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EC1802 Revised 1948 Stem Rust on Wheat, Oats, Barley, Rye

J. E. Livingston

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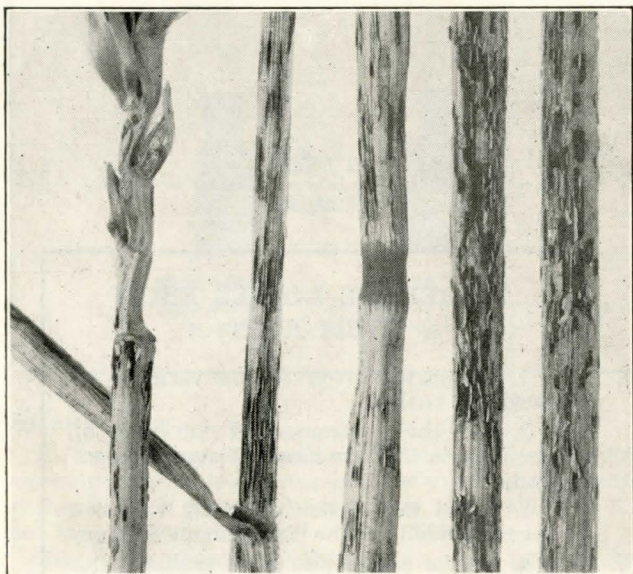
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EC 1802-48

STEM RUST

ON WHEAT,
OATS, BARLEY, RYE



Means a LOSS to

- FARMERS
- INDUSTRIES
- CONSUMERS

Extension Circular 1802, Revised - 48

J. E. Livingston

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The University of Nebraska Agricultural College
Extension Service and United States Department
of Agriculture Cooperating
H. G. Gould, Acting Director, Lincoln, Nebraska

TO REDUCE LOSSES FROM STEM RUST

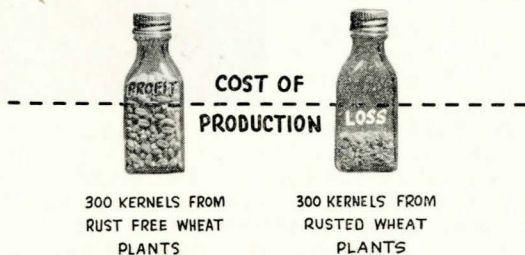
1. Eradicate rust-spreading varieties of barberry bushes.
2. Use the recommended varieties of small grain that are most resistant to stem rust.
3. Select the earlier maturing varieties recommended by the Experiment Station.
4. Insofar as possible plant grains at the recommended seeding dates on well prepared soil, thus hastening maturity and helping to escape the hazard of stem rust.

When Stem Rust Ruins Grains

The Tragedy Begins With the Farmer, Plagues Related Industry, and Ends With the Consumer

300 KERNELS *or* 300 ACRES

The Relative Profit or Loss is the Same



Farmers Lose

As late as 1944, Nebraska grain growers lost one-fifth of their wheat crop and one-tenth of their oat crop to this disease. Once stem rust appears in the grain field it is too late to apply practical control measures.

The yield decreases. Rusted grain is light in test weight, and discounted at the market. Profit is available only if the crop from a field returns more to the grower than the costs of production. Many fields in some Nebraska localities were not harvested in 1944 because of the damage from stem rust.

Industries Lose

The Nebraska sacrifice of at least 13,000,000 bushels of wheat and oats to stem rust in 1944 had its repercussion in industry as well as on the farm. Plans and commitments were made on the strength of the prospective crop. Revenue was lost by the merchants, wholesalers and transportation companies. Labor which would have been required to harvest, transport, process and distribute the 13 million bushels of grain vanished.

Consumers Lose

The 13 million bushels of Nebraska wheat and oats destroyed by stem rust within a few weeks in 1944 meant the loss of a vast amount of food and feed.

