diseases usually support "sooty" molds. Thus, molds often indicate damage which may have already been caused by another problem in the field. Foot rot, hail, freeze or other maladies may predispose plants to sooty molds.

Several fungicides control "sooty" molds, but their use is rarely economical. Resistant varieties are not known, but differences in tolerances are recognized.

Scab or Head Blight (Fungus - *Fusarium* spp.)

Scab found on wheat in its most usual form causes a head blight, recognized by premature ripening or bleaching of one or more spikelets of a head anytime after flowering. When wheat is in the dough stage the light yellow color of diseased spikelets of a head shows in sharp contrast with the healthy green of the rest of the head. A light pink or salmon color may appear at the bases of infected spikelets and along the edges of the chaff. This color is from quantities of summer spores of the fungus. Kernels of severely affected spikelets have a grayish-white, salmon or reddish color; are badly shrunken and wrinkled; and have a noticeable rough, flaky seed coat. By harvest time

Sooty mold on the head

Downy mildew

under conditions favorable to the fungus, the heads first attacked may become speckled with superficial, tiny, blue-black particles which are the spore-bearing bodies.

A seedling blight can be caused by the scab fungus and is noticeable when the infected plants appear stunted. Later these plants turn yellow and die. Roots of diseased seedlings are rotted, reddish brown colored and may be covered with a mass of grayish or pink mold.

Grain from head-blighted fields is less palatable for livestock feed and sometimes contains sufficient mycotoxins to induce muscle spasms and vomiting in man, swine and certain other nonruminant animals. Toxins remain stable for years in stored grain.

No highly resistant varieties are available but some of the soft white wheats are less susceptible. Chemical seed treatments give partial control. Crop rotations with at least a 1-year break in cereal and grass cultivation is helpful. Deep plowing to bury crop residues also is recommended since fungus survives best on surface debris.

Downy Mildew (Fungus - *Sclerospora macrospora)*

The downy mildew fungus attacks all cereal grains and a number of other grasses. It usually is found in low, poorly drained areas where seedlings are exposed to excessive moisture.

Plant symptoms produced by downy mildew are variable. Some diseased plants tiller excessively and are severely dwarfed; many tillers grow only a few inches tall. Leaves of dwarfed plants become fleshy and striped with yellow or almost completely yellow. Thickened leaves are twisted, curled, stiff and erect. The plants rarely produce heads. Still other plants may be only slightly dwarfed; the leaves are slightly yellow, thick, twisted and erect. Any heads that are produced are distorted and abnormally large; the chaff may be fleshy and green and have a more open appearance than healthy heads. Stems below the affected heads may be thick and deformed. In bearded varieties beards are distorted, abnormally long and sometimes trapped in the flag leaf. Diseased heads produce no viable grain.

Usually control measures other than water management are not warranted. In problem areas improved drainage and elimination of susceptible grasses help eliminate some sources of the disease. Rotating wheat with a hay non-cereal crop is beneficial.

Black Point (Fungi - *Alternaria, Helminthosporium)*

Reference was made to "black point" under sooty molds. Any of the dark spored fungi attacking the glumes, spike, head or kernels can cause a discoloration on the germ end of the seed. Black point describes the discolored embryo resulting from the presence of the fungi. The discoloration is believed to be due to toxic substances produced by the dark-colored fungi.

The fungi causing sooty molds usually develop on maturing wheat plants during wet weather or high

Black point

Head trapping (late freeze damage)

humidity and when harvest is delayed because of adverse weather. Fungicides applied to maturing heads is not economically feasible. Chemical seed treatments are economical, they improve germination and they decrease infection of seedlings grown from diseased kernels.

Grain Molds

Molds that invade grain can be divided into two groups, based primarily on their time of invasion — field molds and storage molds.

Field molds invade grain before harvest or after grain is cut. Field molds include primarily species of *Helminthosporium, Cladosporium, Alternaria* and *Fusarium* and require high grain moisture content (20 to 22 percent or more) to grow.

Storage molds invade grain at moisture contents in equilibrium with relative humidities of 70 to 90 percent; thus they are able to invade grain at lower moisture levels (as low as 15 percent for some species) than field molds. Species of *Aspergillus* and *Penicillium* are the principal storage molds and often are involved in mycotoxin problems.

