

Information Bulletin 29

**FIELD
MANUAL OF
COMMON
WHEAT
DISEASES
AND PESTS**

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FIELD MANUAL OF COMMON WHEAT DISEASES AND PESTS

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This manual was prepared by Dr. C. M. Christensen, University of Minnesota, and Drs. H. J. Dubin, S. Fuentes, J. M. Prescott and E.E. Saari, all of the CIMMYT wheat pathology staff.

The purpose of this manual is to help agricultural field workers identify common diseases and pests of wheat.

Specific chemical control procedures are not given since these may differ from country to country. Local plant pathologists and entomologists should be consulted concerning disease and pest identification as well as for specific control measures.

STEM RUST (BLACK RUST)

Puccinia graminis f. sp. *tritici*

The pustules (masses of uredospores) are dark reddish brown, (Fig. 1) and may occur on both sides of the leaves, on the stems, and on the heads. With light infections the pustules are scattered, but with heavy infections they may coalesce. Before the spore masses break out through the epidermis they cause a roughening that can be detected by running the thumb and finger along the stem; as they break out they give a ragged and torn appearance to the surface tissues. As the plants mature, masses of shiny black teliospores (the overwintering stage of the rust) may be produced.

The first infection in a field usually is light, and develops from windborne spores that may have come from hundreds of kilometers away. The disease develops rapidly when there is free moisture—rain or dew—and high temperatures. The first crop of uredospores is produced about 14 to 21 days after infection, and these spread the rust to nearby and sometimes to distant plants. If the first infection occurs when the plants are young, and the subsequent weather is favorable for the development of several successive infection cycles, a complete crop loss may result. Plants with lighter infections may yield shrivelled kernels of low test weight. Late plantings are more likely to be severely damaged by stem rust than early plantings.

Stem rust is a major disease of wheat throughout the world. Control is by means of resistant varieties.



LEAF RUST (BROWN RUST)

Puccinia recondita

The pustules or spore masses are smaller than those of stem rust, circular (usually they do not coalesce), and orange to orange-brown (Fig. 2). They are produced almost exclusively on the upper surface of the leaves.

As the plants mature or during unfavorable weather, masses of black teliospores may be produced. In winter-wheat areas the mycelium that produced uredospores in the fall may live over winter and produce a new crop of spores in the spring, and successive crops of spores may be produced every 7 to 14 days. The uredospores are wind-borne and, like those of stem rust, may be carried for hundreds of kilometers and still cause infection.

Leaf rust is found wherever wheat is grown, but it is most likely to appear in epidemic form where the weather during the growing season is mild and moist. As with stem rust, late plantings are more likely to be damaged than early plantings.

Control is principally by resistant varieties.



STRIPE RUST (YELLOW RUST)

Puccinia striiformis

The uredospore pustules of stripe rust form narrow stripes (hence the name) on leaf sheaths, leaves (Fig. 3, left), stems, on the outer and inner sides of the glumes (Fig. 4), and on the kernels. The stripes are yellow to orange-yellow. Primary infection is from wind-borne uredospores that may come from hundreds of kilometers away. When infection occurs early in the season followed by a long period of cool weather, a severe epidemic may develop, with heavy losses in yield. At temperatures above 23-25°C, production of uredospores ceases and teliospores or the black-spore stage occurs (Fig. 3, right). In contrast to stem and leaf rust, late plantings may decrease disease incidence since higher temperatures arrest stripe rust.

Control is by means of resistant varieties.

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BUNT (STINKING SMUT)

Tilletia caries, *T. Foetida*, *T. controversa*

These three species are considered together because their symptoms in infected plants are similar. Each causes "bunt balls". That is, the kernels of an infected plant are replaced by a dense mass of black spores, enclosed by the outer membrane of the kernels (Fig. 5). The bunt balls of *T. foetida* and *T. caries* are approximately the same shape and size as the wheat kernels that they replace, whereas those of *T. controversa* are nearly spherical. *T. foetida* can be separated from *T. caries* only on the basis of microscopic characters—the spores of *T. foetida* being smooth and those of *T. caries* being covered with netlike ridges. The spore masses have a fetid odor.