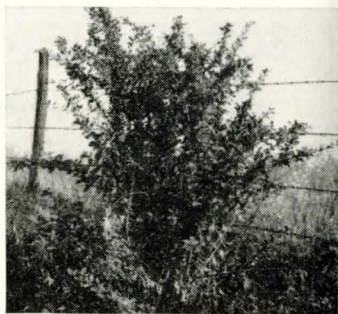
All of us—the storekeeper, the butcher, the baker, the druggist, the doctor, the dentist, the teacher, the builder, the service station worker—felt the adverse influence of the crop loss.

**RUSTED GRAIN PLANTS PRODUCE SHRIVELED,
POOR QUALITY KERNELS!**

Two Sources

1. From Barberry

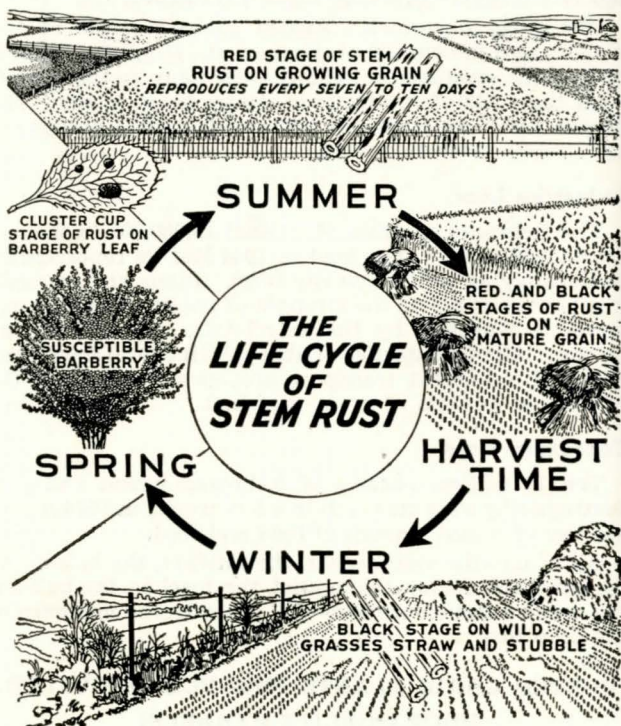
There are four stages in the development of stem rust. One stage lives through the winter on old straw and grass, and produces tiny stem rust spores in the spring. These infect only the leaves of the barberry bush. The next stage then develops on the barberry leaves, producing millions of spores. These spores are carried in the air currents like particles of dust



The barberry.

and deposited on the leaves and stems of grains and many grasses. There the rust fungus grows into the stem tissues, producing the common red stage of stem rust. Millions of red spores are produced every few days.

As the grain matures, the red rust spores are replaced by black spores which remain dormant through the winter. Thus, the object in destroying the rust-susceptible barberry bushes in the northern states is to eliminate the method by which the stem rust organism is spread from the old straw, stubble, and grasses of the past year to the green growing grain of the next year.



of Stem Rust

2. Blown In From Other Areas



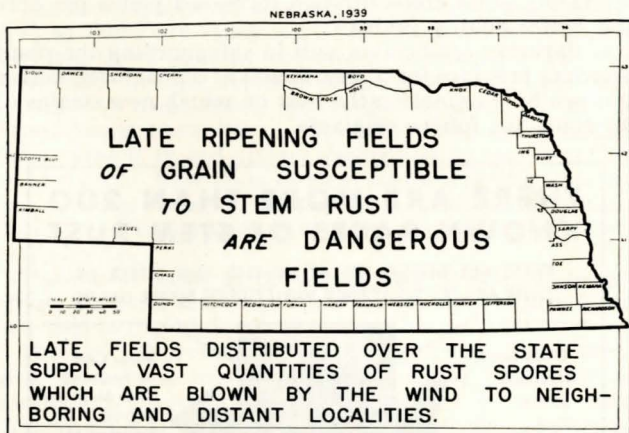
The South.

Under certain conditions rusted grain in Texas and northern Mexico serves as another source of stem rust for grain crops in the Missouri Valley states.

In Texas and northern Mexico the stem rust organism is capable of surviving the mild winter in the red, or repeating stage. When severe stem rust occurs in the South the tiny rust spores are blown into the air above the fields and drift with the air currents. These spores may be carried long distances. Generally

speaking, this northward spread of rust is by progressive stages and the first infection of grain in Nebraska from this source usually occurs later than infection from local barberberries.

