OSSES TO BARLEY OATS AND RYE

What to Look For
and
Where to Find It

Being one of a series of articles in relation to crops, their common diseases, and insect pests to which they are subject

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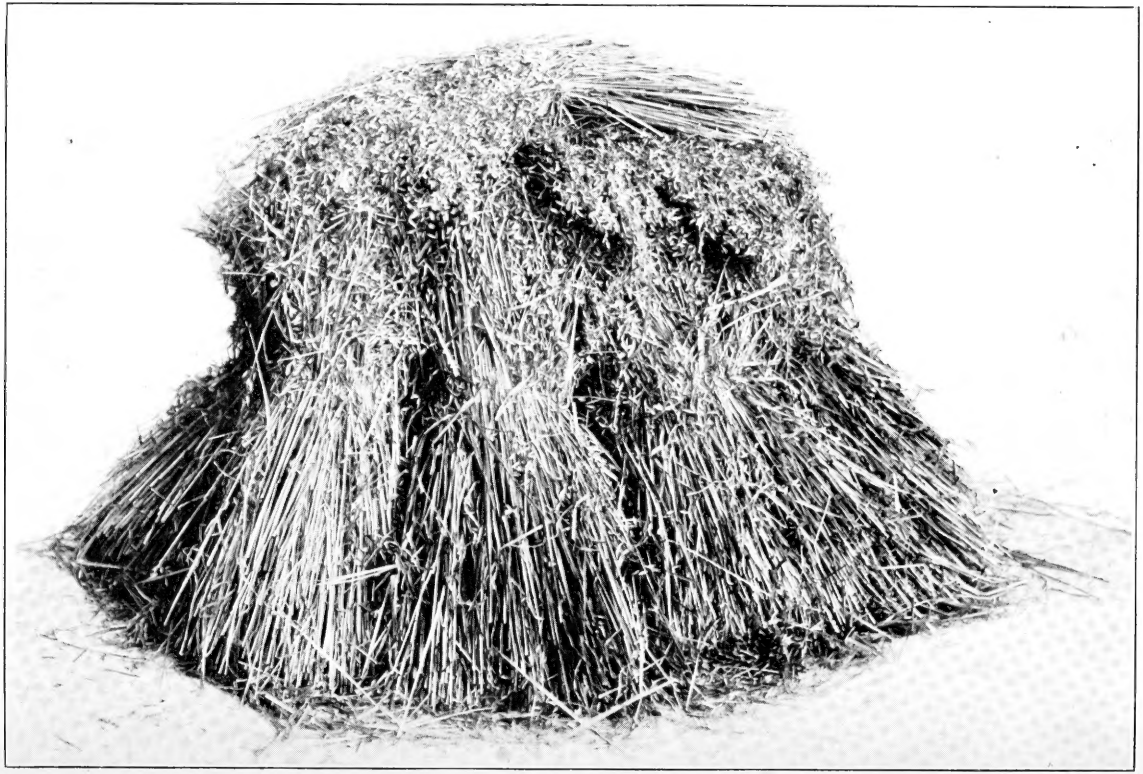

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BARLEY, OATS AND RYE

These important rotation crops—their nature and special characteristics.

"Stand and they will have to walk around you, but if you lie down they will walk all over you."

INTRODUCTION

Diversification of crops was an almost unheard-of practice in the early farming operations of the Middle West. Wheat and corn were the crops most commonly raised, and they were sufficiently diversified to satisfy the grower of that period, for the wheat produced a ready revenue and the corn sufficed for feed—both grain and roughage—for such livestock as the farmer might chance to have on his land.

At length, however, constant cropping and careless methods of soil preparation and of seed selection brought about wheat-sick conditions and robbed the soil of much of its old-time fertility. Haphazard corn culture did not overcome the weeds, and a gradual reduction of yield and a resultant loss of revenue made it necessary to introduce other crops to make farming operations profitable again.

With the farmers strongly inclined to the idea of grain farming, and their farms already equipped with the machinery for such operations, it was natural that barley, oats, and rye should next be added to the list of farm crops and their seeding more generally introduced.

Barley, because of its early maturity, was a valuable aid in eliminating the weeds. Its feeding qualities were recognized, and where an excess was produced it was easily and readily marketed. Thus did barley establish itself, and the acreage devoted to this crop has been steadily increased.

Rye, it was soon determined, could be profitably grown where other crops failed. The poorer soils were therefore seeded to rye. Its sturdy growth and satisfactory production under most adverse conditions are often most surprising. Rye has been called the grain of poverty because it will produce a fair crop on land too poor for other cereals or in a climate unadapted to them. "It is too poor to grow rye," is an expression often used to indicate extremely deficient soil. The fact, however, that rye produces well on poor soil does not mean that it will not thrive when sown in more favorable surroundings, for the better the soil the greater the possibility for an increased yield.

Oats have been more generally seeded than have rye and barley, although, generally speaking, their moisture

and soil requirements are more exacting than those of either rye or barley. Oats now rank third in value among cereals, corn being first and wheat second.

While the total commercial value of barley, oats and rye is as yet less than that of wheat alone, the benefits accruing to the farmer who grows them cannot be readily measured in dollars and cents, for their value as rotation crops is immeasurable and their more general planting will result in greater returns.

PART I

INSECTS

Ravages of insects are in many instances the direct results of man's efforts to bring large areas of the country from a condition of nature hastily into a high state of cultivation. The destroying of hundreds of varieties of plant life growing over large areas, the replacing of these with a selected few, and the increasing of their productiveness to the greatest extent constitute agriculture itself, and though

GRANDFATHER

Grandfather says he never had his crops destroyed by these new fangled bugs and insects.

There are a number of present day problems confronting the agriculturist that "Grandfather" did not have to contend with. Old ideas and methods do not fit in with present day farming.

by such a practice our agriculturalists are practically feeding the civilized world, it is nevertheless directly contrary to the natural order of things.

Insects outnumber all other forms of animal life inhabiting the earth. If the entire insect population of a single acre of farm land could be brought together and carefully examined, hundreds of different kinds would be found, some of them doubtless new to the naturalist, the great majority

unknown to the farmer, but all either directly or indirectly affecting the financial interests of the latter.

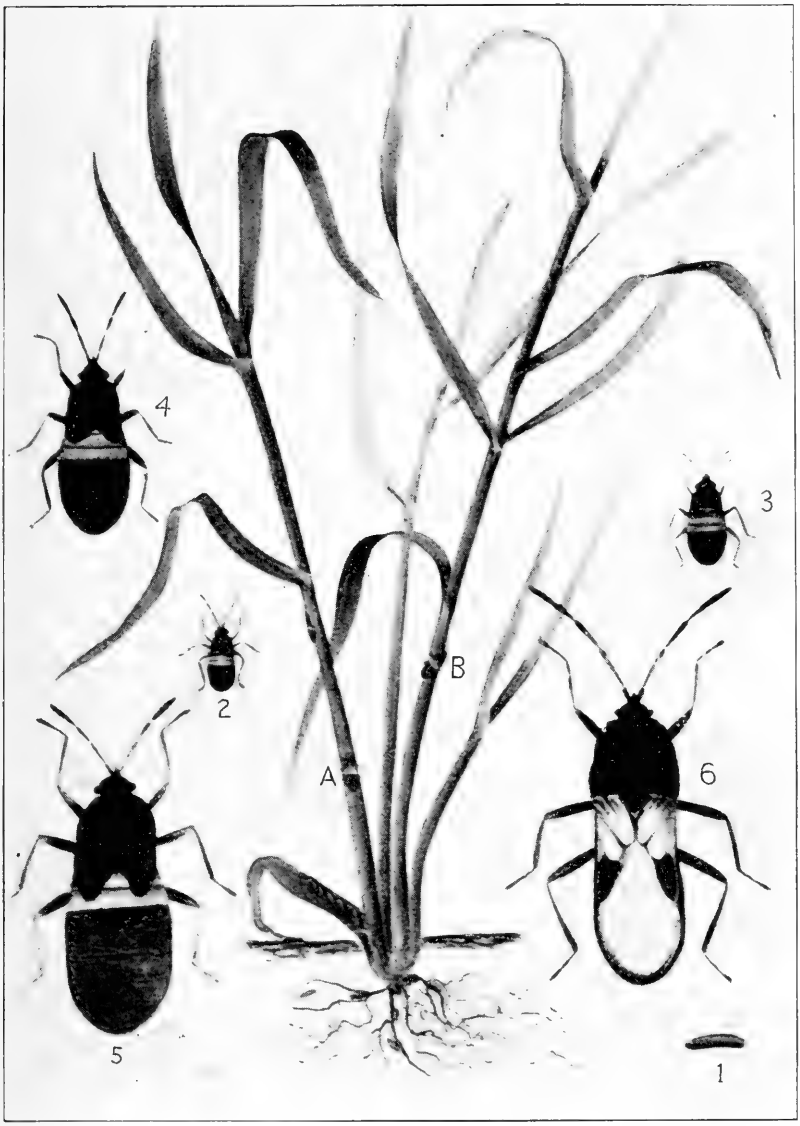
A surprisingly small percentage of insects infesting the various fields are injurious to the crops. A great many of them prey upon other species of insect life, and the small damage they cause to the grains and grasses is more than compensated for by their habit of devouring the really destructive varieties.

The annual recurrence of many destructive insects is prevented by the activities of their enemies, and these with unfavorable weather conditions hold the devastating attacks in check; otherwise their yearly toll would be much greater. Climatic conditions, however, affect both friend and foe, and many outbreaks of the depredations of insects are doubtless due, not to conditions especially favorable to the pests, but to those fatal to their natural enemies. Unhindered by these, the noxious species develop rapidly and in destroying numbers.

The farmer himself knows little regarding the habits of any of these insects, despite the fact that he may have spent the greater part of his life in their midst and sustained greater or less annual loss by reason of their ravages. While the modern husbandman has greatly increased his information on many phases of agriculture, he has gained very little material knowledge of the insects, both helpful and harmful, which inhabit his lands. Indeed, the modern farmer who plants his grain with a drill, harvests it with a self-binder, and threshes it with a twentieth-century outfit probably knows little if any more of these insects than did his grandfather, who a century ago sowed his grain broadcast, reaped it with a cradle, and threshed it with a flail. Inconsistent as it may appear, few farmers have any acquaintance with the insects that variously destroy from 5 to 95 per cent of their crops each year.

Chinch Bug

Although at times the chinch bugs are numerous and wreak destruction over large areas of the grain-farming regions, the appearances of this insect in numbers sufficient to attract attention are often separated by intervals of several years, and many farmers consequently do not know it at sight.



THE CHINCH BUG.

1, Larva; 2, 3, 4, 5, and 6, various sizes, enlarged.
A and B. Showing bugs on stalks.

When fully grown it is readily distinguished from other insects of a region by its size and form and by the peculiar distribution of the white on its back. If one looks at the insect from above, its outline appears as an elongated

oval with rather straight sides and broadly rounded ends. Its length is three-twentieths of an inch or a little less, and its breadth about a fourth as much. The head and front parts are black, and all the surface is minutely hairy except that of the wings. The wing-covers, which conceal the abdomen, are milk-white, with a triangular black shield between them in front and a black blotch at about the middle of each side. These invasions of the white area give it roughly the form of the letter **X**, and this cross-mark of white on the back is the characteristic mark of the species. In winged specimens which have recently changed by molting from the preceding stage, the black mentioned in the foregoing description is represented by a dull pink, the wing-covers, however, being wholly white, with pinkish veins.

The chinch bug molts four times after hatching and changes its appearance materially with each molting. There are thus five distinguishable stages, the first three of which together are often called the red stage of the insect.

In the first of the red stages the young chinch bug is pale red throughout, with a band of yellowish color across the base of the abdomen.

In the second stage the red of the head and the breast changes to a dusky tint, and the abdomen becomes a bright vermilion, with a pale yellow band across its base and with faint dusky patches on its rear segments.

In the third stage small rounded pads appear just back of the front legs, projecting backward in the place of the future wings. About one-half of the body is wholly black or dusky, and the abdomen is a dusky red with a patch of darker red near the middle, the light band across its base still remaining, although partly concealed by the wing-pads at its ends.

In the fourth stage the original red color has wholly disappeared, the general tint varying from dusky gray behind to black in front, with a remnant of the pale band across the base of the abdomen showing behind the much-enlarged wing-pads.

The egg is a very slender oval, about .03 inch in length, rather narrowly rounded at one end, and slightly docked or squared at the other.

There is probably never a year in which the chinch bug

does not injure grass or some cereal in various parts of the territory it infests. It is, however, subject to extremely wide fluctuations in number, becoming at irregular intervals a pest of such frightful character as to appall the agriculturist and reduce whole districts to temporary poverty. It has, indeed, modified in important ways the agriculture of large sections of our country, leading to the permanent abandonment of small grain culture in many counties and forcing the use of leguminous forage plants and at times even a substitution of orchard culture for the raising of grain and grass.