Many molds are not capable of producing mycotoxins even though they may invade grain. Just because a given sample of grain is moldy, it is not necessarily toxic. Mycotoxins are chemical compounds produced by molds which are toxic to animals.

Place emphasis on proper harvesting, handling and storage to reduce the potentials for mold growth.

OTHER WHEAT PROBLEMS

Frost and Winter Injury

Climate is the most important factor regulating growth of wheat in Texas. The crop is well adapted to the environment in average sessions; but in years with unusual cold weather, damage may be heavy. Cold injury is not usually a simple thing but is complicated by moisture stress, disease injury or nutritional deficiencies. Winter injury to actively growing plants may be very severe when early or late freezing weather occurs in wheat that is not dormant. Dormant wheat may be suffocated by ice and snow or may be injured by soil heaving. Dormant wheat damage by cold weather is less noticeable and more unusual than frost injury in Texas.

Frost. Freezing temperatures are most damaging to wheat when they occur during stem elongation, heading or flowering. Frost that occurs during the fall is less damaging than when it occurs during spring growth. Wheat tissue usually is hardened during the winter months and frost damage is less likely to occur.

Wheat suffers three principal types of frost injury depending on the growth stage when the frost occurs. The first type of injury occurs when freezing temperatures cause a damped-off or banded appearance to young seedlings. The second type of injury occurs when the wheat is in the jointing growth stage. Dark, water-soaked and sometimes swollen areas appear at the nodes. Cells at the node are killed and plants break

Cold wind scorch

Color banding

off at the node area. The third type of freeze symptom occurs when plants are in the boot stage. If freezing temperatures occur at this point, sterility usually is associated with head development. There also may be some awn trapping and distorted growth of the developing head.

Suffocation. When soils become water logged during the winter months roots begin to suffocate because of the lack of soil oxygen. Wet fields may freeze over during the winter months, killing young plants.

Soil heaving. Soils that freeze and thaw sometimes expose the crown and roots of plants to desiccation by sun and wind. Plants heaved from the soil because of the freezing and thawing phenomenon usually are killed unless favorable growing conditions exist quickly so they can stimulate new root development. These plants usually remain weak and undeveloped throughout the growing season.

Well drained soils are less likely to have heaving damage than those in which the crop residue is removed by baling the straw or burning stubble. Leaving crop residue on top of the soil by stubble mulching or minimum tillage practice aids in reducing losses from soil heaving.

Cold Wind Scorch

Cold wind scorch appears most frequently on wheat that is growing rapidly and has lush tender growth. Usually the tip end of leaf blades are scorched or burned. This condition is associated with low temperatures below the freezing level when windspeed is 20 to 30 miles per hour. Usually this condition is temporary and no permanent damage results.

Color Banding

Color banding is an abnormal coloration on young seedlings. This condition results from temperature extremes. A period of extremely high temperatures followed by extremely low temperatures causes stress on young seedlings. Color-banded seedlings have a series of distinct, yellow-white bands on the seedling leaves. These bands are approximately 2 centimeters wide on the seed leaves. Usually 3 to 4 days following the stress period plants produce normal growth.

Yellow Berry

Light-colored grains are called "yellow berry." Varieties differ considerably in the severity of yellow berry, but a variety may be much more severely damaged in some years than others. Weather conditions and temperatures during the heading and maturing process have a definite bearing on the amount of yellow berry. Excessive moisture during this period increases the proportion of yellow kernels by causing nitrogen to leach from the root zone and may also cause maturity to be slow. Yellow berry seeds usually have a higher proportion of starch than that of normal colored seeds.

Make sure that adequate nitrogen is available during the head maturity period.

Storage Molds (Fungi - *Aspergillus, Penicillium* and others)

Storage fungi usually infest wheat seed before harvest and are carried on the seed into storage. The amount of damage to stored seed is dependent upon the moisture and temperature of the grain in storage. The moisture content of stored wheat, which is also affected by seed injury, contaminated debris and insect activity, is much more critical than temperature. Fungal activity is very minimal when stored grain moisture is below 13 percent.

When storage molds become active in stored grain there is often a musty odor associated with decaying grain. Keeping the moisture level below 13 percent and preventing insect pest buildup usually insures that storage mold damage will be held to a minimum.