Stem rust blown in from other areas is important in Nebraska only when: (1) viable stem rust spores are carried into the state in large quantities by winds, (2) the strains of rust are capable of seriously injuring the varieties of grain grown in the state, (3) Nebraska's grain crop matures later than normal, and (4) the weather is favorable for the rapid development of the disease.



Rust spores drift from locality to locality with the air currents. A sprinkling of late fields and of patched fields become reservoirs for the stem rust spores. A moderate amount of stem rust infection on one acre of wheat has been estimated to produce as many as 10 trillion rust spores.

Effective Aids

A. Barberry Eradication Will Accomplish the Following:



1. Destruction of the barberry eliminates the plant on which the disease develops after overwintering on old straw, stubble and grasses and before attacking the new crop of growing grain.

2. Every rust-spreading barberry bush destroyed means one less source from which early destructive stem rust epidemics may develop.

3. Barberry eradication aids in lowering the cost of producing grain crops through increased yields per acre and better quality grains.

4. Barberry eradication aids in safeguarding the plant breeding program for improvement of wheat, oats, barley and rye by eliminating the host on which new strains of the stem rust fungus originate.

THERE ARE MORE THAN 200 KNOWN RACES OF STEM RUST

THESE ARE DESIGNATED BY NUMBER AND DIFFER IN THEIR ABILITY TO ATTACK VARIETIES OF SMALL GRAIN

When Races Hybridize on the Rust Spreading Barberry Bush

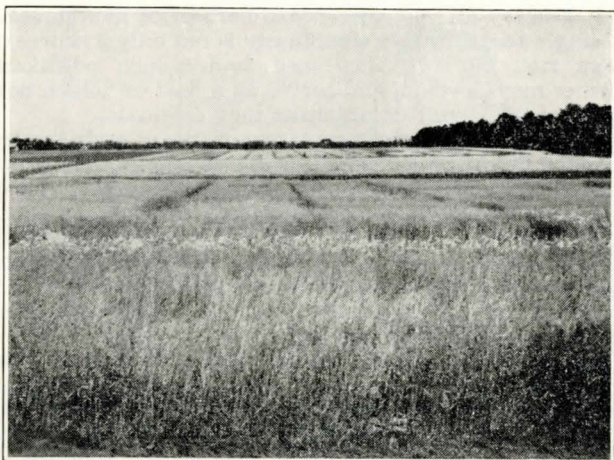


Races Can Be Produced That May Attack Varieties of Grain Now Considered Resistant

HYBRIDIZATION OCCURS ONLY ON THE BARBERRY

in Rust Control

B. Development of Disease-Resistant Varieties Is a Step Forward



Plant breeders are constantly striving to develop superior varieties of grain in plots like this one at the Nebraska Agricultural Experiment Station.

New and better varieties of wheat, oats, and barley are being produced and will be distributed as they become available. Several varieties of oats and wheat with considerable resistance to stem rust are now ready for use by Nebraska farmers.

Hybrid Races Are a Constant Hazard

The development of new varieties is not a simple task. Just as there are many varieties of wheat, oats, barley and rye, there likewise are many varieties and races of stem rust. Certain varieties of grain are highly resistant to some of these races, but very susceptible to others. Experiments have shown repeatedly that the origin of these races is traced almost exclusively to rust infection on barberry. New races of stem rust are produced when two existing races of the organism cross, or hybridize, during the early stages of rust development on the barberry leaves.

These new races of stem rust may attack commonly grown varieties and complicate the problem of producing new and better varieties of grain.

The task of producing rust-resistant varieties is complex because so many different races of rust must be considered. Approximately 200 distinct races of stem rust which attack wheat have been identified in various grain-producing regions of the world. Oats are attacked by 13 different races, and rye by 14 races. Some of the wheat and rye races also attack barley.

The existence of these races within the varieties of stem rust explains, to a great extent, why a given variety of grain may appear resistant in some years and in some localities, and be severely attacked in other years.

