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×THE STORY OF BLACK STEM RUST  
OF GRAIN AND THE BARBERRY

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Black stem rust of grain is known to every farmer in Minnesota and the neighboring states. In 1916, a bad rust year, it caused a loss of about 30,000,000 bushels of wheat in Minnesota. In 1917, altho not a bad rust year, the loss through rust in the whole United States was estimated at about 16,000,000 bushels, or 1½ per cent of the total crop.



Fig. 1. Clean and Rusted Wheat

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## WHAT IS THE RUST?

Rust is a parasite which lives on wheat, oats, and other grains, and on grasses, from which it steals its food. When the rust attacks the grain plant, it causes a serious disease which injures the plant, reducing or totally destroying the yield. Rusted plants produce light-weight, shrivelled grain, and at harvest time the straw is marked with numerous black stripes and is often crinkled and broken.



Fig. 2. Plump and Rust-Shriveled Grain

### LIFE STORY OF BLACK STEM RUST (See Figure 3)

The rust parasite is a fungous plant of microscopic size and is made up of very small, much branched, thread-like strands which grow inside the leaves and stems of the grain plant. The parasite spreads from one wheat plant to another by means of very small bodies called spores which act somewhat as do the seeds of other plants. The rust parasite has several kinds of spores and each kind is especially adapted to its particular use and season. In the summer the rust produces on the wheat or other grain the red or summer spores. These are egg-shaped and orange red in color. They are formed in stripe-shaped pustules just under the "skin" of the leaf or stem, which is broken open to release the spores into the air. These red summer spores are formed in great numbers and are so numerous that they form clouds of red dust when the binder goes through the field. They are so small and so light in weight that they are easily taken up by the wind and carried to neighboring plants or they may be carried many miles and start the disease in a new place. When a summer spore falls on another wheat plant and when it becomes moistened by a drop of dew or rain, it sends out a little thread which grows into the wheat plant and starts another infection and thus more rust. When the season is favorable, the summer spores spread the disease so rapidly and so widely that a general epidemic with a tremendous loss in yield results.

At about harvest time, a new kind of spore is produced, viz., the black or winter spore. This spore is also formed in stripe-shaped pustules, but in this case the pustules are black and are found mostly on the stem or head. These black pustules, or stripes, are very conspicuous and are formed when the damage from the disease becomes most evident and hence the farmer speaks of the rust as the "black rust." The black stripes of winter spores remain on the straw and stubble over winter and do not develop until late in the spring, viz., in April or May. The winter spore is not generally carried by the wind, but germinates on the straw where it was formed. When it germinates, it sends up one short thread from each of its two compartments and on each of these

<sup>1</sup> There are several distinct kinds of rusts on grains and grasses, but of these the most serious is the black stem rust. This bulletin deals only with this kind.

threads it usually forms four very small, round, colorless spores (sporidia). These tiny sporidia are now blown about by the wind and may again propagate the disease, but they are not able to infect another wheat or oats or grass plant. They can only continue to develop the disease if they fall on a totally different plant, viz., the common barberry, which is an ornamental shrub grown in lawns and gardens and often used for hedges.