Bunt may stunt affected plants, sometimes severely, especially those infected with *T. controversa*. The plants may produce fewer than normal culms. Usually all kernels in an affected head are smutted. The heads of smutted plants have an irregular or ragged appearance because the glumes are pushed apart by the smut balls (Fig. 6). Infection of the emerging sprout of the germinating embryo occurs from spores on the seed or from dormant spores in the soil. Infection is favored by cool weather at the time of seed germination.

Control is by means of resistant varieties and also by treatment of the seed or the soil with suitable fungicides.



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KARNAL BUNT (PARTIAL BUNT) *Neovossia indica (Tilletia indica)*

Some individual kernels in an infected head are completely smutted, but most of them are only partially smutted, with some tissues of the kernel remaining normal and some converted into a mass of smut spores (Fig. 7). Infection occurs at flowering time, from secondary spores produced by chlamydospores that have lain dormant in the soil since the previous harvest time, or from contaminating chlamydospores on the seeds. Karnal bunt occurs principally in India and Pakistan where, at times, infection may be heavy enough to reduce the yield seriously.

Control is by means of resistant varieties.



LOOSE SMUT

Ustilago nuda f. sp. *tritici*

The entire inflorescence is converted into smut spores, and these are carried away by the wind, leaving only the rachis and the remains of the floral branches (Fig. 8). The spores that land on the flowers of wheat plants germinate and infect the developing embryo of the seed. The mycelium of the smut fungus remains dormant in the tissues of the embryo until the seed begins to germinate. The mycelium then grows with the growing point of the plant, and at flowering time it replaces the floral parts of the head with masses of black spores.

Control is by means of resistant varieties, by use of seed known to be free of the smut, and by application of systemic fungicides to the seed.



FLAG SMUT

Urocystis tritici

Black masses of spores are produced in narrow strips just beneath the epidermis on leaves (Fig. 9) and leaf sheaths and occasionally on the culms. Infected plants usually are stunted, and the heads may not emerge. Severe infection induces the leaves to roll up, producing an onion-type leaf. As the infected tissues die they break into shreds and liberate the spores, which contaminate the soil and also the seeds at harvest. Germinating seeds contaminated with the spores, or sound seeds planted in contaminated soil, are invaded by the germinating smut spores. Optimum temperature for infection is about 20 °C, and percentage of infection decreases rapidly at soil temperatures above that.

Control is by means of resistant varieties and by fungicidal seed treatment.



POWDERY MILDEW

Erysiphe graminis

Mycelium and conidia of the fungus form pale gray and somewhat fuzzy or powdery patches on the upper surface of the leaves, (Fig. 10, 11) and sometimes on the stems and glumes. This superficial material can be easily rubbed off with the fingers. The host tissues beneath the patches of mycelium become pale yellow, and heavy infections result in death of the leaves; if this occurs early in the life of the plant, the yield of grain will be reduced. Development of powdery mildew is favored by cloudy, cool, and humid weather.

In greenhouses, where wheat plants commonly are grown for experimental purposes, powdery mildew can be controlled by means of fungicides, but in the field, resistant varieties generally are the most practical form of control.

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DOWNY MILDEW

Sclerospora macrospora

Wheat plants infected with downy mildew have more than the normal number of tillers, with short, erect, irregular or crooked yellowish-green culms, and thick, erect leaves in whorls. Many of the tillers die prematurely. The heads may be branched, and some of the floral tissues grow into leaflike structures (Fig. 12). In young infected plants, no fungus spores or mycelium are visible, but later masses of brownish spores are formed in the subsurface tissues of the leaves, between the veins. Local epidemics occur sporadically when the conditions are favorable (high soil moisture, poorly drained soil). Infection may come from inoculum on weed hosts, or from inoculum in the soil from the previous crop. No widespread and destructive epidemics occur.

There are no specific control measures, but the likelihood of infection is reduced by crop rotation, elimination of weed hosts, and good surface drainage.



SCAB, HEAD BLIGHT

Fusarium spp.