C. Certain Farm Practices Are Essential in Controlling Stem Rust

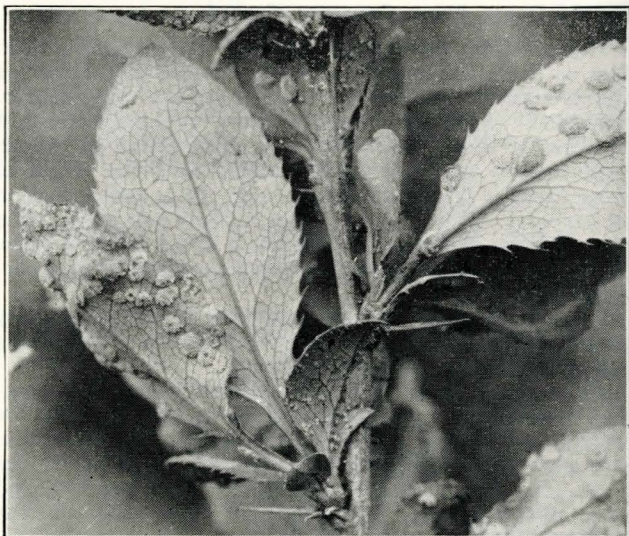
Stem rust must be prevented, as it cannot be controlled successfully once it becomes established in a field of grain. The following measures will provide practical control for the disease:

1. Destroy all rust-susceptible barberries in Nebraska. A single barberry in a community is not only a source of stem rust but furnishes seed from which additional bushes may develop, and serves as a host on which new races of the stem rust organism may originate.

2. Sow the more rust-resistant varieties of grain recommended by the State Agricultural College. The Nebraska Experiment Station, in cooperation with county agents of the Nebraska Extension Service and the Nebraska Grain Improvement Association, has compared many small grain varieties in different localities throughout the state. The results of these studies, showing the most desirable varieties for a given locality, are available at the office of the county agricultural agent.

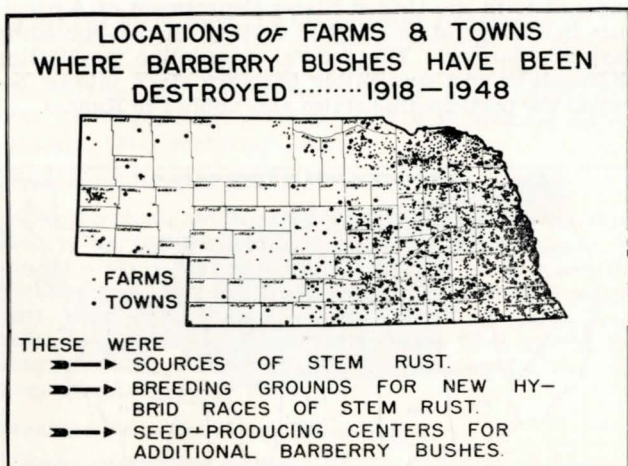
3. Generally speaking, the earlier a grain field matures the greater are its chances of escaping damage from stem rust. Seed fall grain as early as possible in accord with the recommended seeding dates. Seeding too early or too late may increase losses from Hessian fly, root rot or winter injury. Sow spring grains just as early as the soil can be properly prepared, and on well prepared land. Use every cultural practice that will help produce a healthy, strong, early maturing crop.

Progress in controlling stem rust varies directly with the advancement of each of the above control measures. Neglect of any one of them may seriously retard the progress of the control program.



Stem rust infection on barberry leaves. The raised spots on the leaves are orange-colored and honeycomb-like in appearance. They are produced by the stem rust fungus. Although the disease appears different from that on the grain stems, it is caused by the same organism.

Progress in Eradication



The barberry shrub was introduced into America from Europe by colonists and was first brought to Nebraska by the early settlers for garden, hedge and ornamental use about 1870. From these and other plantings made as late as 1918, seed was scattered by birds and other means to orchards, tree claims, pastures, and along ravines, streams, and fence lines, where wild bushes developed and continued to spread.