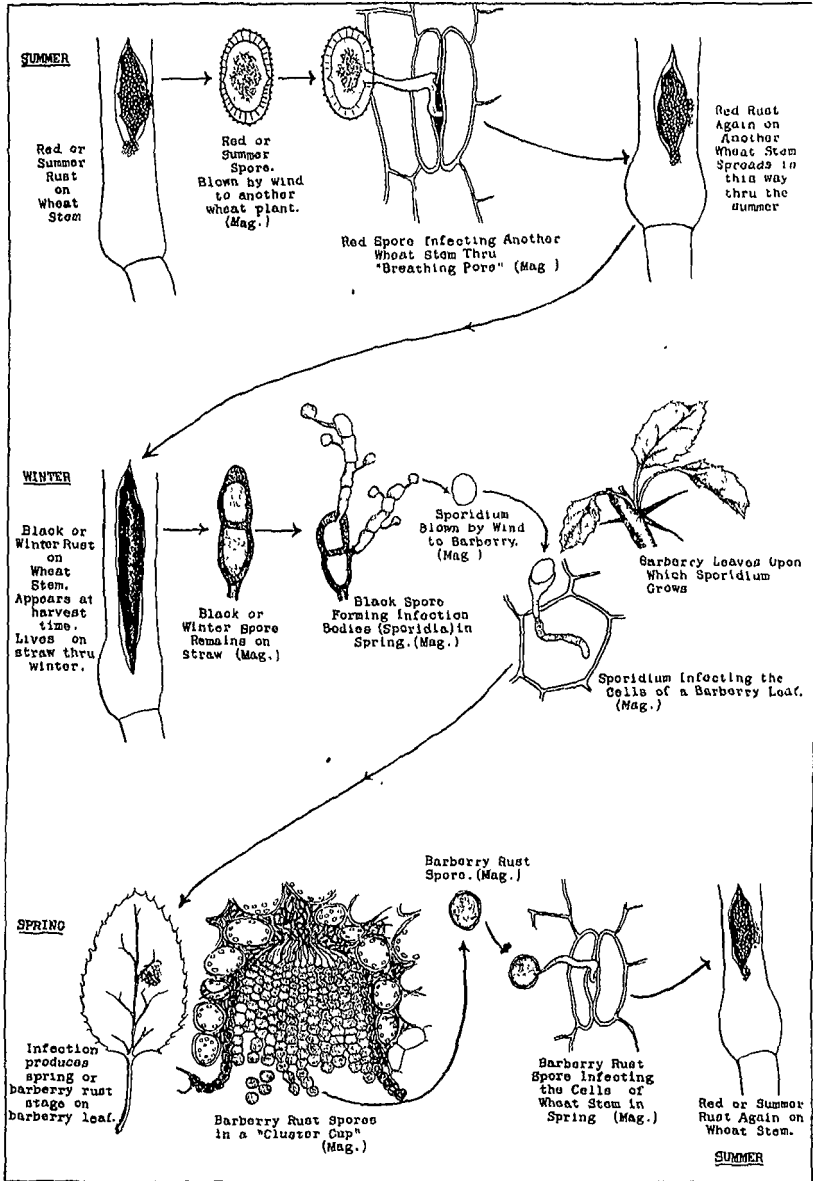


Fig. 3. Life Story of Black Stem Rust of Wheat  
Follow the arrows. (Mag.=magnified—as seen through the microscope.)

### The Barberry Stage of Rust

On the leaf or fruit of the barberry the sporidia from the winter spore may start another infection and from this infection there is produced from early in May until midsummer, or, sometimes late summer, still another kind of spore called the cluster-cup spore. It gets this name from the fact that on the yellow and swollen spots on the barberry leaf, clusters of small orange-colored cups are formed and in each cup a large number of reddish spores are produced in long chains. These spores are also picked up by the wind and again the disease is spread, but here again the spores can not infect the same kind of plant on which they were formed, that is, they can not infect another barberry plant. If, however, they fall on another wheat plant under favorable conditions, they will infect the wheat plant and from this infection the summer spores are once more produced. The summer spores then continue to spread the infection as described.

### SUMMARY OF LIFE STORY

The life story may be briefly summarized as follows: (1) The red or summer spores spread the disease from wheat to wheat or from wheat to grasses and back to wheat. (2) The winter spores formed on wheat or grasses at harvest time remain on the straw until spring when by means of sporidia the infection of the common barberry takes place. (3) The cluster cups, or spring spores, on the barberry start the infection again on the wheat or grasses. Figure 4 illustrates the round-the-year travel of the rust.