There is no very definite regularity in the recurrence of its periods of greatest destruction. These are, however, clearly dependent on the periodicity of the weather, injury by the chinch bug reaching its maximum after several dry years, and being suspended by the occurrence of two or three wet years in succession. The chinch bug period is, however, less definite and tangible than the weather period, since not every change in the weather is followed by a notable corresponding change in the chinch bug situation. The rise and the fall of a wave of chinch bug abundance occupy unequal periods of time, the period of annual increase being longer than the period of decline. Three or four or even five years of notable injury to crops may succeed one another, each worse than the preceding, before the maximum is reached, and then, within a year or two, hordes of these insects which may seem to have taken permanent possession of the fields and meadows over an immense district may disappear so completely that it will be difficult to find even a few living specimens.

The chinch bug inflicts injury by sucking the sap from the plants. Being without jaws for biting, it can appropriate only fluid food by piercing the tissues of its food plant with the hair-like stylets of its beak and then sucking out the sap from the lacerated cells. Owing to its immense numbers, it may so rapidly drain a strong and thrifty plant that this will wither and fall to the ground as if cut off at the root.

The points of special economic interest in the life-history of the chinch bug are the stage and place of its hibernation and the method of its escape from fields of wheat and other grains at harvest time. The bug passes the win-

WINTER QUARTERS OF THE CHINCH BUG

Clumps of red sedge grass in which over 6,000 chinch bugs were found hibernating during the winter.

ter as a full-grown winged insect among the roots of tufted grasses, under stones on grassy knolls, under leaves, sticks, logs, and bark, in thickets and the borders of woods, beneath the rails and boards of fences, and in similar sheltered situations. From these winter quarters it emerges in spring, the exact time varying according to the weather, flies freely about in every direction and to considerable distances, settles generally in fields of small grain, the young growth of which affords it an abundant and attractive food, and deposits its eggs there on the ground about the base of the plant, on the roots a little under the surface, or sometimes on the lower part of the plant above the ground.

At harvest time the young of the new generation are in various stages of development, owing to the fact that the eggs are laid at intervals during a period of about a month. There are at harvest some winged bugs in the field, but the great majority of them are of ages varying from those just hatched up to the stage preceding the last molt. Forced out from these fields of small grain by the ripening of the plants and the consequent pressure of starvation, they enter fields adjoining in a continuous throng, making their migration almost wholly on foot. They thus concentrate in overwhelming numbers on the plants at the borders of the newly entered field, draining and killing everything as they go.

When the majority of the brood have acquired wings, flights of the adults occur, resulting in their dispersal through the field. The eggs for a second generation are laid most commonly in cornfields, particularly on roots of grasslike weeds growing among the corn. This second generation of the year reaches the winged stage late in August and early in September and leaves the fields in search of winter quarters from the middle of the latter month to about the middle of October.

It should be noted, however, that none of these movements are made simultaneously by all the chinch bugs of a locality. Even the migration from the winter quarters is a gradual one, and in some cases the chinch bugs have not all placed themselves for the laying of their eggs before the oats are sown, or even by the time the corn is planted. These crops are therefore likely to become somewhat infested in spring by the first generation of the year, even

though there may also be an abundance of other plant life growing at the time.

If the weather is very dry at harvest, and especially if drouth and the abundance of the bugs have combined to kill both grain and grasslike weeds by harvest time, chinch bugs will desert such fields almost as fast as they can get out of them. If, on the other hand, the grain ripens gradually and normally and the stubble is left with green weeds interspersed, the bugs are likely to linger for days and even for weeks before the harvested field is completely free of them.

The chinch bug injures all the grasses and cereal crops, but is strictly limited for food to plants belonging to the grass family and to certain wild sedges. It is most destructive to barley, although it is likely to damage oats very severely. It infests the meadow and pasture grasses generally, and may destroy them as completely as it does any other crop; but owing to their perennial growth they afford in spring much less fresh and succulent herbage than the young and delicate plants of the grain fields. The chinch bug never injures clover, cowpeas, or any forage crop which would not commonly be recognized as grass; neither does it injure potatoes, beans, or fruiting plants of any kind.

The chinch bug is subject to the attack of various predaceous insects and vertebrate enemies. Of the former the ladybugs furnish a good example, and of the latter certain birds, especially the quail, may be mentioned. But these enemies are insignificant so far as concerns their effects upon the numbers of the bugs, when compared with certain fungous or bacterial diseases to which these pests are liable. These diseases sweep them off by the million, and are usually the most potent factor in checking their outbreaks.

Cutworm

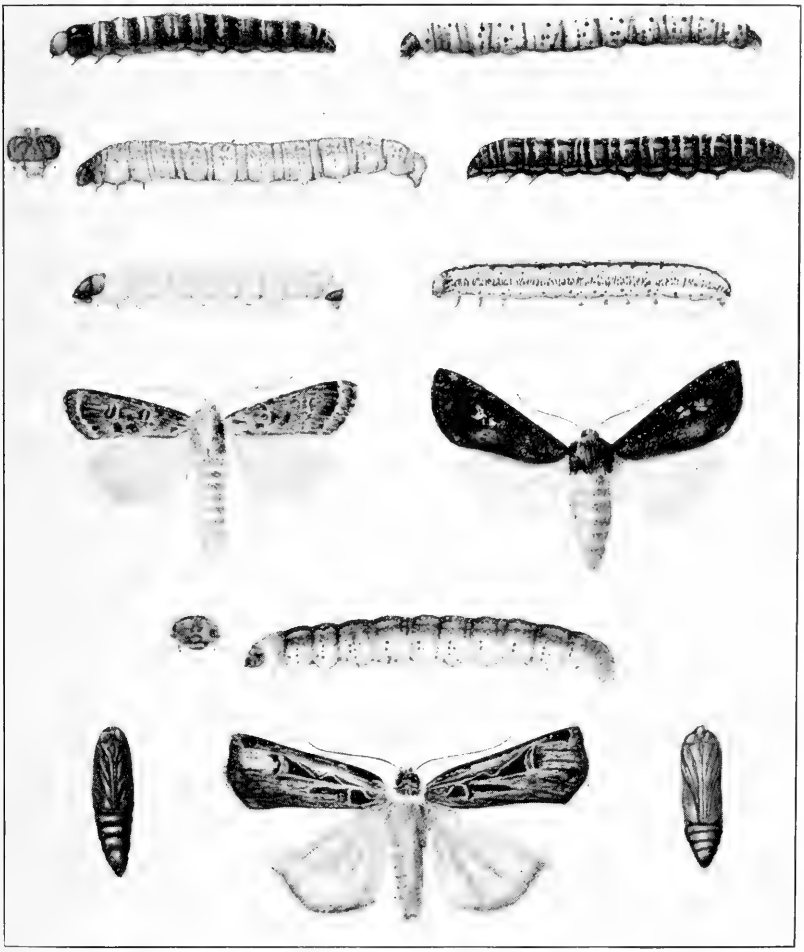
There are thirteen prominent species of cutworms, as follows: (1) the glassy cutworm, (2) the greasy cutworm, (3) the variegated cutworm, (4) the spotted cutworm, (5) the western striped cutworm, (6) the clay-backed cutworm, (7) the bronze cutworm, (8) the W-marked cutworm, (9) the granulated cutworm, (10) the dark-sided cutworm, (11) the common striped cutworm, (12) the red-backed cutworm, (13) the bristly cutworm.

As their name implies, the injury caused by their attack

consists of cutting the plants apart either just below or above the surface of the ground, causing in either instance total destruction.

The species vary in color and size, their average length being about $1\frac{1}{2}$ inches.

Cutworms are either single or double-brooded. Usually



SPECIES OF THE CUTWORM, MOTHS AND PUPA

the eggs are laid in the latter part of the season, ordinarily after August 1, and hatch before cold weather, the larvae making their destructive attack in the latitude of central Kansas the following May and first half of June. They

change to the pupa stage in June or early July. These dates vary according to the latitude, being earlier in the South and later in the North.

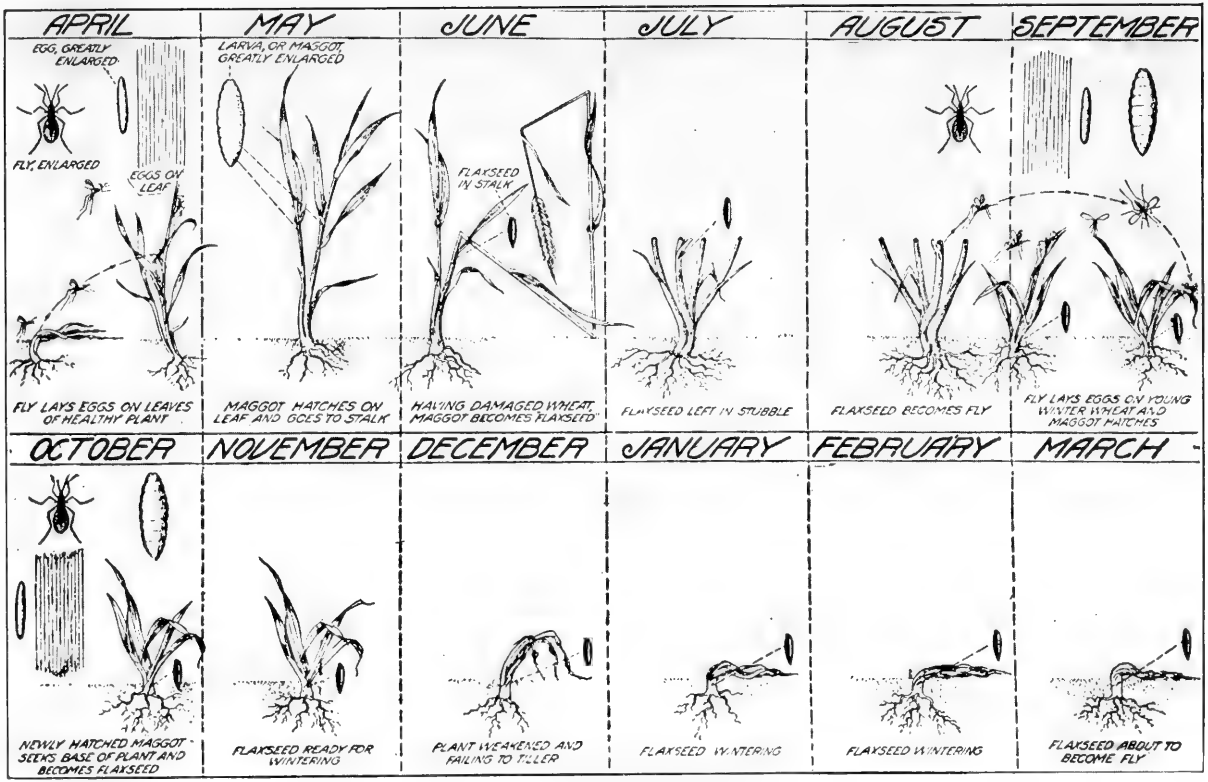
Cutworms attack every kind of farm and garden crop, young trees, shrubbery, and weeds, causing a more general damage to plant life than injuries caused by all other insects combined. They destroy an average of 2 per cent of all cereal crops grown in this country annually.

The Hessian Fly

Pull up a few hills of grain and strip the outside leaves down to the crown. If a brownish-colored object about the size of a grain of flaxseed is noticed near the base of the leaf and in or near the main stalk, then it is infested with the Hessian fly. This method of identifying the fly may be followed from the latter part of October until the middle of March, but cannot be employed either in the early fall after wheat-sowing or in April and May and part of June, because the fly is then in the worm stage. It is in the worm stage, which is also known as the larva or maggot stage, that the insect does its damage. After the fly develops past the worm stage it changes to the flaxseed stage and remains hidden in one place because it can neither eat nor move about. Furthermore, it is tough and hardy in this stage. It cannot be drowned, frozen, starved, or trampled to death in the field.

In the early spring the "fly" emerges from the pupa, which is commonly known as the flaxseed stage. This fly crawls out of the ground, using the straw as a ladder, and soon lays pinkish-colored eggs on top of the leaves near the sheath. Each female lays about seventy-five eggs. While she is heavy with eggs she will not fly far, but when her body is lighter she may visit and lay eggs in fields some distance from the place where she originates.