The task of eliminating the pest from the state has not been easy. Locating the scattered shrubs requires a systematic inspection of all uncultivated territory where brush and trees may be growing. Seed produced by the bushes may lie dormant in the soil for a period of twelve or more years before germinating and giving rise to new bushes.

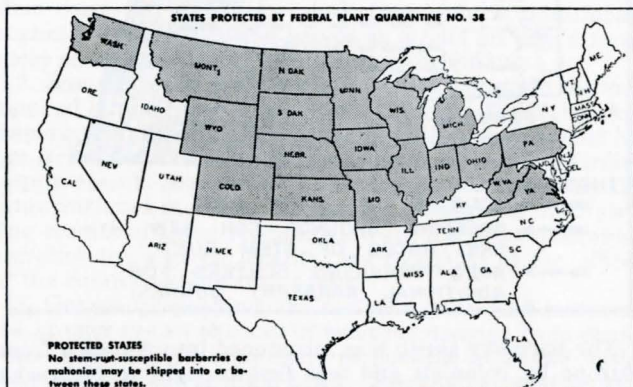
The number of rust-spreading barberry bushes within the state has been greatly reduced. Those that remain must be destroyed to prevent the reseeding of barberry-free territory.



A federal worker collects a sample of grass which is severely infected with stem rust. The barberry bush growing a few feet to the left of the worker was responsible for the severe development of stem rust on the nearby grasses. This example was found in Wheeler County in 1948.

States Cooperate in the Control Program

Eighteen states (shaded on the map below), are actively engaged with the United States Department of Agriculture in a cooperative effort to destroy all rust-spreading barberry bushes. The federal quarantine prohibiting shipment of rust-susceptible barberry stock into or between the participating states also applies to Kansas.



Stem Rust Control Is Progressing

The downward trend of losses resulting from stem rust can be attributed to the eradication of barberry bushes, the production of improved rust-resistant varieties of grain, and better farming practices on the part of growers, all of which contribute to effective control.

Nebraska's Annual Rust Losses Decline

A study of data from the thirteen northern grain-growing states where stem rust control practices have been under way for several years, reveals that the average yearly losses from stem rust have been reduced by about one-half. For Nebraska the reduction amounts to approximately one-third.

Barberry eradication has reduced the number of stem rust races that prevail each year. It has been shown repeatedly that more races of stem rust are found on grains and grasses close to barberry bushes than are found in areas where the rust-susceptible barberry does not occur or in regions where the barberry does not become infected with rust. As the grain-growing areas have been cleared of rust-susceptible barberry, the number of different races found each year has declined.

Number of Races in Nebraska Reduced

A study of the prevailing races of stem rust occurring on wheat in Nebraska for the years of 1924 to 1944, inclusive, reveals that the average number of races found per year decreased by 31 per cent. It is even more encouraging that during the past several years only two or three races occurred in more than trace amounts. To produce and maintain varieties of grain that are resistant to stem rust will be less difficult as the races of rust become fewer in number and changes from one race to another become less frequent.

Do You Know

Reducing Stem Rust Is a Cooperative Enterprise

The stem rust problem can be solved only by using all of the known methods of control: (1) barberry eradication, (2) use of the more rust-resistant varieties of grain, and (3) using farm practices that will produce strong, healthy, early-maturing plants.

Premature Harvest Will Not Reduce Rust Losses

Studies made at the Nebraska Experiment Station relative to harvesting winter wheat at different stages of maturity show that premature harvesting may lower the yield as much or more than it would be reduced by stem rust. Harvesting winter wheat in the early dough stage reduces the yield approximately 29 per cent, and in the late dough stage about 10 per cent, compared with grain harvested in the ripe stage.

Weather Does Not Cause Stem Rust

Stem rust does not occur unless spores of the fungus are present to cause infection on the grains and grasses. Moist warm weather merely favors the growth and spread of the stem rust organism.