Several species of *Fusarium* attack the heads of wheat as the kernels are forming. If the kernels have just begun to form at the time of attack, they may be totally destroyed. If they are in the late milk or early dough stage at the time of attack, they may be greatly shrivelled (Fig. 13. Left, sound grain. Right, infected). If they are mature at the time of attack they may be normal in size and shape, but will have a friable and chalky texture. The glumes of severely blighted heads are almost white, or pale salmon pink, or reddish (Fig. 14, 15. Fig. 15 —Left, healthy. Right, scabbed). Development of scab is favored by warm, humid weather at and after heading time. If such weather prevails for several days or more, infection is almost inevitable, and losses may be severe. Inoculum of the fungus or fungi that cause scab is more or less universally present in the soil.

Scabby grain is likely to be toxic if consumed by swine, but may be consumed by poultry as a portion of their ration without obvious injury.

The same species of *Fusarium* that cause scab or head blight also cause root rot and crown rot.

No specific control measures for scab are available. Different varieties differ in susceptibility, but none are immune.



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SEPTORIA LEAF AND GLUME BLOTCH

Septoria tritici, *S. nodorum*

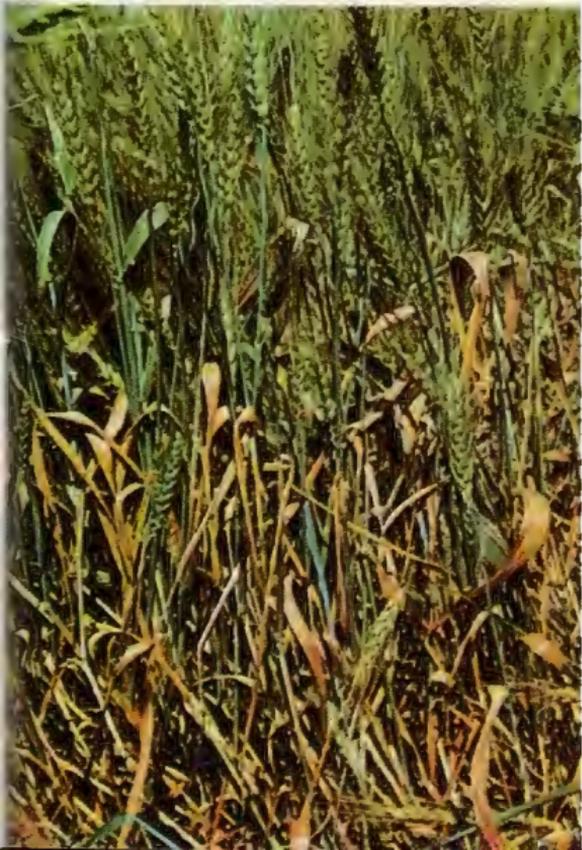
S. tritici infects the leaves primarily, (Fig. 16) and *S. nodorum* infects the glumes (Fig. 17) and culms primarily, but both may occur on any of the above-ground parts of the plant (Fig. 18). They are difficult to distinguish from one another in the field. Both cause lesions that at first are oval to irregular and elongate. The center of the lesions are pale straw color, and bear numerous small black pycnidia in which spores are borne (this is especially true of *S. tritici*). If cool, moist weather prevails in the fall, *Septoria* can invade and kill most of the rosette leaves and tiller primordia of young winter wheat plants. With similar weather in the spring or summer, the fungus can invade wheat plants at any stage of growth. Light invasion produces scattered lesions, but heavy invasion kills parts or all of the leaf. Depending on when infection becomes severe, yield may be reduced only slightly or very heavily. These *Septoria* diseases have always been present, but during the last decade they have become of increasing importance and have caused serious epidemics in many areas of the world.

In some regions aerial application of fungicide to control *Septoria* blight is effective and economically feasible. Crop rotation to avoid accumulation of inoculum, burning of stubble, and plowing under of volunteer wheat plants and weed hosts in the fall are recommended sanitation measures, but their value as control measures is variable. Some resistant varieties (especially to *S. tritici*) are available.