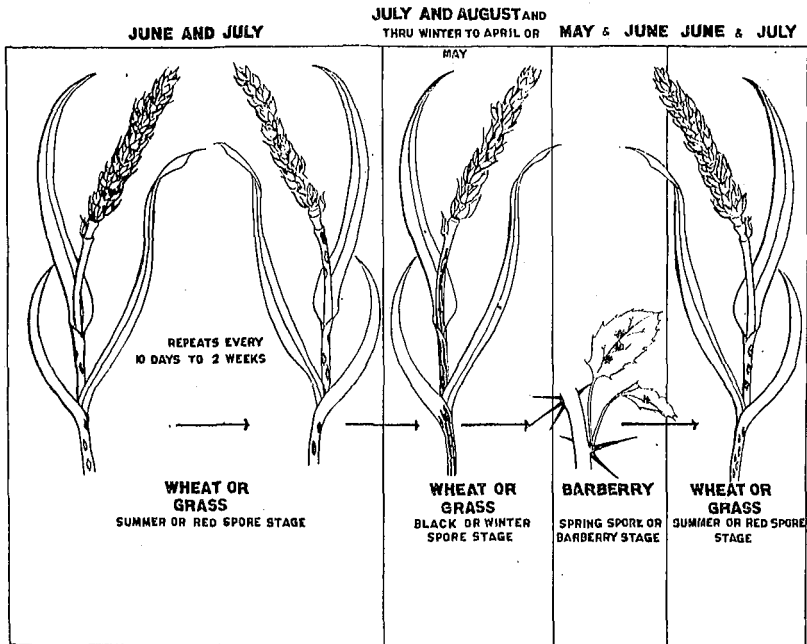


Fig. 4. Yearly Travels of Black Stem Rust of Wheat

### EFFECT OF WEATHER

Many people think that rust is caused by weather, especially wet weather. They are only partly right. The real cause of the rust is a parasite, but the weather greatly affects the development of the parasite. In some years the

weather is favorable to the development of the rust and then epidemics occur. One must keep in mind, however, that the weather may be favorable at one stage, for instance, the barberry stage in May and June, but not favorable for the development of the summer and winter stages in July and August. If the weather is favorable for all of them, a heavy epidemic occurs. The most favorable weather for the development of the summer stage is that in which cool nights with heavy dews alternate with warm, muggy days. Heavy dews furnish excellent moisture conditions, but heavy rains wash a great many of the spores down into the ground. Very hot, dry weather is unfavorable to the rust. Cool weather or any other condition which delays the ripening of the grain gives the rust more time for development.

### GRASSES AND THE RUST

Black stem rust of grains also lives on certain wild and cultivated grasses and, in the summer spore stage, can pass freely from wheat to these grasses and back again to wheat. The wheat rust goes especially to wild barley (squirrel-tail) grass, western wheat grass, and many other grasses. In fact, practically all of our wild and cultivated grasses are attacked by some grain rusts. It would be a great help in fighting rust if such a weed grass as wild barley could be completely eliminated, but of course this is not practicable. It is very clear, however, that clean farming—i.e., clean cultivation and keeping down weeds and grasses in fence corners and old pastures and on roadsides—will help to reduce the chances for rust, and if every farmer would keep his farm as clean as possible from these weed grasses, it would undoubtedly help in the control of rust.

But these grasses are even more important from another point of view. Especially in the southern states and to a more limited extent in Minnesota and neighboring states, the rust may sometimes live over winter on grasses or winter grains and on volunteer grains in the summer or red spore stage. This is especially important because this summer spore stage is the only stage which can go directly from these grasses to wheat, since the winter spore stage must go first to the barberry. Thus it is seen that some rust can probably live through the winter without the barberry, but experience shows that in Minnesota this method of living over the winter is not so important as the barberry stage. Nevertheless it must be reckoned with, and emphasizes the necessity of keeping down as nearly as possible the wild barley and other weed grasses.

### EARLY VARIETIES AND RUST

Experience has shown that early varieties of grains are very valuable in Minnesota. One reason for this is that early varieties frequently ripen their grain before the rust is able to injure them. All of our early hard spring bread wheats, such as Velvet Chaff and Marquis, may, however, be very seriously injured by rust if the rust gets an early start and if weather conditions are favorable. While, therefore, it is very important that early varieties be grown if possible, it must be kept in mind that early varieties are by no means a sure cure against rust. The importance of barberry lies chiefly in the fact that it enables the wheat rust to get an early start.

### RUST RESISTANT GRAINS

It is a commonly known fact that some of the wheats known as durum or "macaroni" wheats will produce excellent crops even in a heavy rust year. They are resistant to rust—not because of an early-ripening habit, but because the rust is not able to injure them. It is first of all important to notice that not

all durum varieties are resistant to rust, but several varieties are known which have been proved by experience to have constant resistance. In growing rust-resistant durums one must also keep in mind: (1) that for milling purposes durum wheat is usually considered not so valuable as hard spring wheats; (2) that durums are especially adapted for the drier regions (Western Minnesota and the Dakotas); and (3) that other diseases, as scab, may attack durum wheats just as heavily as the hard spring wheats and in some cases more seriously.

Can rust-resistant, hard spring wheats be bred by crossing the resistant durums with the hard springs? The Minnesota Agricultural Experiment Station and the United States Department of Agriculture have been working on this problem for more than ten years. It has been shown that resistance can be "bred" into the hard spring wheats, but up to the present time no wheat of this kind has been developed which has in addition to rust resistance all of the most desirable characters which the best bread wheats now grown already have: viz., high yield, good milling qualities, strong straw, etc. Moreover, such a wheat must be able to maintain its characters under a variety of field conditions and hence must be tested for several years. While promising results have already been obtained, the ideal wheat variety has not yet been developed. It is furthermore encouraging to note that certain hard winter wheats developed at the Kansas Agricultural Experiment Station have proved rust-resistant as well as excellent from other standpoints. The breeding work at University Farm will be continued and will be pushed as rapidly as possible.