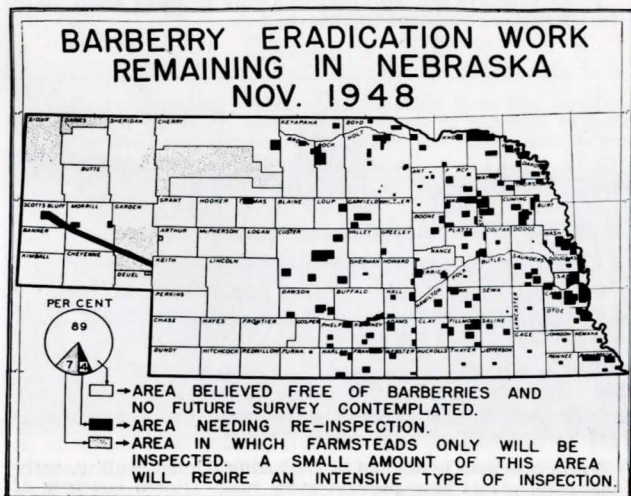
More Than One Kind of Rust Attacks Grains

There are several different kinds of rust that attack grain plants, the most common of which are leaf rust on wheat, leaf rust on oats, and stem rust on wheat, oats, barley and rye. It is only the stem rust of cereals that develops on the barberry.

Barberry Is the Only Shrub Known to Spread Stem Rust

Only certain species of barberry, however, are known to spread stem rust. Instances where a single barberry bush caused extensive damage were common before the barberry eradication program was started.

The Japanese barberry is not susceptible to stem rust and has been planted extensively for hedge and landscaping purposes.



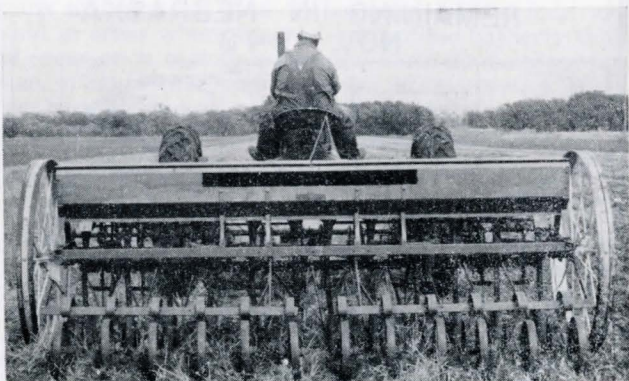
A Cooperative Task



Barberry eradication is easy if correctly done. Apply salt to the base of the bush and then cover with dirt to protect the treatment from livestock. Eradication by digging is not recommended.



Plant breeders are working constantly to make small grain varieties more resistant to stem rust.



Farm practices which aid in producing strong, healthy, early maturing plants help prevent stem rust. (Photo courtesy of Soil Conservation Service, Division of Research.)

A Dangerous Neighbor

The Individual's Role in Barberry Eradication

Each individual can locate and destroy these rust-susceptible shrubs. If such action were taken by every property owner, the task of completely eliminating the pest from the state could be accomplished within a comparatively short time. The other alternative is for a government agency to hire workers to perform the inspection and eradication work.

How to Destroy Barberry

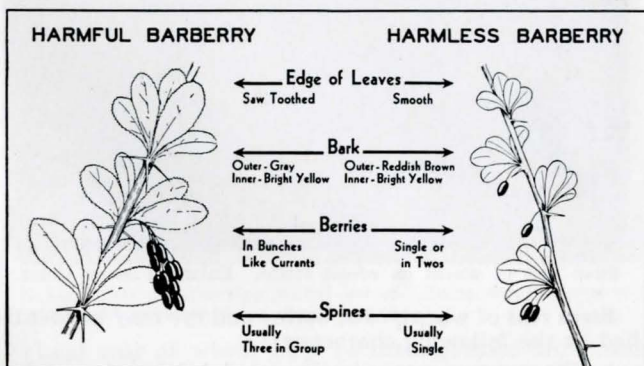
The use of chemicals offers the best means of destroying barberries. Stock salt applied at the rate of 10 pounds per square foot of crown is satisfactory. The canes should not be chopped off until the bush is dead.

Why Now?

The campaign to destroy the rust-spreading barberry has greatly reduced the number of these bushes within the state. It is essential to remove all bushes before they reach the seed-producing stage.