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ERGOT

Claviceps purpurea

The first infection occurs from ascospores released from fruit bodies produced by sclerotia from the previous year's crop, or certain grasses. The sclerotia survive the winter on the surface of the soil or buried just beneath the surface. Within a few days the infected florets produce conidia in a sticky, sweet exudate. Small flies are attracted to this exudate (in humid weather it may be so abundant that it is visible on the glumes) and carry the spores to healthy florets in the same head and to florets in the heads of other plants. The fungus grows in the infected florets and produces the characteristic sclerotia (Fig. 19). Each sclerotium is the product of a separate infection: that is, the fungus cannot spread by itself from one floret to another in the head. Ergot in wheat is relatively common, but seldom severe, in cool and humid northern regions, and is rare in the southern or subtropical wheat-growing areas. Ergot sclerotia contain several potent toxins and should not be used for food or feed.

Where ergot is known to constitute an occasional or regular problem, resistant varieties should be grown.



HELMINTHOSPORIUM AND ALTERNARIA LEAF BLIGHTS

Helminthosporium sativum,
H. tritici-repentis, *Alternaria triticina*

The lesions caused by these fungi are at first elongate oval. *H. sativum* spots generally are chocolate colored and may have a lighter colored center (Fig. 20). *H. tritici-repentis* lesions are lighter than ones produced by *H. sativum* and may have a yellowish border (Fig. 21). Those caused by *A. triticina* are uniformly brown (Fig. 22). As the disease progresses entire leaves and entire plants may be killed. Given the combination of susceptible varieties and warm, humid weather, local epidemics may develop. Leaf blight caused by *A. triticina* is common in India. Leaf blights caused by *H. sativum* and *H. tritici-repentis* are found in most wheat-growing areas of the world, and in the hot and humid lowland tropics they may constitute a major disease complex of wheat. *H. sativum* may also cause root rot or black point disease of the grain.

Rotation decreases the disease incidence. Some resistant cultivars are available. In some areas control by means of aerial application of fungicides may be economically feasible.



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BLACK POINT

Alternaria, Helminthosporium, Fusarium

As a reaction to invasion by fungi, the pericarps of maturing kernels of wheat may become dark brown to black (Fig. 23). Usually this discoloration is restricted to, or is more evident at the germ end. If *Alternaria* is the cause, the dark color is restricted to the pericarp, and the germ is not affected. If *Fusarium* or *Helminthosporium* is responsible, the germ may be invaded and injured or killed. Even if only the pericarps are discolored, black point still is objectionable because of the black specks that end up in the milled products. Some varieties are much more susceptible than others to the development of black point, but if humid weather prevails for a few days to a week just before harvest, black point will develop in any variety.

No specific control measures are known.



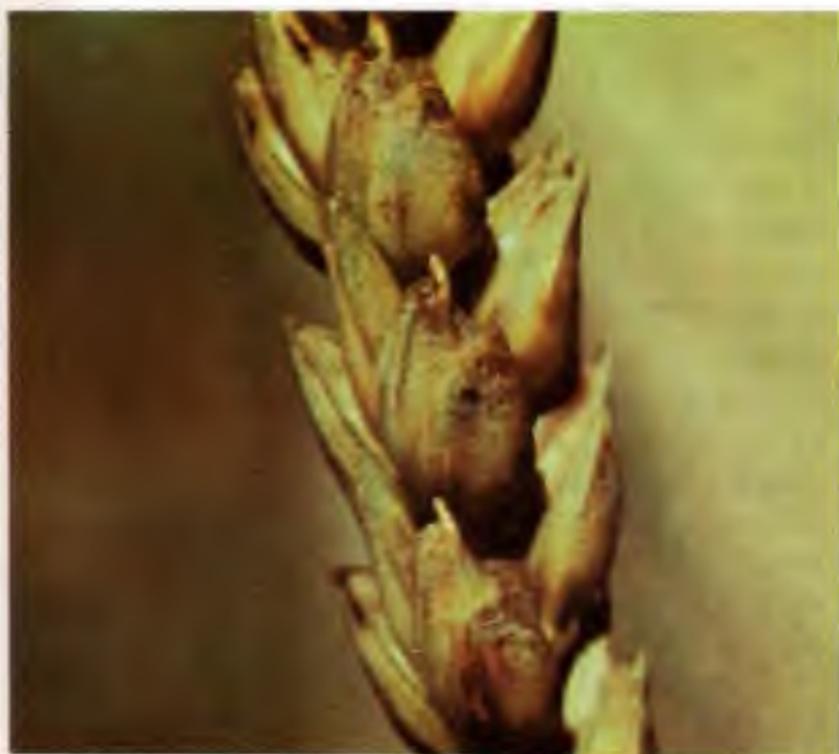
BLACK CHAFF AND BACTERIAL STRIPE *Xanthomonas translucens*