#### CAN RUST BE TRANSMITTED THROUGH THE SEED?

In bad rust years rust is often found on the shrivelled grains of the wheat but this does not necessarily indicate that the rust is transmitted through the seed. In fact, experience shows that the **seed grain probably does not transmit the rust** to any extent. Grain from rusted fields can be used without any increased danger from rust. This does not mean, however, that shrivelled grain should be used. Only good plump seed, whether from rusted or unrusted fields, should be used if it can possibly be obtained. Seed grain from a rusted field of common hard spring wheat will not by any means insure the crop against rust. It is also clear that seed treatment, such as is used so effectively against smut disease, has no effect at all on the rust in the resulting crop.

#### WHAT CAN BE DONE TO FIGHT RUST?

No sure cure for rust on all our grains is yet known. The following measures will help to keep down rust and may prevent it in some years:

Clean cultivation, good seed, early planting, thoro preparation of the seed-bed, destruction of weed grasses, rotation of crops, good drainage, and avoidance of the planting of grains in low, cold-air pockets, are steps in the right direction, but will not save the crop in a rust year. Excessive amounts of barnyard manure should not be used because ripening may be delayed, thus giving the rust a better chance for development.

Certain varieties of durum wheats may be grown where conditions are favorable for these wheats.

Early maturing and non-lodging varieties of grains frequently escape the rust but may go down in bad rust years.

Breeding new and rust-resistant varieties requires specially trained men and equipment and may take years to accomplish.

**Get rid of the common barberry all over Minnesota and throughout the neighboring states.** The United States Department of Agriculture is con-

ducting a large campaign of publicity throughout the North Mississippi Valley, and all of the states involved are preparing to join in an effort to completely eliminate the common (**but not the Japanese**) barberry. Every citizen can help in this movement whether in the cities or in the towns or in the country.

The Minnesota Commission of Public Safety has recently ordered the immediate destruction of all common barberries in the state. It has also prohibited their sale within or importation into the state (Order No. 28).

### The Fight Against Barberry

The charges which are brought against barberry in relation to grain rusts are briefly: (1) it propagates the worst rust, viz., the black stem rust of wheat and other grains. (2) It is practically the only plant upon which the winter stage of the rust, which comes from the wheat straw, can continue to develop more rust. (3) It starts the rust disease early in the growing season and if weather conditions are favorable, the rust may spread many miles in all directions to grasses and grains and from these spots the disease continues to spread until the rust becomes general over large areas.

The experience of farmers in Europe and the United States for over 100 years has shown without a doubt that barberry when grown near wheat fields causes serious rust epidemics. The experiments and observations of many experts in Europe and America in more recent years have shown **conclusively** that barberry, even when grown in towns and cities, is an important factor in the great epidemics of rust which have occurred, as in 1916, over such large areas as the whole North Mississippi Valley. As a commercial plant, the common barberry is of almost no importance at all. As an ornamental shrub it can very easily be dispensed with—other shrubs can be used and the Japanese barberry, which does not propagate rust, is considered a better variety.

Manitoba and North Dakota have passed laws compelling the eradication of all common barberries. South Dakota has placed the common barberry in the class of noxious weeds. **Denmark eradicated the barberry in 1903 and has had no rust epidemics since that time.**

What can we expect to be the certain or probable results of the eradication of barberry? *The complete elimination of barberry will* (1) **certainly** reduce the amount of grain rust and it will **certainly** help the other efforts which are being made to fight the rust; (2) it will **probably** cut down the rust considerably; and (3) it may **possibly** be the controlling factor in the fight against rust.

### How to Get Rid of the Common Barberry

**Dig it up and destroy it. Do it now.** The order (No. 28) of the Minnesota Commission of Public Safety says "forthwith." Remember that the rust begins to appear on barberry in early May and continues until the middle of June and even later.

Be sure to get the whole crown and the larger roots so that it can not sprout again. If it does sprout again, go after it until you get it. Do not destroy the Japanese barberry. It is a safe alien. Learn to recognize both varieties as described and pictured below. Report the presence of any common barberries to the owner or occupant of any premises in your neighborhood. If he does not have them dug up at once, report the location to the State Entomologist, University Farm, St. Paul, who is the agent of the Minnesota Commission of Public Safety for the eradication of the barberry. He will inspect the plants and have them dug out.