The Barberry Is Easy to Identify

The chart below shows how to distinguish the harmful barberry from other shrubs. In shape, the harmful barberry resembles the well known spirea, honeysuckle, lilac, and mock orange. The bushes may reach a height of 12 feet or more.



The rust-spreading barberry bushes differ from the harmless ornamental barberry, as illustrated here, in the type of leaf, color of the bark, the way the berries are borne, and in the number of spines.

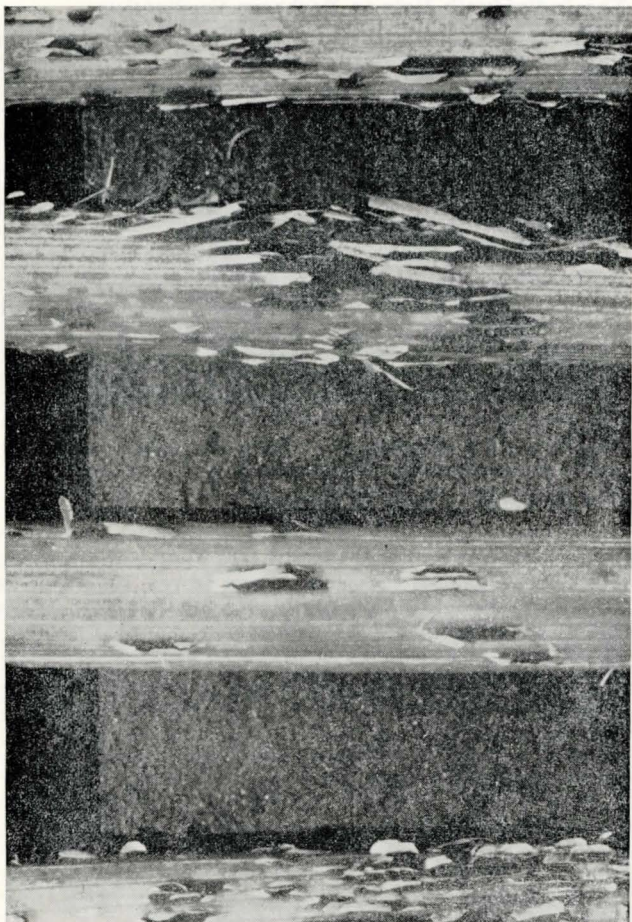
Report the Location of All Barberry Bushes

After the location of a barberry bush is reported, a careful inspection of neighboring properties often reveals additional bushes that have grown from seed scattered by birds or other means. A report of a location of barberry assures the eventual inspection of all neighboring properties.

Where to Report Locations of Barberry

Reports may be made to the county agricultural agent or, if more convenient, directly to the College of Agriculture, Lincoln, Nebraska. Enclose a small twig with your letter.

Don't Confuse Stem Rust



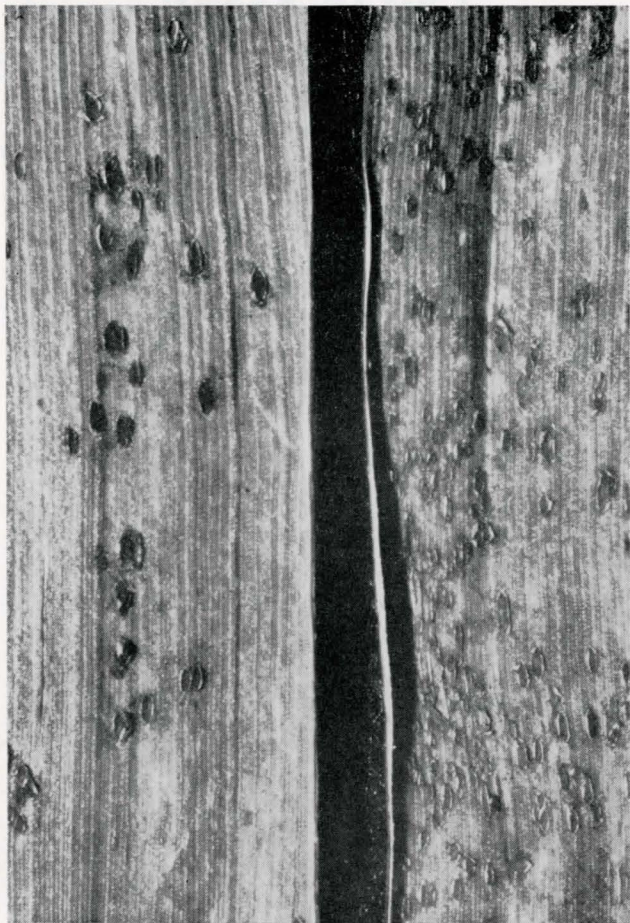
Stem rust of wheat on wheat stems. Enlarged many times.