In the early-sown grain the worms may be so thick as to kill the young plants entirely, or they may be only thick enough to kill the main stalk. In either case the leaves turn yellow and die, but in the latter case a second growth occurs, which is composed of tillers. These have broader and deeper green leaves than the non-infested plants, and consequently look healthier, although the flaxseed may be

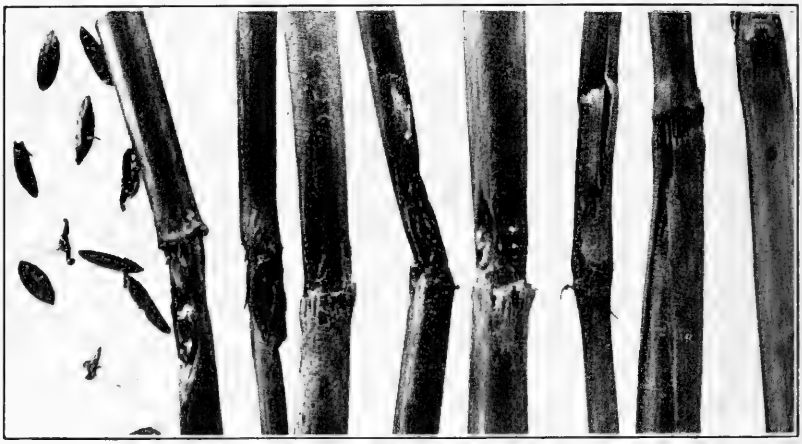


THE LIFE OF THE HESSIAN FLY

at the crown of the plant in the dead stalk which first came through the soil.

Rye and barley are among the main foods of the Hessian fly. Although oats are closely allied in appearance to these plants, they have not been damaged and seem to be free from severe infestation.

Plants are affected both directly and indirectly. They are directly affected because the maggots frequently take



DAMAGE BY THE HESSIAN FLY

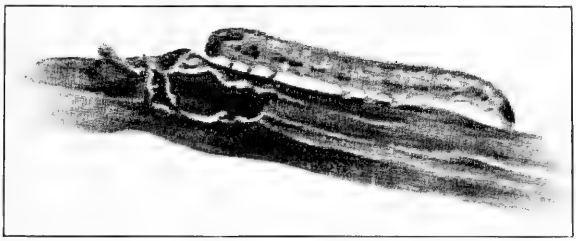
Straws in this condition do not require a hailstorm to break them down; a light wind is all that is necessary.

so much nutriment from plants that these die. Again, plants are so weakened by the presence of maggots that less grain is produced. The grain yield is indirectly affected because weakened plants bend or break at the joints at harvest, and consequently fall over. Lodging of grain always accompanies injury by the Hessian fly.

The Small Stalk Borer

The presence of the small stalk borer in a young stalk of grain is very clearly indicated by the wilting, breaking down and death of the top, and by the presence of a round hole in the side of the stalk. It infests a great variety of plants. In its early stages it is of small size and finds sufficient food within the grass stem, later moving into the small grains. The furrow which the stalk borer makes within the stem runs upward from the entrance opening and of course, varies in size with the growth of the larva.

Sometimes in leaving a stalk it makes a new hole above that by which it entered and in this way may injure in succession several different stalks and various kinds of plants. It is practically indifferent as to the kind of plants to feed upon, the only necessary condition being a relatively thick stem, soft enough to allow it to enter and feed freely within. In the small grains and larger grasses, like oats, barley and rye, it makes its presence manifest by killing or even cutting off the stem within, thus causing the head and the



THE SMALL STALK BORER.

whole plant above the injury to turn white and eventually to dry up. It is only one of several insects which produce this general effect but its injury may be at once distinguished by the round hole which it leaves in the stem of the infested plant.

It is found throughout the United States and Canada, east of the Rocky Mountains.

A more complete description of the small stalk borer is given in the article relative to this insect under the heading of wheat.

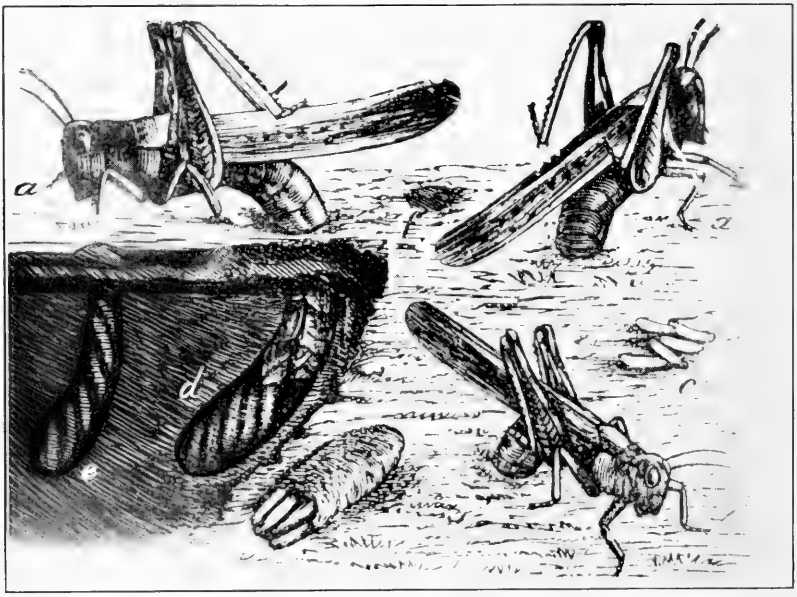
Grasshoppers

There are five species of the grasshopper family: (1) the red-legged grasshopper, (2) the lesser grasshopper, (3) the Rocky Mountain grasshopper, (4) the olive grasshopper, (5) the two-striped grasshopper.

Although they differ in size and color, grasshoppers are alike in their depredations on plant life. They eat anything and everything that grows from the ground. Their preference is for the best, but when the choice plants are devoured others are attacked. The more numerous the grasshoppers, the farther down the list of plant life do

they go, even eating wild grasses and weeds when the supply of cereals is exhausted.

Injury to plant life is similar to the damage done by



ROCKY MOUNTAIN GRASSHOPPER

the army worms. Grasshoppers devour as much of the plant as their appetite calls for.

Army Worm

The army worm hatches from eggs laid by the common night-flying moths or "millers." They are yellowish brown in color, with a white speck near the middle of each fore-wing. They usually travel and do their injury to plants at night.

Army worms are present every year and are among our most numerous native insects.

Feeding ordinarily upon grasses, they prefer these and grasslike grains, even on their desperate marches. They seem to eat with almost equal relish bluegrass, timothy, wheat, oats, corn, rye, and barley, and will likewise readily take sorghum, Hungarian grass, millet, and flax. They are also fond of sweets.

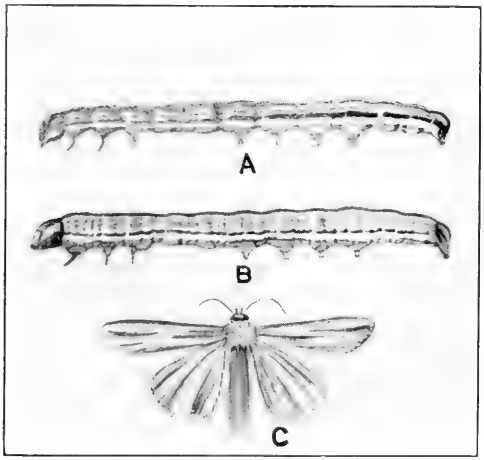
THE ARMY WORM, WITH PUPAE, MOTH, AND EGG

Wheat-Head Army Worm

This caterpillar differs from the common army worm especially in its peculiar preference for the heads and seeds of grasses and small grains. It is often seriously injurious to these crops.

It may be easily distinguished from the army worm, which it closely resembles, by its more slender form and larger head, by the straight dark bands on each side the middle of the head, and by the narrow brown and yellowish lines on the sides of the body.

The life history of the wheat-head army worm is well defined. The species winters in the pupa stage, and the



THE WHEAT-HEAD ARMY WORM

A, *B*, the worm enlarged; *C*, moth of the same.

moths come out in May, being usually most abundant about the middle of that month. Eggs are soon laid and hatch in three to five days. The caterpillars attain their growth in three or four weeks, which brings them to full size in July. The pupa stage is ten to fifteen days in length, moths emerging from late July to August and laying eggs for the second brood of larvae, which come out in September and pupate before winter sets in.

The principal damage the wheat-head army worm does is to wheat, barley, oats, rye, and timothy, the leaves of which are eaten by the young larvae, while the older caterpillars eat the heads when the grain is in the milk.

Grassworm or Fall Army Worm

This caterpillar, occasionally very destructive, appears so infrequently in threatening numbers as to be virtually unknown at each of its appearances to ordinary observers of insect life. As it lives continuously in the South, its appearance in the northern states is due to the spring and early summer migration of the parent moth.

The caterpillar is about 1½ inches in length, black and gray in color, with three narrow white lines the entire length of its back. The head is black, with a white Λ-shaped mark on the face. The insect resembles the common army worm and the corn earworm both in habits and in appearance. From the earworm it is readily distinguished by its smooth skin, the skin of the former being roughly granulate, and from both it may be told at once by the white face mark, which is present in neither of the other species.

Its preference for barley, oats, and rye is so strong that it will eat these grains out from other cultivated crops and weed plants, seldom if ever molesting the latter.

The caterpillars are cannibalistic by nature, eating each other freely, not only when confined together, but in the open field when they become abundant.

The worm's method of attack is to crawl to a spot midway between the ground and the top of the plant, cut the stalk in two, and eat downward on the stub.

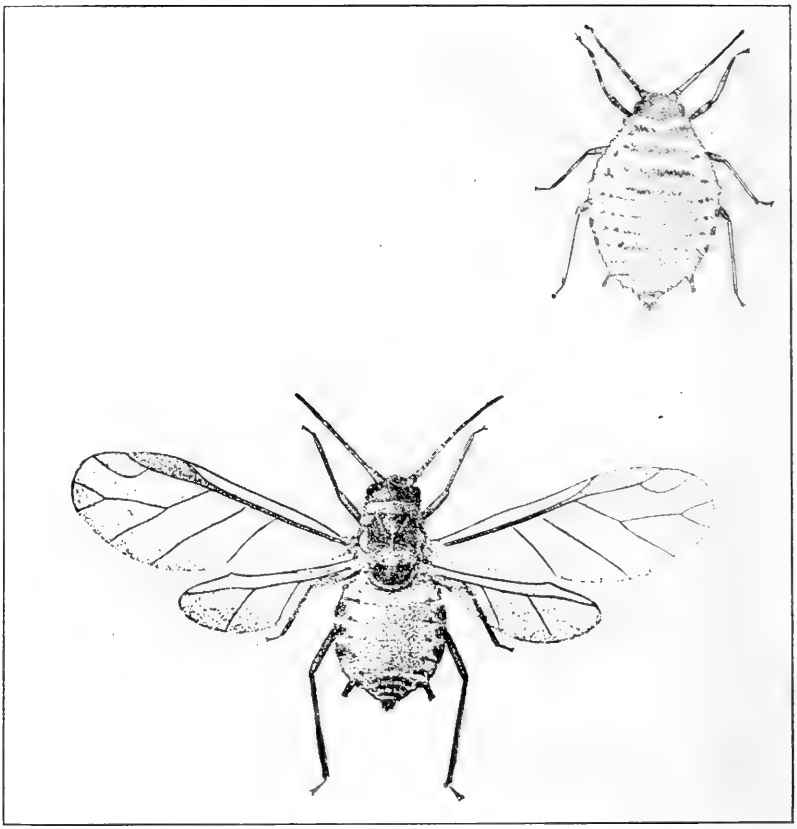
Corn-Leaf Louse

This insect injures corn and sorghum, but prefers barley as its chief food.

It is about 1/100 of an inch long and half as wide, the body being ovate in shape. Its general color is pale green, with black legs.

The insect has a short beak with which it punctures the leaves and stems of barley, eating the sap for food. These punctures become discolored, owing to a bacterial infection following the insect injury, causing the stems to decay and break over.

The corn-leaf louse is nurtured by the common field



CORN LOUSE.
(Greatly enlarged)
It prefers barley to corn

ants during the winter and is of infrequent occurrence in devastating numbers, owing probably to its many enemies by which it is held in check.

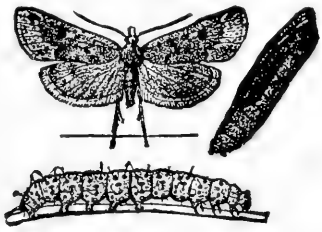
Sod Web-Worms

These caterpillars are about 1½ inches long when full grown, pinkish red or brown in color, and covered with rows of smooth dark spots, from the center of which grows a coarse hair. When disturbed, they make efforts to escape, being extremely active.