**Remember that if you have dug out the common barberry, you have made the wheat crop of Minnesota more nearly safe against the dreaded rust disease.**

## HOW TO KNOW THE COMMON BARBERRY AND THE JAPANESE BARBERRY

Both the common barberry (*Berberis vulgaris*) and the Japanese barberry (*Berberis thunbergii*) are cultivated perennial shrubs grown as ornamental plants in gardens and lawns, or in hedges. They do not grow wild in Minnesota. They both have spiny stems and reddish berries that hang on the bushes over winter. There are two varieties of the common barberry; one green leaved and the other purple leaved—both must be destroyed. The Japanese barberry has green leaves. Figure 5 shows the chief differences between the two.

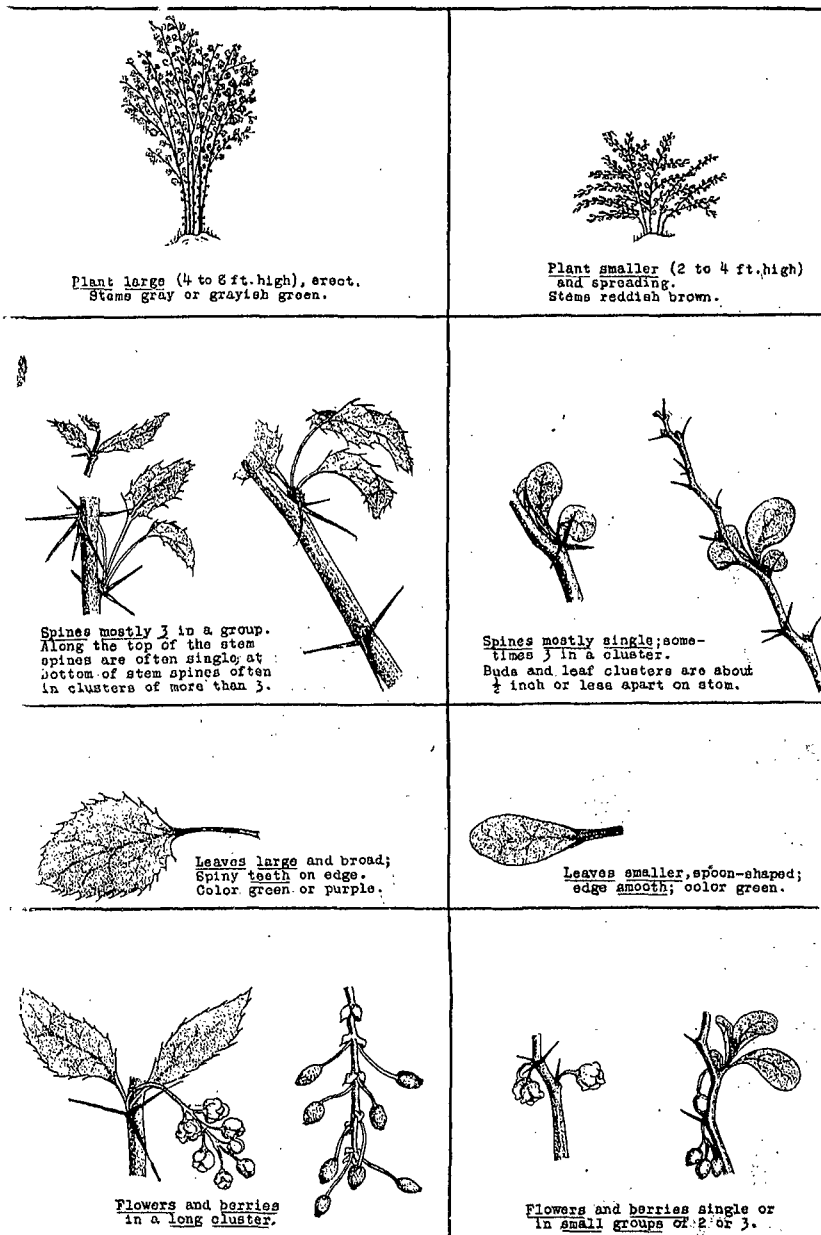


Fig. 5. Common Barberry  
It harbors and propagates black stem rust of grain

Japanese Barberry  
It does not harbor or propagate black stem rust of grain