Stem rust of wheat, oats, barley and rye may be identified by the following characters:

1. The summer spores in elongated, brick-red pustules, which break through the outer tissues of the plant, leaving a ragged appearance.
2. The overwintering spores in elongated, black pustules. These may form in the same pustules as the red spores or in different spots.
3. The rust is found chiefly on the stems, leaves, leaf sheaths, and sometimes on the glumes and awns.

Stem rust may occur on all above-ground parts of the plant. It produces both a red or summer stage and a black or winter stage. The black stage does not appear until about the time the grain begins to mature. Stem rust can usually be distinguished from other rusts by the elongated, brick-red pustule, and the ragged, torn appearance of the tissue at the margin of the pustule. The symptoms of stem rust are similar on wheat, oats, barley and rye.

and Leaf Rust of Wheat



Leaf rust of wheat on wheat leaves. Same enlargement as stem rust photograph on opposite page.

Leaf rust of wheat may be distinguished from stem rust by the following characters:

1. The summer spores in round, orange-yellow pustules, usually on the upper side of the leaf.
2. The winter spores in round, black pustules. These ordinarily do not break through the outer tissues of the leaf.
3. The rust is found chiefly on the leaves and leaf sheaths, but sometimes also on the stems, glumes and awns.

In contrast to stem rust, the leaf rust pustules, as shown in the picture, are smaller, more circular and usually appear to be orange in color.

Leaf rust of oats is sometimes called "crown rust." It may be distinguished from stem rust of oats by the same characteristics as listed above, except that the pustules of leaf rust of oats are much larger than those of leaf rust of wheat.

Keep Nebraska Grain Out in Front!

1. Control Diseases

Rust—

Eradicate barberry.

Plant resistant varieties when available.

Avoid late maturing fields.

Smut—

Treat the seed.

Plant resistant varieties.

And don't forget these other practices—

2. Plant the VARIETIES RECOMMENDED for Your Locality

3. Use Pure Seed

Free from rye.

Free from weed seed.

Free from variety mixtures.

4. Harvest Carefully

Avoid cracking.

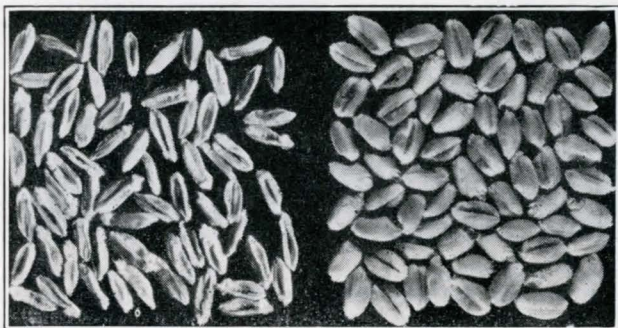
Allow grain to mature.

Harvest only when dry.

5. Store Grain Properly

Clean and spray bins to avoid insect infestations.

Store only dry grain. Moisture content must not be over 12 per cent for safety.



The grain at the left was shriveled by stem rust. Quality grain like that at the right means gains for farmers, industries and consumers.

Acknowledgement is made to the Conference for the Prevention of Grain Rust, Minneapolis, Minnesota, for assistance in preparation of illustrative material, and to the Division of Plant Disease Control, Bureau of Entomology and Plant Quarantine, Washington, D. C., for assistance in preparation of this circular.

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