These two diseases are different aspects of a single disease complex, the site and extent of the symptoms depending on the strain of the bacterium, the variety of the host, and the environmental conditions. If the symptoms are primarily on the glumes, it is called "black chaff" (Fig. 24), if they are primarily on the leaves, it is called "bacterial stripe". Symptoms consist first of narrow brown stripes that in wet weather have a water-soaked appearance and that may exude sticky yellow droplets. These dry to form a translucent film on the surface of the affected tissues, and this film may crack and break up to give a scaly appearance (Fig. 25). If the infection continues, entire leaves may be killed, and yield will be reduced. These diseases are widely distributed, but they are only important where susceptible varieties are grown and the weather during the growing season is wet.

Control is by use of resistant cultivars, rotation, and clean seed.

Note: FALSE BLACK CHAFF is described under genetic diseases.

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TAKE-ALL

Ophiobolus (Gaeumannomyces) graminis

The fungus causes a root and lower stem rot. Basal tissues as well as roots may be shiny black (Fig. 26). Magnified with a hand lens, dark fungal hyphae known as "runner" hyphae may often be observed on the sub-crown internode beneath the old leaf sheaths. Severe infection may produce stunted plants with whitened culms and spikes (Fig. 27). The disease generally occurs in scattered patches throughout the field. It is most prevalent on alkaline, infertile soils with abundant moisture. Liming or minimal tillage practices may increase incidence.

Common Root Rot, caused by *Helminthosporium sativum*, as well as Dryland Foot Rot, caused by certain *Fusarium roseum* strains can occur together with *O. graminis* thus making proper identification of the disease difficult.

Rotation and fallowing decrease incidence of Take-All and other root rots as does proper plant nutrition. Resistant cultivars are not available at present.

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STRAWBREAKER (EYESPOT)

Cercospora herpotrichoides

The most obvious symptom of this disease is the "eye-like" elliptical lesion produced on the lower stem (Fig. 28). The lesion is bordered by a dark ring with a lighter inner portion, but these ultimately may coalesce losing the eye-like appearance. Severe infection may cause the culm to break near the ground thus giving the disease the name of "strawbreaker" as well as "eyespot" (Fig. 29). The fungus does not attack the roots. Severe disease occurs on winter wheat where growing seasons are cool and damp. Spring wheats generally are not affected by "eyespot".

Control is achieved through rotation, burning of stubble, and resistant or tolerant cultivars. Good control may be obtained with some systemic fungicides.

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CLADOSPORIUM AND ALTERNARIA DISCOLORATION

Cladosporium spp., *Alternaria* spp.

Wheat plants heavily infested with aphids, or killed by certain pathogenic fungi may, especially in moist weather, be so heavily invaded by *Cladosporium* and/or *Alternaria* that they become blackened (Fig. 30). Technically this is not a disease, since the fungus is invading dead or dying tissues, but it occurs commonly enough in certain regions to justify mentioning it. This condition occurs commonly with plants killed by root or foot rot fungi.



BARLEY YELLOW DWARF (BYD) Virus

Leaves of infected plants are yellowish, with green streaks extending into the yellowed areas (Fig. 31), there may be reddish tinges as well (Fig. 32). The leaves may become somewhat rolled, with the ends pointing upward, and the edges of the leaves may be serrated. Plants infected when young may be stunted. Infections at the time of tillering may cause severe losses, but infections after heading have little effect on yield. The virus is not seed-borne, but is transmitted by numerous species of aphids. BYD seems to be increasing in importance, especially in Latin America. It is worldwide in distribution.

