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2-1-1948

### Stem Rust

C. M. Nagel

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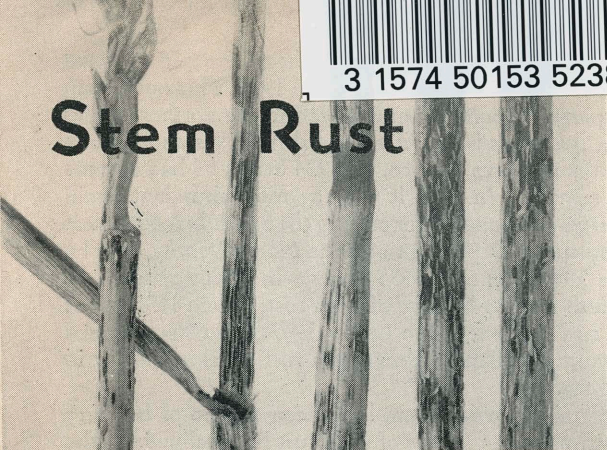
Nagel, C. M., "Stem Rust" (1948). *SDSU Extension Leaflets*. 110.  
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# Stem Rust



Stem Rust on Grain

BELOW: The raised spots on the barberry leaves are orange-colored and honey-comb-like in appearance. They are produced by the stem rust fungus (a mold). Although the disease appears different from that on grain stems, it is caused by the same organism.

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Extension Leaflet 110

February, 1948

AGRICULTURAL EXTENSION SERVICE  
S. D. AGRICULTURAL EXPERIMENT STATION  
South Dakota State College  
U. S. DEPARTMENT OF AGRICULTURE



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S087



# Stem Rust

C. M. NAGEL\*

**There Are Several Reasons Why the Stem Rust Disease of Small Grains and Forage Grasses Is Important to the People of South Dakota.**

When stem rust ruins grain, the tragedy begins with the farmer, plagues related industry, and ends with the person who buys the finished product.

**THE FARMER.**—The major cost to the farmer (his seed, labor, etc.) in producing the grain crop has already been paid when stem rust strikes. When rust appears in the grain field it is too late for practical control measures. Fewer bushels are produced per acre for market or for feed. The production cost per bushel is increased. Rusted grain is shriveled, light in test weight, and therefore, brings a lower price at the elevator.

**INDUSTRY.**—The dependence of industries upon the grain crop was tragically emphasized when the spring wheat farmer in one year lost an estimated 100,000,000 bushels valued at \$65,000,000 because of stem rust—sixty-five million dollars worth of purchasing power lost.

The 100,000,000 bushels represented a total of approximately 75,000 car loads of grain which would have been moved to market.

Local merchants and others who had advanced credit on the strength of the crop prospect could not collect their money.

Wholesale firms had millions of dollars worth of orders cancelled.

**THE CONSUMER.**—The 100,000,000 bushels destroyed by stem rust within a period of a few weeks meant the loss of a vast amount of food and feed.

The jobs which would have been required to harvest, transport, process, and distribute the 100,000,000 bushels of grain vanished.

The opportunities to produce and distribute manufactured articles and services disappeared when stem rust reduced the farmers' purchasing power.

When a destructive plant disease strikes and brings about such a great financial loss to a crop in a wide region, not only is the farmer severely set back financially, but nearly every individual gainfully employed is likewise more or less affected.

## 75% Decline In Stem Rust Losses

In the past, stem rust has been one of the most destructive diseases of small grains in the United States. It is caused by a fungus which spreads by means of tiny dust-like spores or "seeds." The spores are carried many miles by the wind and, if weather conditions are favorable, infection occurs whenever

\*Head, Department of Plant Pathology, South Dakota Agricultural Experiment Station. This leaflet was prepared at the request of the Agricultural Extension Service. The writer wishes to acknowledge the assistance given in the preparation of this manuscript by the personnel of the Division of Plant Disease Control, Bureau of Entomology and Plant Quarantine, U. S. Department of Agriculture. The illustrations were furnished through the courtesy of the Conference for the Prevention of Grain Rust.