The injury done is similar to that inflicted by cut-worms, but always underground. Rarely are the stems completely severed until the whole plant is eaten up. The

first injury is done by the caterpillar gnawing the outer surface beneath the ground and about the roots. Then the caterpillar works upward, eating a furrow lengthwise along the center of the stem. The leaves are also eaten, the lower ones first. Then the tips are eaten off, or irregular elongate holes are eaten through the blades.

Sod web-worms injure the plant at night. Search must be made for them by day by digging around the affected



VARIOUS STAGES OF THE WEB WORM.

hills. The web-worms will be found just below the surface, each in a retreat formed by webbing together a mass of dirt, cylindrical in shape.

The damage they do is generally attributed to other causes, as the larvae live a retired life below the surface, eating at night and remaining in their nests during the day, hence they are rarely seen. Their average toll in an infested field is about one stalk in ten, and the damage is kept up throughout the entire growing season.

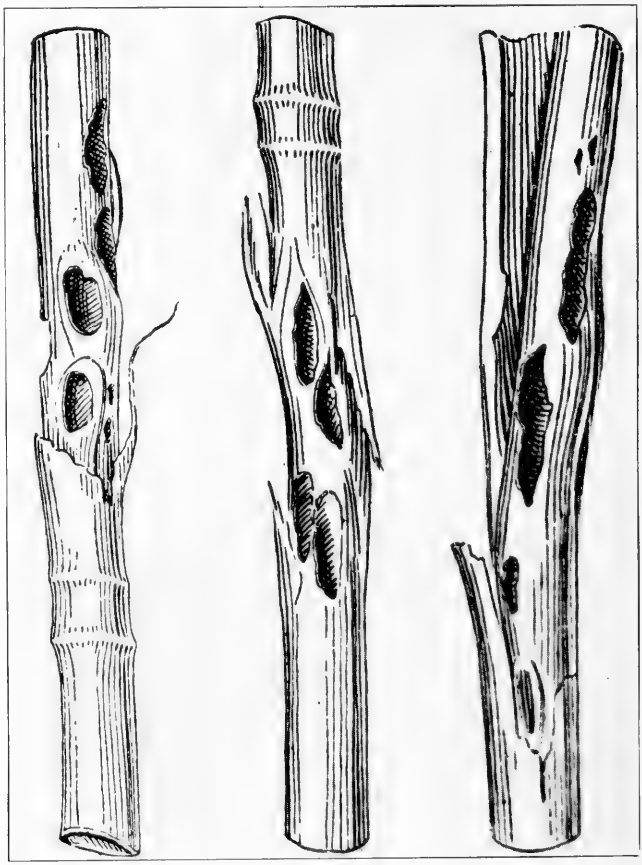
The Straw Worm or Joint Worm

There are two generations of this insect annually, both of which are destructive. To the observer the adults look like shining black ants, some with, others without, wings; their legs are banded with yellow and they have red eyes. They are about ⅛ of an inch long, most of them being females and wingless. These females of the first generation deposit their eggs in young wheat plants when the stems of the plants extend but little above the surface of the ground.

The egg is placed in or just below the wheat head, and the larva, or worm, works within the stem, usually causing a slight enlargement. When the worm is fully grown it will be found in the crown of the plant, having eaten out and totally destroyed the embryonic head, its body occupy-

ing the cavity thus formed. The larva, or worm, is of a very light straw color, almost white, with brown jaws. In May, June, or July (depending on location) the larvae become full grown and pass at once through a short pupal stage. The pupae are at first the same color as the larvae, later changing to a jet black.

In a few days the fully developed insect gnaws a circular hole through the stems and makes its way out, and



STRAWS INJURED BY STRAW WORM

this second adult deposits its eggs, usually in the second joint below the head. The larvae from these eggs are the ones found in the plant and can be located in the straw always below the upper joint, generally above or below the second joint.

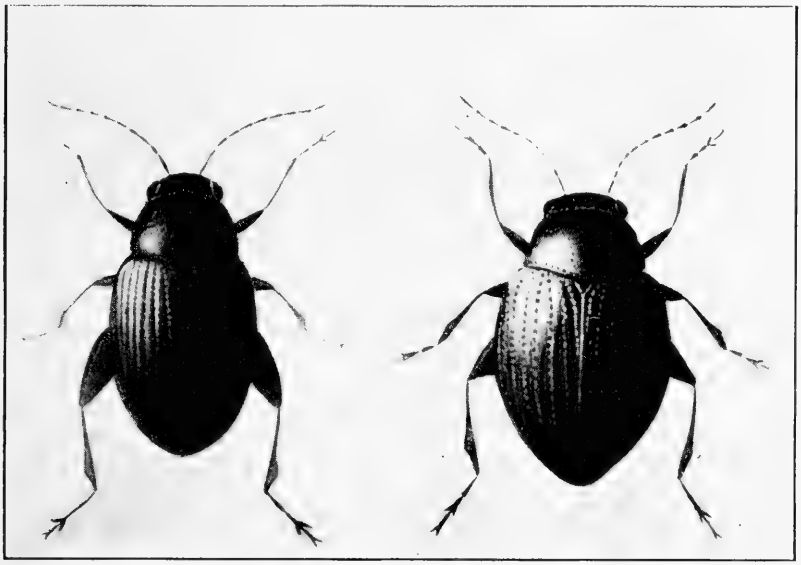
Both the work of the spring brood in fall rye and that of the summer brood in spring crops are so carried on that the planter does not know his loss unless it amounts to a very large percentage of the crop, and then he may attribute it to some other cause.

Generally the injury is not noticed until about harvest time, when the stalks often begin to break over and many white heads appear in the field. This condition very closely resembles that of Hessian fly loss and is often confused therewith.

The straw worm is closely related to the joint worm, and as their appearance, history, and life cycle and depredations are so nearly identical, they are usually considered as synonymous.

Flea Beetles

Of the several species of the beetle family, but one has been found that seriously injures small grain. This is known as the flea beetle. It is about one-tenth of an inch



THE FLEA BEETLE.

(Greatly enlarged)

Sometimes called the corn flea beetle. The injury it does in the Middle West is confined largely to the small grains, although it often bears the name of "corn flea beetle."

long, oval, and plain brown. It feeds principally on grass and grain, but has done some serious injury to corn and has also damaged sugar-beets. Wheat and oats are its principal foods.

The species is generally distributed over the United States east of the Rocky Mountains, and is also reported from Montana, Utah, and California. The beetles do not eat holes in the leaves of the grain; they simply gnaw out the tissues from beneath, leaving the veins and upper surface untouched. The greatest damage they do is the severe injury to barley, the leaves of which they eat out in narrow channels. The larva breeds upon the roots of the plant. The worst injuries are done on low lands and near the winter shelters of the beetles. The beetles winter over and are abundant in May, when they pair. They generally lay their eggs by the first of July, but a new brood comes out in the latter part of the month, becoming abundant in August and continuing until the close of the season. The injury done to small grain is principally in early summer, shortly after the beetles come out of their winter quarters.

PART TWO

DISEASES

A crop-grower, through lack of information as to what plant diseases are, often suffers much damage from them, entirely unaware of the fact that his crop is affected by disease. For instance, smut to the extent of 15 or even 40 per cent is sometimes entirely overlooked by an otherwise observant man. Even when it is called to his attention, the average farmer is inclined to underestimate its ravages. His attitude of wilful disbelief in the prevalence of a disease prevents his taking proper action to eradicate or curb its activities.

That there are many such devastating agencies at work in the soil, the seed, and on weeds adjacent to fields is all too frequently unknown or their insidious workings underestimated. These agencies are identified as rust, mold, smut, blister, blight, scab, mildew, and soil- and seed-sick conditions and other forms whose workings are not so readily recognizable or so manifestly destroying.

The occurrence and prevalence of disease conditions is remediable and can be avoided by various "better farming" practices which are discussed later in this article.

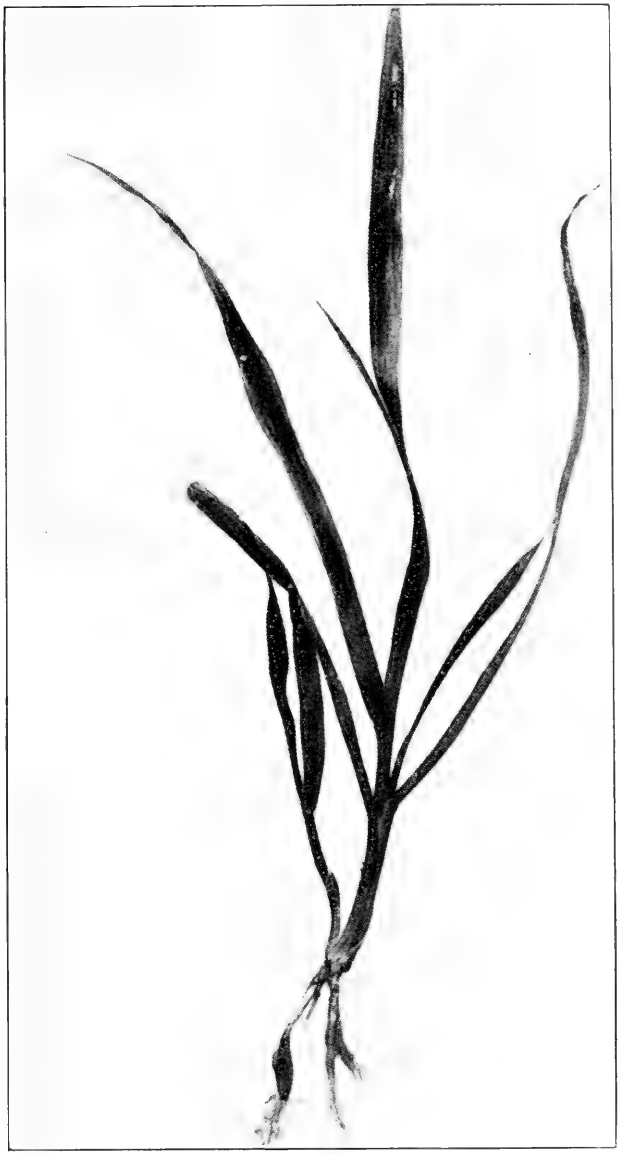
Losses Due to Soil and Seed Sickness

Fungus infestation of the soil and seed, much as wheat sickness, is frequently encountered in barley, oats, and rye.

This soil-sick condition is the result of constant cropping of grains liable to attack by the various minute fungi that infest the plants from the roots even to the mature grain, by which the condition is spread to fields not before inoculated. These minute organisms live through the winter on the stubble, in the seed, or in stable manures; they may attack the roots of the grain, causing a malformed root system, a tendency to re-root above ground, a lack of stooling, a deformity of the joints, or a sapping of vitality from the straw so that it falls over. They may become manifest in a yellowing or tip-burned leaf, in the lack of filling of the heads, or in the production of miscolored and misformed grains. Their presence is indicated by the ashy

CRINKLE-JOINT

Crinkle-joint or break-over disease is not an insect trouble, as many growers have believed, but a fungus infection associated with weather conditions.



THE BROWN BLADE BLIGHT OF OATS

The early results of this infection is a yellowing extending to the tips of the leaves; if a day or so of hot weather follows this yellowing, the leaves will quickly assume a brown color which is typical of the blight and results in an almost total collapse of the infected leaves.

color of the straw, the blackening of root system, and the generally unhealthy condition of the field, parts of which may "crumple over" while grain of the same day's seeding, growing adjacent, remains standing and is evidently in good condition.

The infection is transmitted from field to field by wind, by washings of soil, and by the planting of infected seed. Selection and disinfection of seed and proper rotation of crops will lessen its effects.

These losses most frequently resemble those caused by hail, and the greatest care must be taken to differentiate correctly between the two.

The losses may become evident at any time and are often referred to by various names. A few of the most familiar forms are here described under the names most frequently applied to these better known forms of soil or seed sickness.

Barley Leaf Blotch

Barley leaf blotch is the cause of spots and perforations in the leaves of barley, and when present in quantity on both leaves and stems it stunts the plant and causes a poor yield. It is perhaps the most frequently encountered of all fungous parasites and has been found on both wild and cultivated plants. It appears in the form of pale-green, translucent spots on the leaves, which finally become perforations and increase in size, often to a considerable extent, and manifest the characteristics of having been eaten by an insect. The injury inflicted also has an appearance similar to hail damage.

It is entirely possible that 90 per cent of the perforations with ragged outlines so frequently met with on otherwise vigorous foliage are caused by this fungus.

Red Mold

This disease attacks the grain of oats, rye, and barley and various grasses and occurs in all parts of the United States. Grain attacked by this fungus is rendered useless for marketing. The grain affected becomes swollen, and orange, crimson, or dull deep-red specks form on the surface of the kernel. Sometimes the entire head is more or less covered with the red mass, which is quite gelatinous when wet.