Several other virus diseases transmitted by aphids, leafhoppers or fungi, and with symptoms similar to those caused by BYD, occur in some regions of the USA, Canada, and Europe. However, these are of unknown significance elsewhere. Symptoms are generally inadequate to differentiate the various wheat viruses in the field.

Control of aphids, where this is economically feasible, may reduce losses from BYD. Breeding material with good resistance to BYD is available.

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BACTERIAL SPIKE BLIGHT (YELLOW EAR ROT)

Corynebacterium tritici

Bacterial spike blight involves the inflorescence. Infection is accompanied by a yellowish exudate (Fig. 33). In some regions it is associated with gall nematodes (*Anguina tritici*) but it may occur alone. Clean seed helps control the disease.

COCKLE WHEAT

Anguina tritici

Brown galls or "cockles", which contain the nematode, form in place of the seed (Fig. 34). The disease may occur in combination with *Corynebacterium tritici* (Fig. 35) or alone. Leaves may be rolled or twisted or have other distortions. Spikes are smaller than normal and the glumes protrude outward.

Rotation and clean seed help control the disease.



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ROOT CYST NEMATODE

Heterodera spp.

Affected plants are stunted and slightly chlorotic. The roots are much shorter and much more branched than those of healthy plants, and have a bunched appearance, with many small, gall-like cysts (Fig. 36).

Crop rotation will reduce the population of nematodes in the soil. Breeding material with resistance to the root cyst nematode is known, but resistant commercial varieties are not yet available.



HESSIAN FLY

Mayetiola destructor

The adults are minute dark grey, fragile-looking flies about 4 mm long. The females whose abdomens are reddish in color lay strings of eggs on the upper side of the leaves. The eggs hatch into larvae that crawl down behind the leaf sheaths, where they settle and rasp and suck the plant juices. Young larvae are red, the mature ones white (Fig. 37). The pupae are brown and shiny, and are about the size and shape of a flax seed (4 mm); they are found behind the leaf sheath, and constitute the overwintering stage of the insect (Fig. 38). There are two generations per year: the spring generation infests both spring and winter wheat, the fall generation infests winter wheat. The Hessian fly is mainly a pest of winter wheat but can also attack barley and rye. Heavy infestations result in stunting, lodging, and reduced yield.

The population of flies can be reduced by appropriate cultural practices; also wheat lines with good resistance to Hessian fly are available.



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WHITE GRUBS

Various species

White grubs are the larvae of May beetles or June beetles, of which there are many species. Eggs are deposited in the ground, and the larvae feed on the roots of many kinds of plants, including wheat. The larvae of most of the damaging species live for three years, and do most of their feeding the second year. The creamy white grubs can be detected by turning up the soil and shaking or sifting it to expose them; when fully grown they may be several centimeters long and nearly one centimeter thick. They have three pairs of legs in the thorax (Fig. 39).

The above-ground symptoms on the plants are simply poor growth, or, in young plants, death. If the grubs are not seen, the symptoms might be attributed to root rot. Various soil treatments are available that control grubs. In addition populations can be reduced by avoiding planting cereals on sod fields.



WIREWORMS

Various species

These are the larvae of "click" beetles, so called because when an adult beetle is placed on its back, it arches its body, then snaps it back sharply enough to give an audible click, the motion sending the beetle a short distance up in the air so that it can land right side up. There are many species of these beetles, and the larvae of all of them are soil-inhabiting wireworms. These are shiny, cylindrical, hard-bodied, and reddish brown to dark brown. They eat the roots of many kinds of plants (Fig. 40). Fig. 41 shows the damage done by wireworms. Some of them require five years to complete their life cycle. Adequate control may be obtained with soil application of insecticides.

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ARMYWORMS, CUTWORMS

Pseudaletia unipuncta

The adults are moths, the females of which lay eggs on plant parts near the ground. These hatch in a few days and the larvae (Fig. 42) feed on the plants, consuming the leaves and cutting off the stems. Heavy infestations can be very destructive. Soil treatment with insecticides gives good control.