HERBICIDE INJURY TO WHEAT

Use of highly active and persistent herbicides on croplands has resulted in some injury to wheat plants. Symptoms may be similar to a disease; therefore, the producer may think of disease instead of herbicidal injury.

The most common herbicide problem may occur from the soil residue from soil-active herbicides used in previous crops. Triazines, atrazine and propazine and the dinitroanalines, Treflan® and related compounds may be involved. Injury to wheat may be failure to emerge, emergence and root inhibition, chlorosis of seedlings and seedling death. Evidence of herbicide residue may be an injury pattern due to band applications in the previous crop rows, or there may be a definite field pattern resulting where part of the wheat field follows a row crop and part follows wheat. Broadcast herbicide applications may cause general damage over the whole field. Carefully follow label restrictions for the herbicide to avoid damage from soil-active herbicides.

A second type of herbicide injury to wheat can come from improper use of hormone-type herbicides. Banvel® has soil activity and is used at high rates for perennial weed control. Excessive rates may cause wheat plants to grow prostrate with deformed and sterile heads. The phenoxy compounds such as 2,4-D can cause damage when applied too soon or too late. Symptoms may include lodging, "onion leaf," reduced tillering and blasting of florets.

The third kind of injury may result from accidental applications of dessicants and contact herbicides to non-target wheat. Paraquat® and arsenic acid cause sudden death of leaf tissue in spots. Heavy applications may kill plants in a day or two. Roundup® can destroy plants in a week or two. Yellowing and blanching leaves precede death.

New herbicides may be released with even more severe damage potential. Growers should read and learn more about any new chemical. Zorial, often used in cotton, has a long soil life and can cause wheat seedlings to turn pure white. Others may be released with different symptoms.

Low fertility

Varietal responses to herbicides may become more important. TAM W-101 and Newton varieties tolerate the herbicide Sencor® and Lexone® much better than other varieties. These herbicides are used in wheat to control wild oats and bromegrasses.

Herbicides are a necessity in modern agriculture, but they must be used with knowledge of their safety, effectiveness and danger to rotational crops such as wheat. With sandy soils and semi-arid conditions the life of herbicides in the soil is longer; therefore, additional planning is necessary.