Scab

Scab seems to be generally distributed in America and is often the cause of considerable loss. Under conditions favorable to the disease the loss may be as high as 20 per cent. It appears only upon the heads, when these are about half ripe, as yellow or pink incrustations on the spikelets, on the base of the chaff, or covering the stalk. The affected heads ripen prematurely and turn yellow. After ripening of the head, the diseased parts are shrunken. The grain itself is hollow, shriveled, covered with thick surface spores, and incapable of germination.

Only a few grains upon the head may be affected, these occupying any position, basal, terminal, or intermediate, or the whole head may be diseased. The loss occurs in injury to the quality of the grain and in a lessening in quantity.

Seedlings in the field are often killed by scab, which is carried over in the seed, and as high as 50 per cent loss has been caused to sprouting grain.

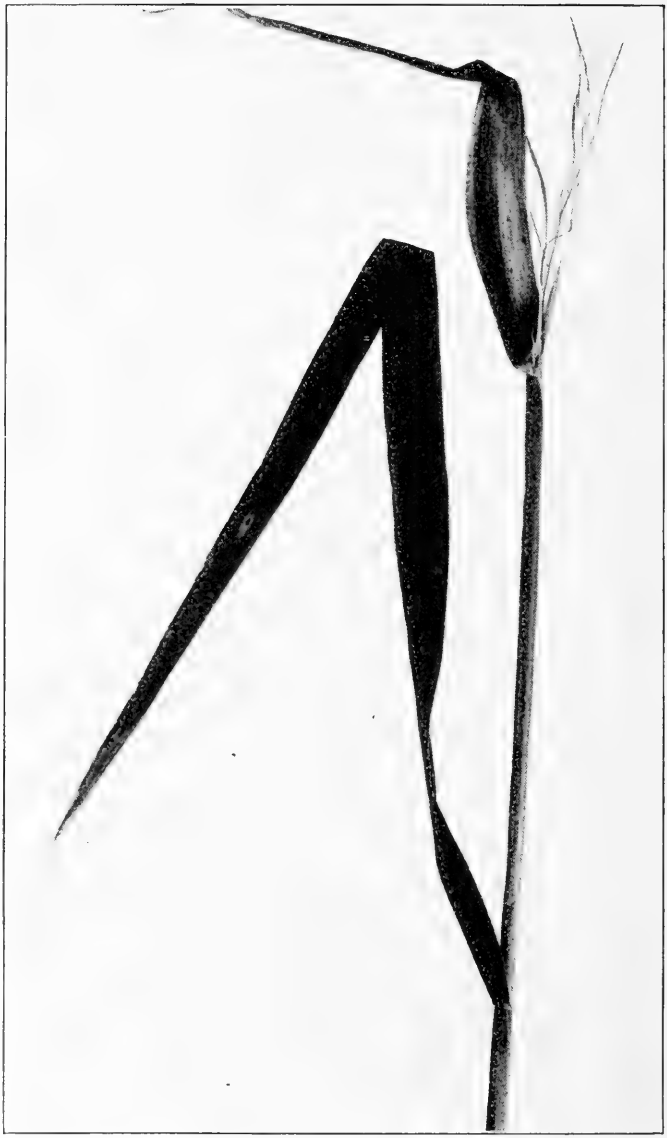
Powdery Mildew

The usual characteristics of the fungous infection commonly termed powdery mildew are exhibited by a whitish, flour-like coating in irregular circular spots upon the leaves and other plant parts. In damp shady places the mildew is often very injurious, although rarely over an extended area. There are various distinct kinds of mildew, the characteristics of which are indistinguishable to the eye. It is not believed that mildews are readily transferable from one plant to another. They are found upon barley, oats, and rye, often causing an ashy appearance on stalk and leaves, sometimes working into the plant until the stalk is blown over or breaks at the infected point.

Blight and Blast of Oats

The different manifestations of fungi in oats depend much upon the age of the plant and the part attacked. Observation in the fields has shown that among seedling plants but few become infected by way of the roots or that portion of the stem which is underground.

In plants beyond the seedling stage it is very common to find the yellowing portions following the stem and extending to the very tip of the leaves, sometimes affecting



OAT BLAST

Showing the "blast" of oats resulting from the bacterial blight disease. The flag leaf has completely collapsed, and the lesion has passed downward, attacking and blasting the head. Sometimes the sprouting head is completely killed before it emerges from the sheath. The small light spots on the lower leaf show the beginning of the blight.

only one side of the blade and again yellowing the middle or the whole of it. Just where these infections begin, it is sometimes difficult to tell. Often they are found beginning on the stalk, but more often they originate in the blade and work backward to the stem. There is no doubt, however, that the disease at times, starts in the roots or in that part of the stem in contact with the soil. In older plants it is usual to find the whole plant showing a general collapse of the foliage resulting from the disease working into the stem from an early infection of the lower leaves.

In many cases of this kind breaking over of the upper leaf tips may occur when bacteria are not present in them. They are, however, present in the lower leaves and lower stalks. The appearance of the disease is characterized by a primary yellowing of the blades, which later changes to a mottled red and brown. This latter coloring occurs as the leaves are dying. This stage, in extreme cases, gives the field the appearance of having suffered a severe attack of red rust.

Bacterial attack is one of the causes of blast in oats. The greatest loss to oats from the fungi is due to the injury to the blade. This causes a lowered vitality which induces blast. This injury results, as a rule, from primary infection through the sheaths and blades. A direct blasting of the heads is often due to the injured blades coming in contact with them.

This diseased condition is worse in certain localities than in others and varies even in fields but little affected. There is almost conclusive proof that the minute organisms causing blight and blast bring about a condition in the soil which is detrimental to the growing oat plant. Such areas may therefore be termed "oat sick."

Anthracnose

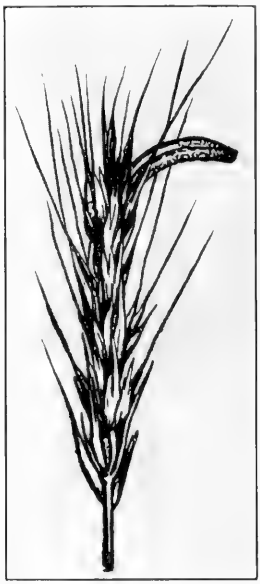
A serious disease of cereals and other grasses, chiefly affecting cotton, rye, and oats, was discovered within recent years. It is a destructive agent of very general distribution and is frequently found in many fields. It may inflict very serious damage. In one field it was estimated to have reduced the yield from 75 bushels to 25 bushels per acre, and it is assigned as the general cause of shriveling such as is often attributed to rust. The whitening and blighting

of plants preceding ripening may be credited to this infection. Upon the heads the disease resembles scab, with the difference that no rose-colored coating is present. Upon close examination black scales are found instead, and parts of the head above the point of attack die. Aside from a total loss to that portion of the head directly affected, the general decrease in vigor of the plant results in shriveled, light grains in the balance of the head. The black scales sometimes become so numerous as to cause a most noticeable blackening of the stalks and leaf sheaths.

Ergot

Ergot is widely known as a black or purplish body, several times larger than the seed of the affected plant, which displaces the grain.

This disease is caused by the attack of a fungus upon



SPIKE OF ERGOT ON RYE

the embryo while the plant is in bloom. The germ invades and consumes the forming grain and replaces it with the ergot, which consists of a mass of interwoven fungus. Under suitable conditions the mature ergot germinates, each organism sending forth several clusters with club-shaped knobbed tops. From these the spores issue to infect

susceptible plants in blossom at the time. For some days the fungus spreads from blossom to blossom by means of other spores, and each infected ovary results in another ergot.

Loss to the grain and damage to the plant are slight. Chief injury from ergot arises from its effect upon the cattle which eat ergotized grain or graze upon badly infected grasses. The disease occurs commonly upon rye and wheat and upon many other species of grass, such as wheat grass, wild rye, blue-joint, Kentucky bluegrass, Canada bluegrass, red-top, timothy, and rye grass. Barley is sometimes affected by ergot in the same manner as rye.

Ergot is easily identified by the greatly enlarged and changed appearance of the grain, which resembles a horn or spur. This condition is thus most often called horned or spurred rye, and these names are more frequently encountered than is the more proper one of ergot.

Loose Smut of Oats

Under the name "smut," "blackheads," etc., loose smut is known wherever oats are grown. Grain and more or less of the chaff are replaced by a powdery black mass which shatters out as it ripens, leaving later only the naked branches of the spikelets.

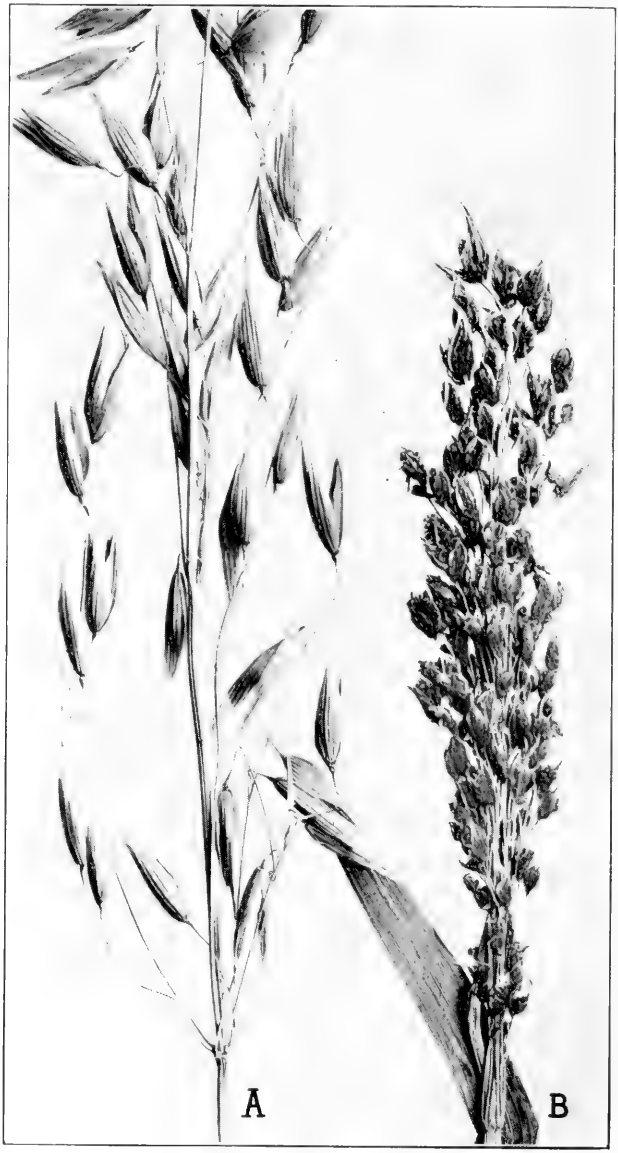
Usually all the spikelets of a head and all the heads of the affected plant are smutted. There is considerable difference in the resistance offered by different varieties, but in view of the perfect protection afforded by proper treatment, this fact is of small significance.

The damage caused by smut is usually underrated. One count found the oat smut to constitute from 8 to 10 per cent of the ordinary crop. By actual count of nearly 11,000 heads the New York Agricultural College determined the average loss from smut to be 8 per cent. In some fields the loss was found to be as high as 20, 28, and even 30 per cent. The Kansas Agricultural College, counting smutted heads in that state, found different fields to have 8, 15, and 18 per cent of smut, while single portions of a field showed as high as 39 per cent.

The reasons for underestimation of the damage done by oat smut are the dwarfing of many of the affected plants, which thus are unnoticed by a casual glance over the field,

and the fact that many smutted heads remain invisible unless unrolled from their enveloping leaves.

Infection occurs only upon the very young oat plants, and they may be considered immune after the leaves have



HEADS OF OATS

A, a healthy head; *B*, head covered by loose smut.

COVERED SMUT

C, smut blown off; *B*, smut partly inclosed; *A*, smut entirely inclosed.

protruded ½ inch beyond the leaf sheath. The chief infection, therefore, comes from smut spores which are on the seeds when they are planted.