WHEAT STEM MAGGOT

Meromyza americana

Adults are small yellow and black flies. The females lay eggs on the upper portions of wheat stems, one per stem. The larva (Fig. 43) bores into, and consumes the interior of the stem, killing the upper part of the stem and the head. Usually only a few plants in a stand are infested, and there is no increase or spread of the infestation during the growing season. No appropriate control is known.

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STALK BORER *Papaipema nebris*

This is another member of the large cutworm family, the adult being a moth. The larva occupies and consumes the interior of the stem (Fig. 44) much as does the wheat stem maggot. Damage is usually insufficient to warrant control.

SAWFLY, WHEAT STEM SAWFLY *Cephus cinctus*

The adults are small fly-like wasps (Fig. 45). Eggs are deposited on the upper nodes of the stem, and the larvae bore (Fig. 46) into the stem and work downward. Near the base of the stem a pupation chamber is constructed, plugged at both ends, after which the larva cuts a groove around the interior of the stem at ground level. Damage to the stem tissues reduces yield, and the stems of infested plants may break near the base, where the interior groove is cut. No adequate control available.



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CEREAL LEAF BEETLE

Oulema melanopus

The adult beetles are 4 to 5 mm long, with a black head, light brown thorax, and shiny blue wing covers with parallel lines of small dots (Fig. 47). The larvae are dull to bright yellow. The adults hibernate under debris and lay eggs on the leaves of host plants in early spring. The larvae change into pupae (Fig. 48) in June, and the adults appear in July (in the Northern Hemisphere). Both the larvae and the adults feed on the leaves, causing longitudinal chewed strips between the veins (Fig. 49). Satisfactory control is obtained with insecticides.



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STINK BUGS

Various species

Adult stink bugs have a shield-shaped body (Fig. 50), and emit a disagreeable odor when crushed. They have piercing mouthparts that can readily penetrate the tissues of the glumes and the developing kernels of the head, from which they suck juices and into which at the same time they probably inject toxins. Attacks during the early stages of kernel formation destroy the kernel, and attacks during later stages result in lightweight kernels of chalky texture. Good control is given by several insecticides.

APHIDS

Various species

There are a number of species of aphids, all of them small, soft-bodied, almost-transparent sucking insects (Fig. 51). Any of them, when present in sufficient numbers, can cause yellowing and death of the leaves. The green-bug (*Schizaphis graminum*) is especially damaging (Fig. 52). As it feeds, it injects a toxin into the leaves and sheaths (Fig. 53) resulting in the development of necrotic areas, often accompanied by purple striping and rolled leaves. In addition, many species transmit the barley yellow dwarf disease. Excellent control is obtained with insecticides.

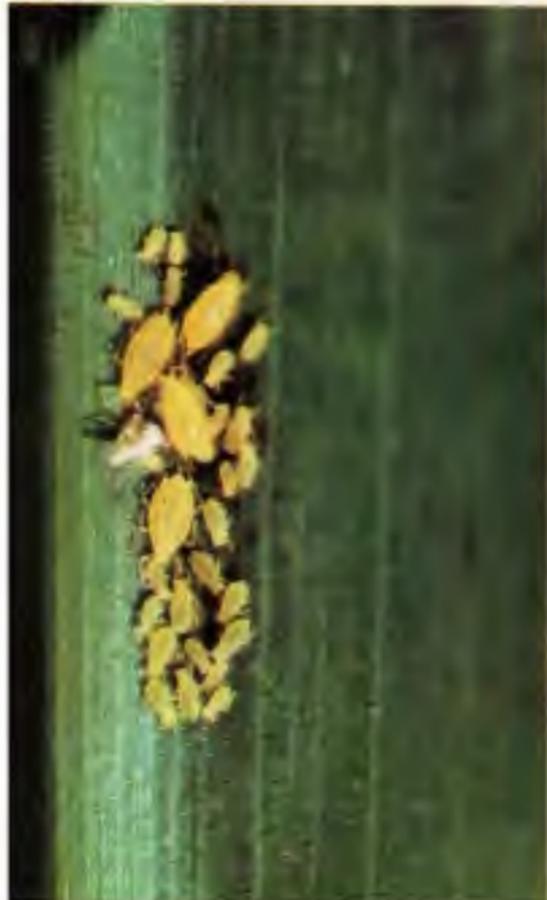
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THRIPS