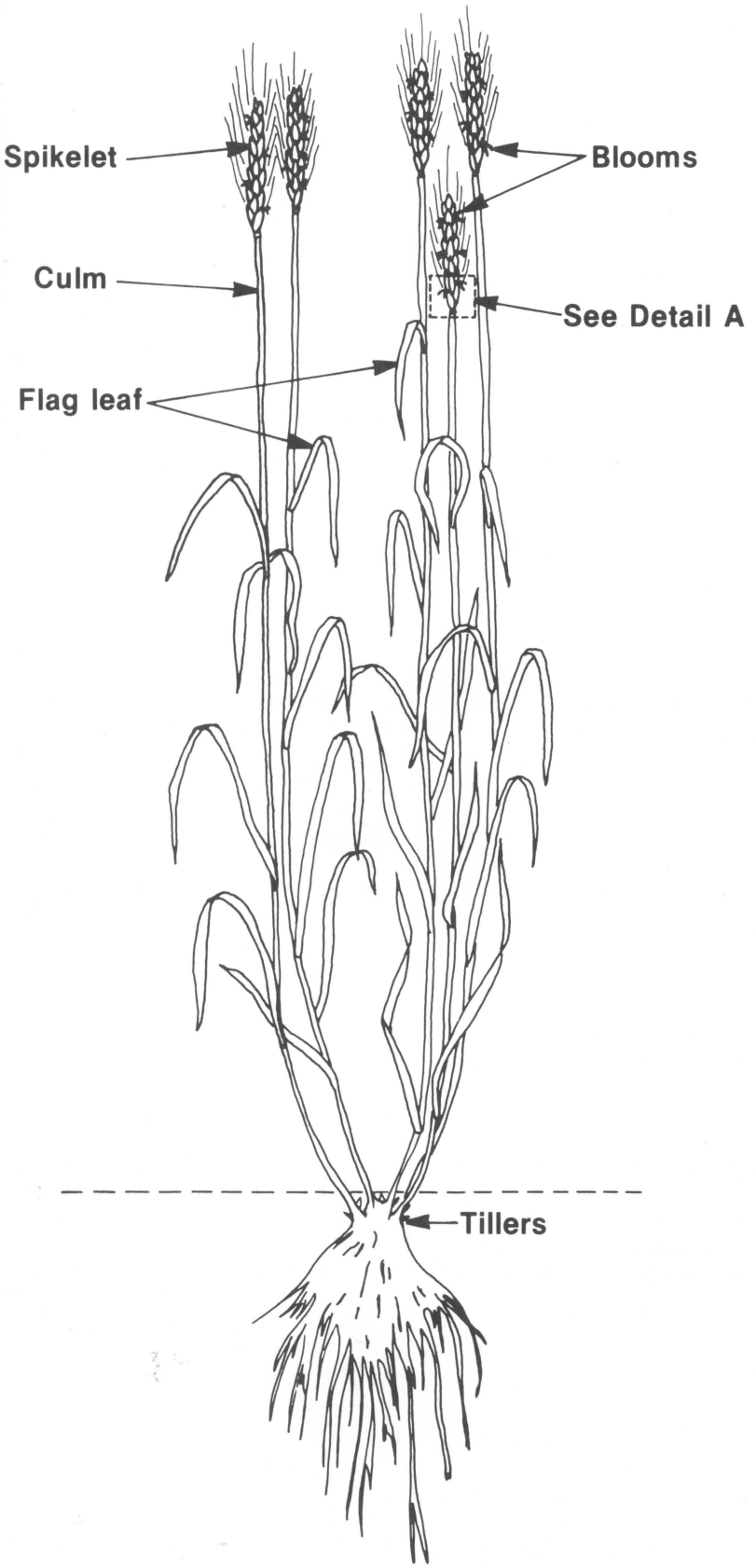
Low Fertility

Yellow berry, as previously mentioned, can be more prevalent when stresses from deficient nitrogen and warm temperatures are present during heading and maturity. Nutrients can be manipulated to enhance the plant's ability to tolerate or resist disease stresses.

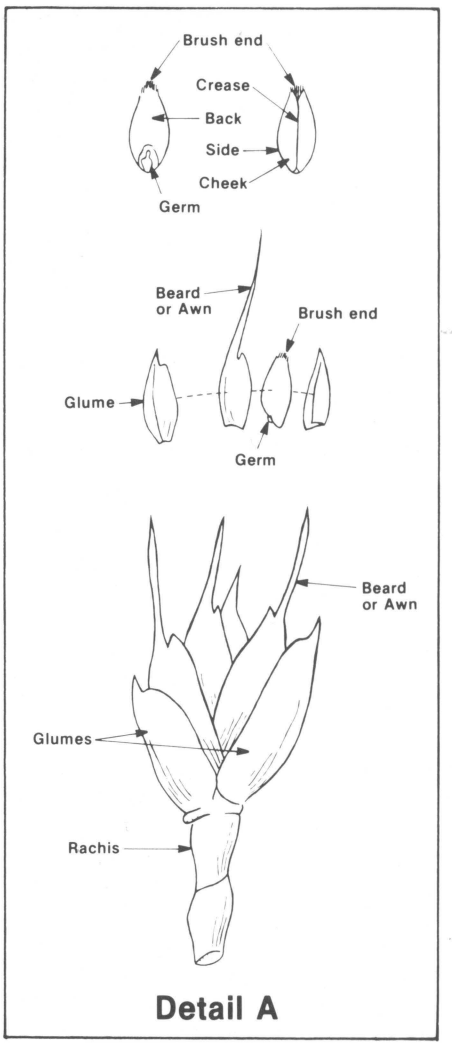
Nitrogen, phosphorus and potash are used in large amounts by the wheat plant while other nutrient elements are essential but are used in moderate or minute quantities. Most nutritional elements are interrelated so the adjustment of one may affect the performance of others.

The greatest demand for nutritional elements is between tillering and heading. Nutritional disorders of wheat are vague but can be associated with stunting or uneven growth, loss of green color, lack of tillering and vigor, low yields and shriveled grain.

Correct nutritional deficiencies by applying fertilizers as prescribed by a soil test.



Parts of a Wheat Plant



Detail A

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