Covered Smut of Oats

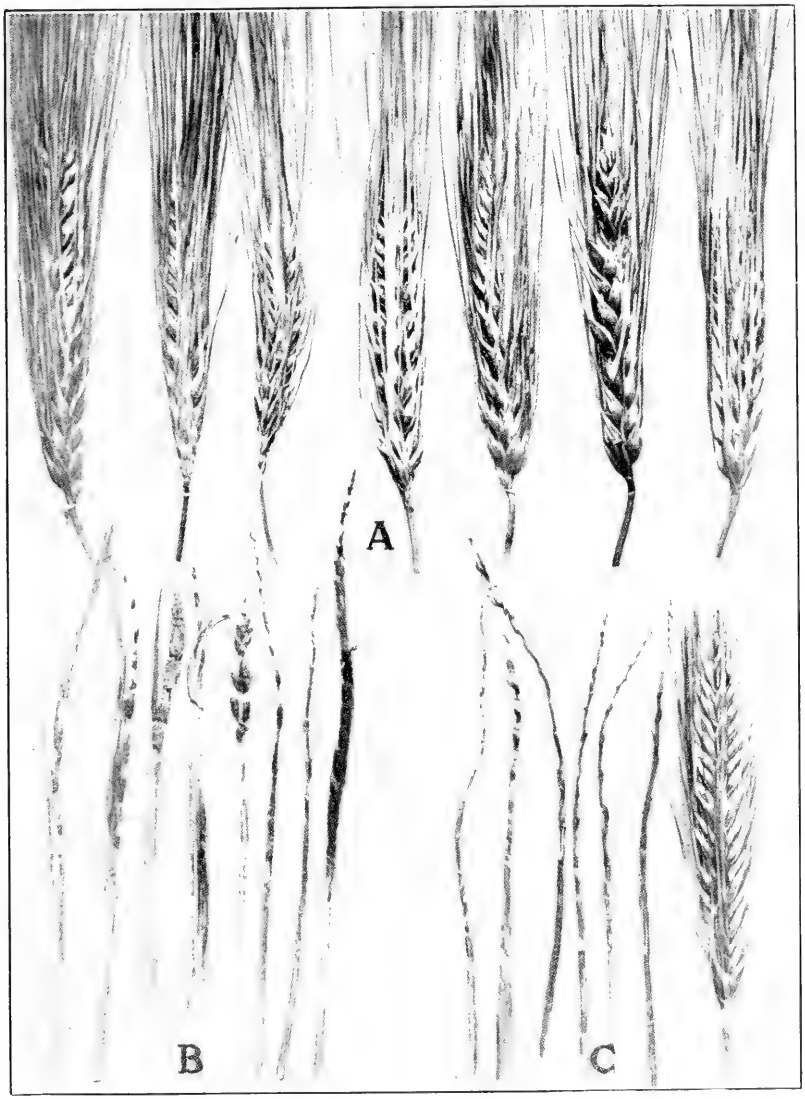
Covered smut differs from the loose smut in the less complete destruction of the flowers and in its less dusty spore-masses, which are also blacker than in loose smut.

SMUTS OF BARLEY

The loose smut of barley, showing the various stages in the development of a smutted head.

Loose Smut of Barley

This disease was considered, up to a few years ago, to be insignificant. Lately it has assumed importance, and is now blamed for an annual loss of from 5 to 10 per cent of



SMUTS OF BARLEY

The loose smut of barley: *A*, heads from a sound plant; *C*, a smutted plant; *B*, a partially smutted plant.

our barley crop. It is present to some extent in most fields of this country, though often unnoticed on account of the early season of its development and its absence at harvest time. Every spikelet of the barley head is usually affected, and adjacent leaves are occasionally smutted.

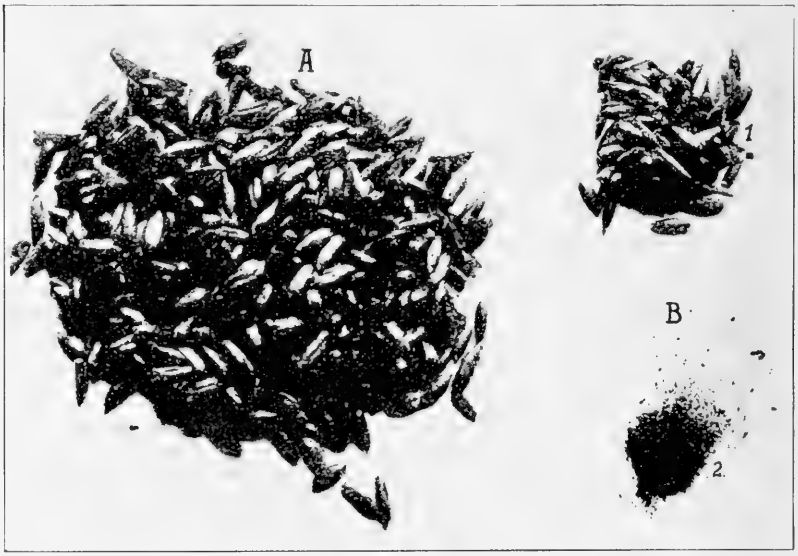
The smut-masses, when they first appear, are covered by a white or gray membrane which soon breaks, and the powdery mass of spores blows away. This character enables us to distinguish loose smut from the covered smut.

The smutted plants head early, the disease reaching its maximum at flowering time. The wind blows the spores from the diseased heads to blossoms on surrounding plants, and the fungus, reaching these, gains a foothold. In this way the smut is spread over the entire field.

The life history of this smut is similar to that of the loose smut of wheat.

Covered Smut of Barley

In the covered smut the smut-masses occupying the place of the grains are at first covered by a membrane



COVERED SMUT OF BARLEY SHOWING ITS EFFECT ON KERNEL

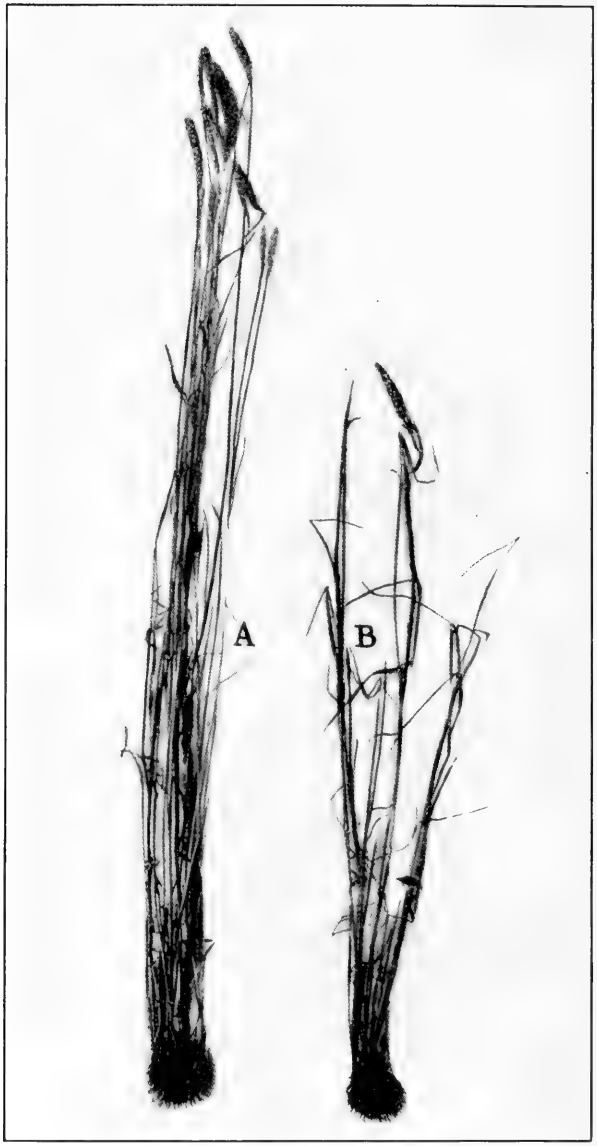
A, kernels from a healthy plant. Weight 23.2 grams. *B*, (1) kernels from smutted plant. Weight 2.5 grams. (2) smut dust produced instead of kernels. Treatment of the seed will stop this waste.

composed of the outer husk of the barley. This membrane retains the spores for some time after harvest, and when broken reveals a very dark to purplish-black interior of smut-mass.

Rye Smut

Rye smut is caused by a fungus. It is variously known as stem smut, stalk smut, and stripe smut. All parts of the plant above ground may be affected. The smut appears on leaves, sheaths, or stems, first as long, narrow, parallel

SMUTTED HEADS AND STEMS OF RYE



RYE SMUT

Showing its effect on the plant: *A*, a healthy plant producing well-filled heads, grown from seed that was treated; *B*, a smutted plant one empty head produced; all others were destroyed by the smut. This seed was not treated.

lead-gray stripes. In the earlier stage the black or brownish-black smut dust is under the sheath of the plant; hence the color. Later the covering breaks, and the dark smut-masses are exposed. Smutted plants are usually stunted and misshapen, seldom producing normal heads. If heads are produced, they are almost always empty or are destroyed by the smut. As a rule, nearly every stalk of a plant is smutted.

The disease usually appears about heading-time, although it can be detected earlier and is most conspicuous when the grain is ripening. At this time the straw and leaves of affected plants are often split longitudinally, and the plants may break over, having the same general appearance as when broken by hail.

Smut powder, which develops on diseased parts of the plant, consists of countless numbers of spores (roughly speaking, the seed of the fungus), which may be distributed in various ways When the grain is handled in harvesting and in threshing operations, the spore-masses are smeared on the rye kernels, are blown about by the wind, or may fall to the ground When seed with smut spores on the surface is planted, or when clean seed is planted in smutted soil, the spores germinate, sending out a fungous thread with several branches on the tip. The branches penetrate the tissues of the young plant, grow in them, and again branch until the whole plant contains a network of these fungous threads. The parasite grows up with the rye plant and shortly before heading-time produces vast numbers of spores which give the plant its smutted appearance.

Effect of Rust on Barley and Rye

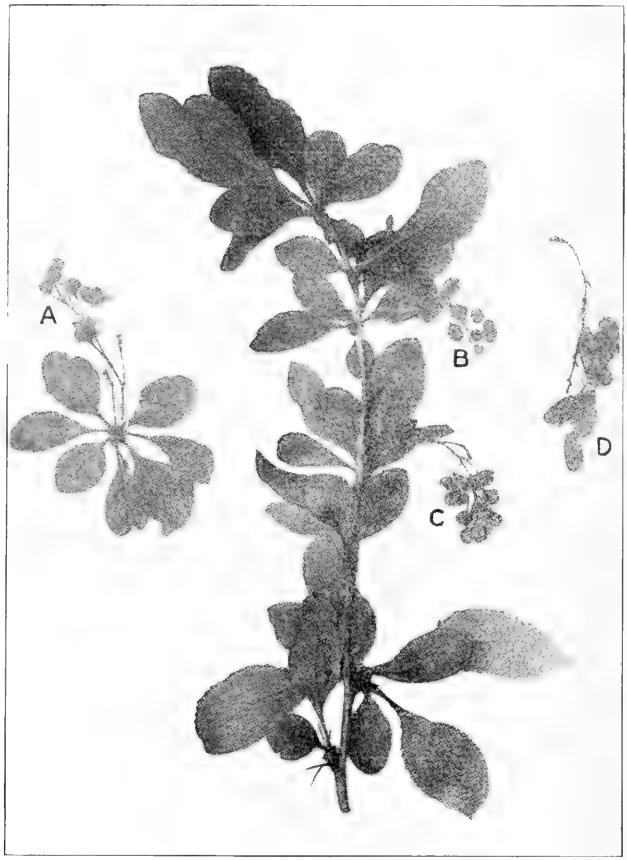
Every farmer knows what rust looks like to the naked eye, for it is usually so conspicuous as to attract the attention of any careful observer.

The most destructive variety of rust is commonly called the "stem rust," or "black rust," and to this species the greater losses are due.

A wet spring, followed by warm, moist weather, provides ideal conditions for the rapid growth and spread of rust. Frequent showers with heat between and heavy dews followed by intense morning heat produce a succulent growth of the plant, which thus becomes particularly sus-

ceptible to the entrance and rapid growth of the rust parasite. Those people are thus not altogether wrong who think that the rust is caused by warm, wet weather.

Rust eats into the joints of the grain, causing entire fields to break over at those points. This effect is often



RUST BREEDS ON THE BARBERRY BUSH

Branches of the barberry bush, bearing cluster cups of the black or stem rust of wheat. Its elimination will lessen this enormous loss to our wheat crops. A, B, C, and D are the rust bearing clusters.

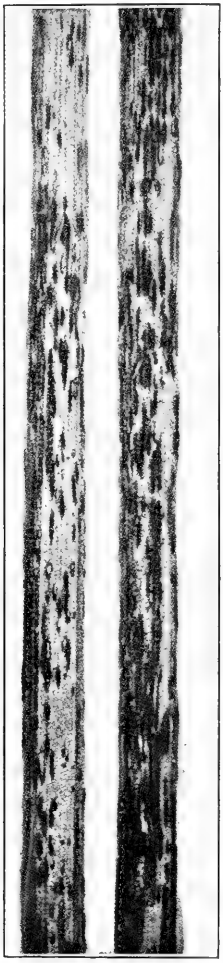
erroneously claimed as hail damage, but as hail never eats out the joint or breaks a stalk at its normally strongest point, this argument of the claimant is easily overcome.