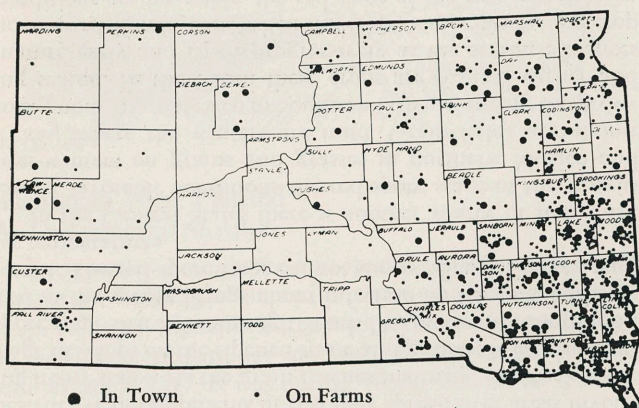
they light on susceptible grain or grass plants. One stage of the rust can grow only on rust-spreading barberry bushes.

Losses from damage to the grain crops in the United States caused by stem rust have exceeded 200,000,000 bushels in a single year. In the 13 Upper Mississippi Valley states where stem rust control practices have been underway for 30 years, average yearly losses from stem rust have been cut in approximately half.

South Dakota has lost as high as 64 per cent of its wheat crops in one year because of rust. An average of 8,358,000 bushels of grain were destroyed by stem rust in South Dakota during the period of 1916 to 1929. The average yearly rust loss was reduced to less than 2,000,000 bushels during the succeeding 15-year period from 1930 to 1944, a reduction of more than 75 per cent.

This reduction in losses from stem rust is the result of:

1. Elimination of more than 136,000 rust-susceptible barberries located on more than 1,500 farm and town places distributed throughout the state, because the barberry plays a



Where barberry bushes were destroyed 1918 to 1947

### Facts About Stem Rust

1. If there were only one kind of stem rust, it would be easy for Experiment Station workers to develop varieties of small grain resistant to that kind of rust.
2. But there are now 200 different strains of stem rust which attack wheat, and new ones develop every year. In developing new varieties of grain, it is difficult to keep pace with the new strains of rust which are produced on barberry leaves. A grain variety resistant to a known rust this year may be attacked by a new rust next year.
3. The most important way in which new kinds of stem rust can originate is by the crossing of rust strains on rust-infected leaves of the barberry plant.
4. THEREFORE, eliminate the barberry and you help prevent the production of new kinds of stem rust.



major part in the life cycle of this important plant disease.

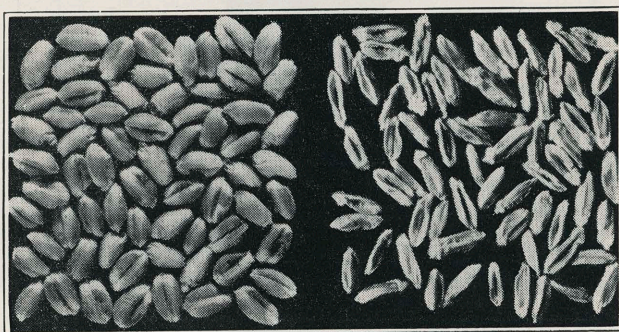
2. Development and adoption of resistant varieties. The South Dakota Agricultural Experiment Station, the U. S. Department of Agriculture, and experiment stations in adjacent states are constantly testing and developing varieties of small grains to obtain varieties more resistant to stem rust and other diseases.



Superior varieties in the making—this is an experimental small grain plot where new varieties are developed. County Extension agents conduct demonstration plots throughout South Dakota. Seeing the agent or visiting one of these plots is the best way to find which variety is best for your locality.

3. Insuring early development and maturity of small grains. Generally, the earlier a grain field matures the greater are its chances of escaping damage from stem rust. Seeding spring grains just as early as the soil can be properly prepared and seeding fall grain as nearly as possible in accord with the recommended seeding dates, aids in assuring an early maturing crop.