Various species

Adult thrips are about 1 mm long, black, narrow, with a tapering, segmented abdomen (Fig. 54). They usually are found behind the sheath of the flag leaf, feeding on the stem. If they are present in large numbers the tissues on which they are feeding will become discolored, and sometimes the stem just below the head becomes crooked. Control is not generally necessary.

MITES

Various species

Mites are small eight-legged creatures related to ticks and spiders. All of them are minute, the individuals being barely visible to the naked eye. Most of the plant-inhabiting mites have sucking mouth parts. When present in large numbers they cause flecking of the leaves on which they are feeding (Fig. 55), and may cause reduced growth and reduced yield, or even death of the plants. Even though the individual mites are so small that they can scarcely be seen with the unaided eye, if one holds a piece of white paper horizontally, and folded so as to form a trough, beneath a leaf infested with mites, and taps the leaf sharply several times, hundreds of mites will fall off onto the paper and can be seen moving about. Rotation and insecticides provide control.



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GRASSHOPPERS

Various species

Grasshoppers are too well known to require description (Fig. 56). Various species are present in many wheat-growing areas of the world. They consume all parts of the plants, and if present in sufficient numbers they can destroy the entire crop. The common crop-damaging grasshoppers overwinter as eggs laid in pods in cultivated ground. In most developed countries devastating grasshopper plagues are largely a thing of the past, due to adequate control measures with insecticides.

HORNETS

Various species

Hornets sometimes deposit their egg masses on the stems of wheat plants (Fig. 57). These need not cause concern, and the illustration is included here simply so that those who encounter such egg masses will know what they are.

BIRDS

Various species

Seeds of various plants constitute a major food for many kinds of birds. Regular feeding visits by small numbers of birds, or a single visit by a larger number, may result in almost total disappearance of ripening seed (Fig. 58).



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HERBICIDE DAMAGE

Misapplication of herbicides can cause various sorts of damage to crop plants. It is impossible to illustrate all of the different symptoms of herbicide injury, but two common examples of such damage, that caused by 2, 4-D (Figs. 59, 60) and that caused by Paraquat (Fig. 61) are shown.



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GENETIC DISEASES

Discoloration resembling that caused by pathogenic organisms, but due to genetic factors, are occasionally encountered. Two are illustrated, false black chaff (brown necrosis) (Fig. 62, 63) and genetic flecking (Fig. 64). False black chaff has often been associated with genes of the cultivar 'Hope' or of H-44 in the pedigree, and is exacerbated by cloudy, humid weather, and by a high intensity of ultraviolet light. False black chaff can be controlled by selecting against it in a segregating population.

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COLD, FROST, AND ICE DAMAGE

Frost at the time of flowering may kill some or all of the flowers, depending on its severity and the length of time that it prevails. This may result in partial seed set (Fig. 65) or in a large percentage of outcrossing. Frosts can kill leaves as well (Fig. 66) as developing seeds. At times ice damage can also be severe.

MINERAL DEFICIENCIES – Nitrogen

In general mineral deficiency symptoms in wheat are not as well delineated as in other crops. However, nitrogen deficiency symptoms are easier to discern. The plants may be stunted, pale yellowish (Fig. 67) and leaf firing often may be observed starting at the lower portion of the plant. Seed production may be decreased considerably (Fig. 68 – left, without nitrogen; right, with nitrogen).

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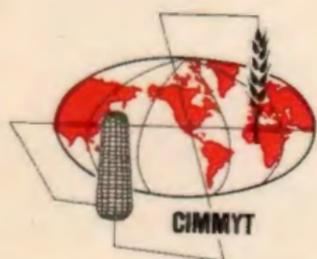


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