The common barberry bush is the host plant of the rust spores, which may be found in clusters attached to the

stalks and leaves. The spore clusters break, and the parasite is then transferred by the wind to the various grains.

Effect of Black Stem Rust on Oats

The black stem rust on oats shows but little difference from the black rust of wheat. Nevertheless it is racially different, as is indicated by the fact that inter-inoculation



STEM RUST

Stems of wheat showing black clusters of spores of "stem rust" or "black rust."

has not been adduced and that a field of one of these crops may be badly affected by its fungus while adjoining fields

of the other crops show no rust or indication of infection.

More common and more injurious than the black stem rust of wheat, it constitutes the most destructive oat rust, totally destroying thousands of acres of oats yearly. As with the black rust of wheat, its attacks are epidemic and fluctuate in destructiveness from year to year. It is usually more common in the northern states than in the South.

Orange Leaf Rust

This rust bears a very close resemblance to that of the same name occurring upon wheat. It is invariably present where rye is grown, and is particularly abundant in the southern states, although, notwithstanding its universal presence, it is not destructive. The fungus remains alive and continues to produce spores over winter in the leaves in the South, as it probably does in colder climates also. Undoubtedly it is in this way carried from season to season by volunteer rye in the field.

Barley and oats are also affected, but seldom seriously enough for any damage to be caused.

Crown Rust

Crown rust, a distinctly different species than either black or red rust, is found only upon oats and is in evidence nearly every season. In the early stages of the crown rust it may be readily distinguished from either the black or red varieties by the ring-like formations on the blades but in the latter stages is not so recognizable but may be differentiated from the other rusts, by the fact that it rarely is found upon the lower stem parts, being confined largely to the leaves. It appears as streaks upon and under the membrane of the leaves but rarely ruptures them as do the other varieties.

The buckthorn is the host plant of the crown rust, spores of which can be found thereon in cluster cups attached to the leaves and stems. When the cups break the spores are carried into the grain by the wind and if climatic conditions are favorable to their growth, very soon become evident over entire fields.

The damage inflicted by the crown rust is very rarely more serious than are the attacks of red rust, hence severe loss from this cause is quite infrequently encountered.

THE COMMON BUCKTHORN

A branch of the buckthorn, showing the cluster-cups of the crown rust.

PART III

CONTRIBUTING CAUSES

A decrease of yield of any crops in a given territory from the normal yield for that section is due to some particular cause. If disease or insect conditions are not apparent, the reason will be found elsewhere, either in climatic conditions, improper seed selection, lack of soil fertility, improper seed bed preparation or other causes, and the most common of these are dealt with here.

The Relation of Soil Selection to Losses

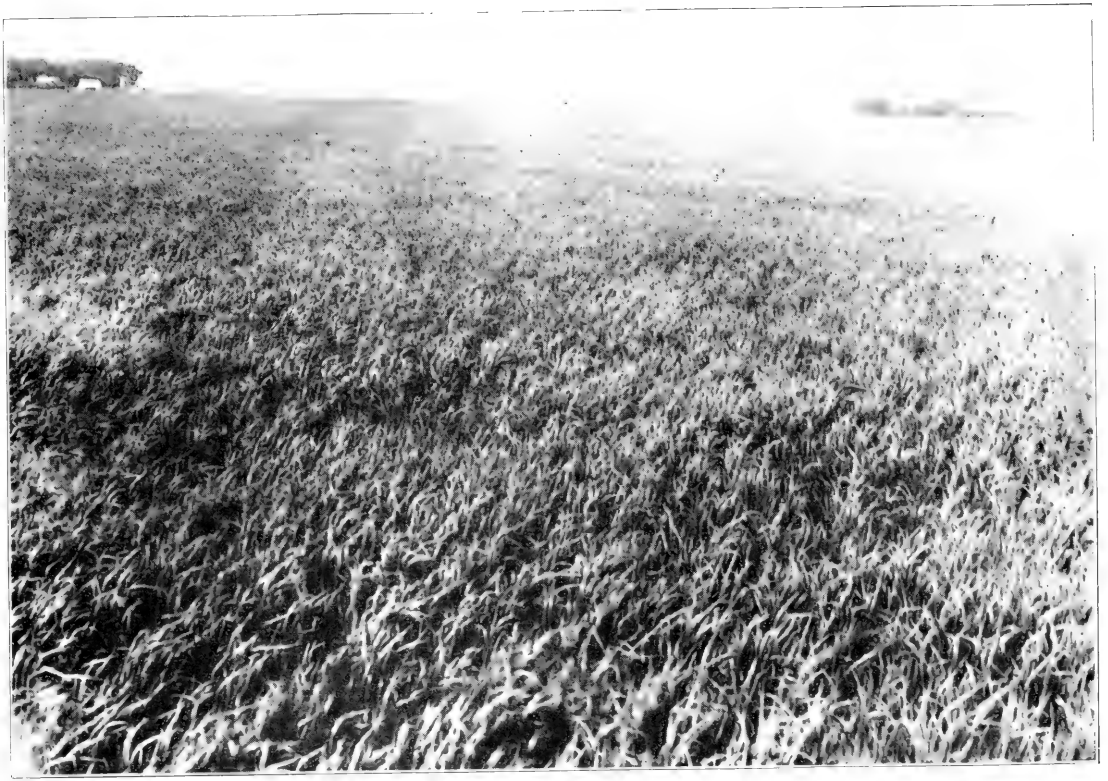
The nature of the soil on which barley, oats, and rye are grown has an important bearing on their final yield, and losses to those grains due to the nature of the soil are more easily confused with that of hail than are those of any of the other crops.

Barley grows unevenly on very rich soil; some of the straws will be heading out while others have developed only to the first joint. This condition is most noticeable at harvest time, for while part of the grain will be ripe and ready to harvest, a portion of it will still be green.

A farmer noting the uneven growth of the grain often contends that hail has so retarded a part of it that a lack of uniform maturity of all heads will cause him a considerable loss, not alone through lack of maturity of part of the grain, but because the green straws stacked or bound with the ripe ones will cause heating and decay before the barley can be threshed.

Both contentions are incorrect, for the uneven growth is not due to the effects of hail, and a proper handling of barley in any season calls for methods which permit of thorough drying, such as stacking the loose barley in low, narrow stacks or windrows, or very loose binding and small open shocking of bundled grain. Not as in other grains, the grade and color of the berry are improved instead of impaired by these methods.

Extremely heavy heads of barley often break the straw close to the top of the stalk much as it is broken by hail,



UNEVEN GROWTH OF GRAIN.

This condition is most pronounced at harvest time when some areas ripen much earlier than others.

and the natural leaning over of a barley head is even credited to hail damage by some growers.

A very poor soil, on the other hand, produces a weak-stemmed plant which is not capable of withstanding a heavy driving rain or a violent windstorm. The grain on such a field "crumples up," not unlike the wheat-sick straws of an affected wheat field.

Oats on especially rich soil are most subject to the effects of rain and wind and often "lodge" in considerable patches. Owing to the heavy growth of foliage, the length of the stem, and the weight of the head, the lower part of the stalk, which begins to mature first, loses its strength, and, weakened here, the plant falls over. As this lodged condition is most frequently noted after a wind- or rain-storm, claims are often made for hail loss. The uneven growth noted in barley is also occasionally found in an oat field.

Rye is better adapted to poor soils than either barley or oats, and it is not so likely to develop their characteristics on rich lands. There is, however, a tendency for the rye stalk to weaken if the head becomes unusually heavy, but this condition is infrequently encountered.

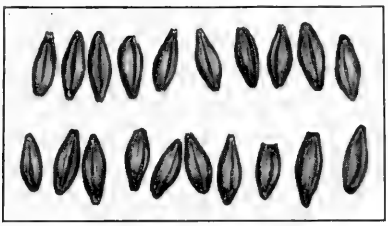
Seed Selection and Seed-Bed Preparation for Barley, Oats and Rye

The results of improper or careless selection of seed are all too frequently overlooked by the farmer, or the consequent weakness of the grain or improper filling of the heads is charged to some other cause. Should the grain be damaged by a hailstorm, the natural conclusion that this is the cause of all the loss is too often accepted by the grower.

Seed bed for barley.—Such damage to barley is often claimed where the actual loss has been caused by the poor seed planted. Unless care is exercised in this particular, a number of conditions may result to the detriment of the growing crop. Where large, plump seeds are planted, a stronger plant and a better yield will follow than if shrunken or broken grains are sown along with the larger and better seeds.

Barley requires a uniform depth of seeding, and unless the seed bed is carefully worked down and the clods elim-

inated, a very irregular depth of planting will invariably make itself manifest in the uneven growth of grain. Such a condition is often confused with hail damage. If the land is not plowed more deeply than for the other cereals and the soil thoroughly worked down to eliminate air pockets and loose ashy surfaces, a poorer yield will almost invari-



SELECTED GRAINS OF BARLEY, NATURAL SIZE

ably result. Where barley follows corn, there will be large areas around the stalks into which air can circulate too freely, with a resultant loss of moisture, unless such stalks have been removed from the field.

Neglect of careful seed selection and seed-bed preparation causes various losses to the crop, such as poor stand, spotted growth, and uneven maturity, and exposes the growing plants to the ravages of disease and insect pests and to the detrimental effects of drought, hot winds, frosts, or too much moisture.

Seed bed for oats.—Every spikelet of oats contains two seeds, one much larger than the other, and the grower often overlooks this fact when selecting seed oats. Smut clings to oats much more tenaciously than to other grain, and if the seed has not been treated for this infection, a sickly crop, having the appearance of hail damage, is likely to result. Inquiry as to whether seed has been carefully selected and treated may reveal the true cause for a supposed hail loss.

As oats are quite subject to oat-sick conditions of soil, fungus attacks, blister, and oat blight are not infrequent. Treatment of seed in many cases overcomes this condition to a certain extent.

Oats will grow better in a medium compact seed bed than where the land is firmly rolled. They are most liable to failure, however, on a loose ashy soil, as their moisture

requirements are greater than those of some of the other cereals. A deeply plowed field seeded to oats more frequently produces a failure than one where the surface is but lightly plowed, and very often excellent crops of oats

OATS ON CORN STALK GROUND

Another example of poor farming. Old corn stalks left in field cause loss of moisture. Grain around these stalks is thereby weakened. Action of the wind whipping against the dead stalks causes a break-over resembling hail damage in these spots.

are obtained where the soil is only disked or if the land has been plowed the previous season and the seed is drilled in without surface cultivation.

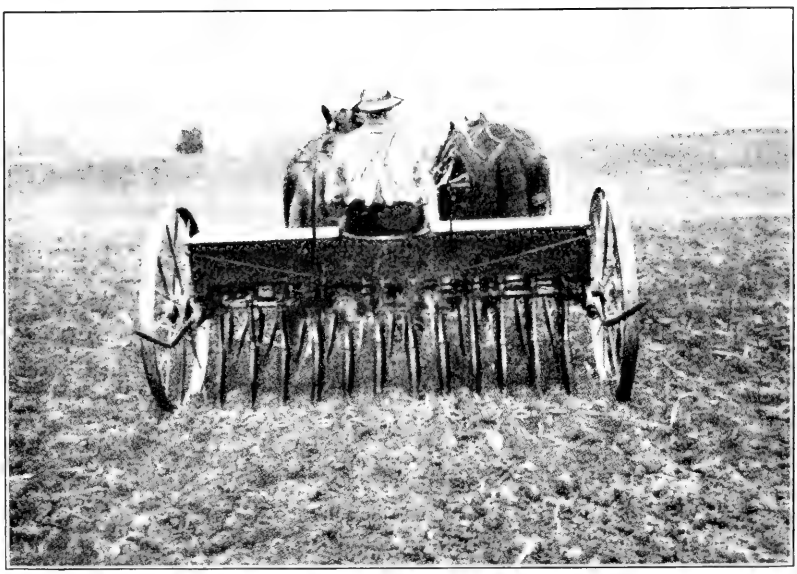
Seed bed for rye.—Very few losses caused by improper seed selection are reported on rye fields, regardless of the

Photograph by I. H. C.

TREATING SEED OATS FOR SMUT

Smut destroys an average of 10 per cent of the oat crop every year. A cash outlay of two cents an acre, plus a slight additional amount of labor will stop this loss.

A



B

SEED BED AND SEEDING OF OATS

The recovery of young oats after they have been hailed usually depends on preparation of the seed bed and methods of seeding. Fig. A illustrates a field being sown to oats with no preparation of the seed bed. Nothing is being done to conserve moisture. Fig. B shows a well-prepared seed bed and the correct method of seeding.

fact that seed selection for rye is usually given less attention than for any other cereal. Treatment for smut and a casual seed grading tend to eliminate even these few losses.

The same methods of seed-bed preparation applicable to winter wheat seem best for rye, and the same general resultant losses are apparent if those methods are not followed.

Shatter Loss

A considerable loss of grain from the head is most frequently claimed where oats are involved. There are several reasons for such contentions and several methods by which to determine the real amount of such loss.

Owing to a number of white chafflike streamers on the oat heads, the grower advances the theory that these are remnants of husks which once contained grains, and he desires to count each of these as having contained a kernel knocked off by hail; then, going to the ground, he adds in all kernels in sight, together with the husks and the chaff of these which have been dislodged from the grain. Then he desires to add about 10 per cent for grain washed away or covered up by the soil.

Although oats are most subject to shatter by hail, there is seldom anywhere near the amount of loss claimed by the grower, nor as great a damage as seems apparent on superficial examination or at first glance.

Since the white streamers are not husks of the grain and have never contained a berry of oats, they must be eliminated from the controversy.

To arrive at a comparative percentage of grain on the ground, a circle can be drawn and the stalks of grain inside counted, then grain and chaff stripped from heads outside the circle, and this fresh mixture scattered inside, until it is mutually agreed that there is as much new grain as old on the ground. As the protecting sheath of the oats breaks up into several pieces of chaff, each about the size of a grain of oats, there is always four or five times as much apparent loss as has actually been sustained. Therefore it is seldom necessary to scatter even as much as 5 per cent of the heads to satisfy the grower that his actual loss is extremely light.

An oat field is especially subject to shatter loss from rain and wind, and this fact must always be taken into consideration by the adjuster.

These conditions are encountered in barley and rye, especially if the grains are overripe, but are not as marked as in oats.

Climatic Conditions Affecting Barley, Oats, and Rye

As a rule these grains may be profitably produced over a greater climatic range than any other farm products; hence they are not so generally affected by climatic conditions. Too much moisture will produce the familiar yellowing, or lack of moisture accompanied with hot, dry winds will cause a burning of the plants, a condition well known to all observers.

Barley is subject to considerable damage by frost soon after it comes out of the ground, but if given a week or two to gain vitality is seldom affected by this condition. The time of sowing will probably have some effect on losses, especially if the planter has attempted to force in barley ahead of the season at which it should be sown in his particular locality. In the spring-wheat territories where frost will possibly affect the barley, it is usually sown after the wheat has been seeded and before oats are planted. The arguments in favor of a later sowing of barley are in the majority, and a hail claim is much less likely to be reported where barley is sown late than where it is planted earlier.

Oats seem to be quite hardy and will withstand many of the unfavorable climatic conditions that are harmful to other crops. Their need of moisture is great, and oats are therefore more frequently affected by drought than are the other cereals. Owing to their very rapid growth, they consume a large quantity of water, and a condition of drought will often be evident in an oat field before it is noted among the other grain.

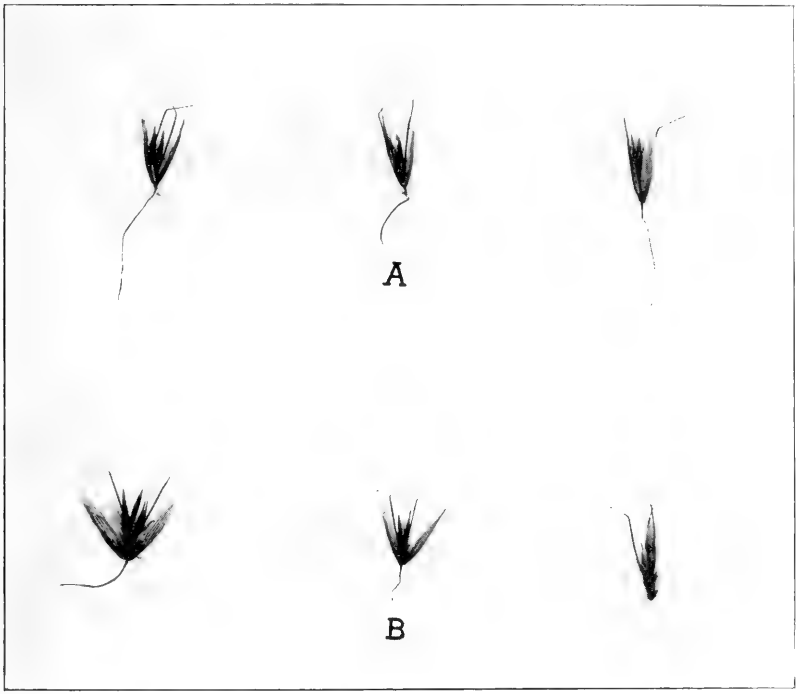
Rye is seldom affected by climatic conditions unless the unfavorable situation has prevailed for a considerable time and has become very apparent in other grains. Rye is subject to winter-killing, as is wheat.

Wild Oats

Wild oats are not easily confused with the cultivated varieties, although some growers gain a false impression of their true hail damage by failure to eliminate the wild variety from their calculation. This is especially true if

any quantity of the wild oats is mixed in throughout the field, as is often the case.

Wild oats mature sooner than tame oats, and their stalks are weaker and much more susceptible to hail or other climatic damage. The berry is smaller and darker,



WILD OATS

A, spikelets of wild oats showing black twisted awns; *B*, glumes spread open showing bristles at base.

with a somewhat different spikelet and head formation. Wild oats are especially prevalent in some sections of the Northwest, and where found in a field they are a rather convincing indication of improper farming methods.

Crop Rotation

Oats, barley, and rye were first introduced as rotation crops and have taken their place in all rotation schemes advocated by the various agricultural colleges and extension departments.

Barley following barley will more often result in a

failure than any other crop, and care must be taken that it is not sown on the same land in succession. An excellent yield of barley one season may induce a farmer to plant the same land to the crop again, and when the resultant poor yield becomes evident he is likely to charge the damage to a hail loss.

On the other hand, oats are less affected by lack of rotation, and, unless an oat-sick situation has developed,

COMPARISON OF OATS IN FOUR-YEAR ROTATION (AT LEFT) AND OATS GROWN CONTINUOUSLY (AT RIGHT)

For the first six years of cropping under these two systems, the oats in the rotation gave 14.95 per cent greater yield and 35.2 per cent greater income. The photographs, taken July 6, show wherein the difference lies.

but few spurious hail claims will be encountered. When oat sickness is prevalent, the soil must be cleared by rotation of other crops for two or three, or even more, years until the land is entirely freed from the infection which has inoculated both the soil and the seed to such an extent that oat-growing is no longer profitable on a tract.

As with wheat, rye may follow rye oftener on the same field than either oats or barley, but it is good farming practice, nevertheless, to rotate according to the systems devised by the local agricultural authorities. Many serious hail claims are reported owing to lack of rotation, and inquiry as to whether or not this essential has been followed may lead to conclusive information establishing the true cause of loss to the crop.

COMPARISON OF OATS ALTERNATED WITH CORN (AT LEFT) AND OATS ALTERNATED WITH WHEAT (AT RIGHT)

For the first six years of cropping under the two systems, the oats alternated with corn approximated very closely the yields obtained in the four-year rotation, while the oats alternated with wheat failed to reach that yield by four bushels per acre.

SUMMARY OF LOSSES TO BARLEY, OATS AND RYE—WHAT TO LOOK FOR AND WHERE TO FIND IT

	NATURE OF DAMAGE	CAUSED BY	LOOK FOR	WHERE FOUND	APPEARANCE OF LOSS
LOSS TO THE HEADS	White Heads	Hessian Fly	Pupae or Flax Seed Stage	In straw from underground to 3rd joint	White shriveled heads.
		Straw Worm, 2nd Stage	Larva (Worm)	In straw, usually just above 1st joint from head	White Heads, Straw broken or very weak.
		Stalk Borer	Larva (Worm)	In stalk, usually near ground	Stalk tunnelled, Head White. Stalk dying.
		Blast (Oats only)	Fungus Condition	On Head or Leaves	Head unfilled and discolored.
		Fungus Attack (Soil or Seed Sickness)	Mildew and fungus spots	At base of head and throughout Chaff and Kernels	Closely resembles insect damage.
		Scab	Reddish Mold	On Heads and Kernels	Head ripens prematurely. Some Kernels shrunken and discolored.
		Anthracnose	Black scales	On Heads and Kernels	Head ripens prematurely. Some Kernels shrunken and discolored.
	Smut Heads Hard or Stinking	Fungus Spores	Smut filled Kernels	Heads only	Kernels and Heads appear nearly normal. Kernels however, filled with smut.
	Loose	Fungus Spores	Smutted Head	Heads only	A loose black powdery mass where head should be or a bare stalk with smut Spores clinging to it.
	Unfilled Heads	Black Rust	Rust Spores	On Stem and Heads	Heads appear nearly normal but are unfilled.
		Red Mold	Mold	On Heads and Kernels	Grains swell and become discolored.
		Scab	Mold	On Heads and Kernels	Grains shriveled and discolored.
		Soil or Seed Sickness	Fungus spores cause ashy straw, insufficient root system. Lack of stooling	From Root to Head	Shriveled, discolored or blighted grains.
		Drought or Hot Winds	Burned appearance	Entire plant	Grains shriveled and light
	Ergot	Fungus Growth	Horn or Spur	On Head	About half the head displaced by the spur of ergot.
		Straw Worms, (First Stage)	Space in head where worm has been	In embryo where head should have been	Stalk headless and unhealthy appearance.
	Entire lack of Heads	Soil or Seed Sickness	Fungus attacks	Roots or Stems	Sick Plant, not enough vitality to mature head.

SUMMARY OF LOSSES TO BARLEY, OATS AND RYE WHAT TO LOOK FOR AND WHERE TO FIND THEM

	NATURE OF DAMAGE	CAUSED BY	LOOK FOR	WHERE FOUND	APPEARANCE OF LOSS
LOSS TO STALKS	Stalk Breaking	Hessian Fly	Larva (Worm) or Pupae stage (Flax Seed)	From ground line to 3rd joint from ground	Stalk weakened and breaks over. Evidence of work inside stalk at that point.
		Straw Worm, 2nd Stage	Larvae (Worm)	In Straw near second joint from top	Tunnels burrowed in stem. Head White.
		Stalk Borer	Larva (Worm)	Usually near ground	Burrowed stem.
		Chinch Bug	Bugs of various sizes	On stalks	Sap sucked from stalk causing it to wither and fall.
		Cutworm	Larva (Worm)	At Base of Plant	Stalk eaten away at ground line.
		Army Worm	Larva and Caterpillar	On all parts of plant	When numerous enough to destroy they are very evident.
		Web-Worms	Larva (Worm)	Under Ground	Stalks eaten away beneath ground line.
		Fungus (Soil and Seed Sickness)	Evidence of Fungus Spores	From root to head	Ashy weak Straw, Poor Heads—Insufficient root system. Absence of stools.
		Gophers	Chewed place on Straw	Rather low	Stalk chewed up one side for about one inch, then breaks.
		Jack Rabbits	Head nipped off	Near top of stalk	As if cut off with knife.
		Grasshopper	Serrated edges of broken Straws	From ground to head	Chewed off stalk. Edges irregular.
Loss to JOINTS	Eaten Out	Black Rust	Rust Spores	On all parts of plant	Joints eaten out and broken over.
		Soil and Seed Sickness	Soil or Seed sick indication	On all parts of plant	Joints eaten out and broken over.
LOSS TO LEAVES	Yellow, discolored or missing	Blight	Fungus Infection	On Leaves	Yellowing and dying of plant.
		Chinch Bug	Bugs of various sizes	All over plant	Stalks being sapped. Leaves drying up.
		Soil and Seed Sickness	Soil or Seed sick indications	All over plant	Yellow leaves, weak ribs. No life to plant.
		Red Rust	Rust spores or spots	On leaves and stalks	Reddish spots often causing holes in the leaves.
		Crown Rust (on oats only)	Rust spores or spots	On leaves	Streaks or rust circles on leaves.
		Leaf Blotch (barley only)	Spots and Perforations	On leaves	Ragged holes in leaves.
		Powdery Mildew	Grayish Mold	On leaves and stalks	Ashy coloring on stalk and leaves. Plant often breaks.

CLIMATIC OR POOR FARMING CONDITIONS ARE FIRST EVIDENCED IN THE WILTING LEAVES

Improper growth of Young Grain—Yellow, Weak, etc.—MAY BE CAUSED BY HESSIAN FLY, CHINCH BUG, SOIL OR SEED SICKNESS OR POOR FARMING OR CLIMATIC CONDITIONS. BEST TO DEFER SUCH ADJUSTMENTS UNTIL JOINTING TIME AT LEAST.

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