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



From Healthy Plants                      From Rusty Plants  
Heavily rusted small grain plants produce shriveled kernels



# Why Barberry



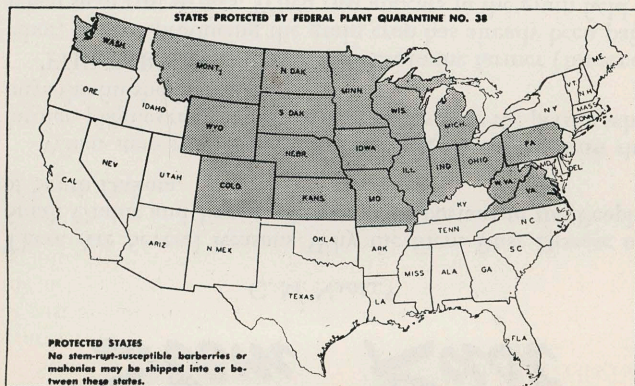
Destroying a large volunteer rust-spreading barberry bush growing next to a fence

such farm practices as will produce strong, healthy, early-maturing plants.

## Cooperative Effort Required to Successfully Conduct Program

Since the rust spores are carried long distances by the wind and many states are involved in the ultimate control of the disease, the state and federal governments have a joint responsibility in conducting the program to control stem rust.

Eighteen states: South Dakota, North Dakota, Montana, Minnesota, Nebraska, Colorado, Iowa, Wyoming, Washington, Missouri, Wisconsin, Illinois, Indiana, Michigan, Ohio, Pennsylvania, West Virginia, and Virginia are actively engaged with the United States Department of Agriculture in a cooperative project to destroy all rust-spreading barberry bushes.





# Barberry Eradication Is Important

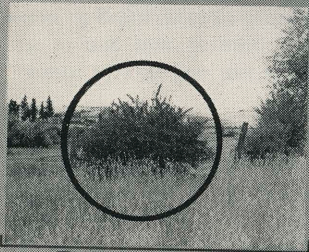
## Where Does Stem Rust Originate Each Season?

The source of stem rust on small grains and grasses in the northern states is from the spores produced in early spring on rust-infected leaves of the barberry plant.

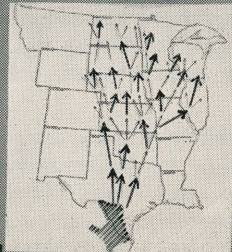
The rust survives the winter in the black spore stage on grain stubble, in straw piles, and on wild grasses. These spores cannot attack new crops of grains and grasses in the spring, but they do infect the leaves of susceptible barberry bushes in the spring. The rust spores which develop from rust infection on barberry leaves are capable of transmitting the disease to nearby wild grasses and grain plants. Within a few weeks the red or summer stage of the rust develops on the stem of these plants. Once this stage becomes established on grain plants, and humid weather prevails, the rust spreads very rapidly from plant to plant and from field to field over large areas. When weather and crop conditions are favorable, these local destructive developments of rust may spread over areas involving many states. As the grain reaches maturity, the black-spore stage develops on the ripened straw and grasses. It is this black-spore stage that lives through South Dakota winter conditions, and in the spring brings about infection on the new barberry leaves. The red spore stage cannot survive South Dakota winter temperatures.

In the Central States there is another source of stem rust. Under favorable conditions the red spore stage of the fungus over-winters on grains and grasses in northern Mexico and Texas, where the winters are mild. Grain fields are almost continuous from Mexico to Southern Canada during the growing season. In the South these crops are planted earlier and mature early and ripen progressively as the season advances northward. Some years, when moisture, temperature, and crop conditions are favorable, the red stage of the rust increases on the grain in the South, producing billions of spores. These spores are swept northward hundreds of miles by the wind and settle on grain fields where they infect the growing plants. The

## THERE ARE TWO SOURCES OF STEM RUST



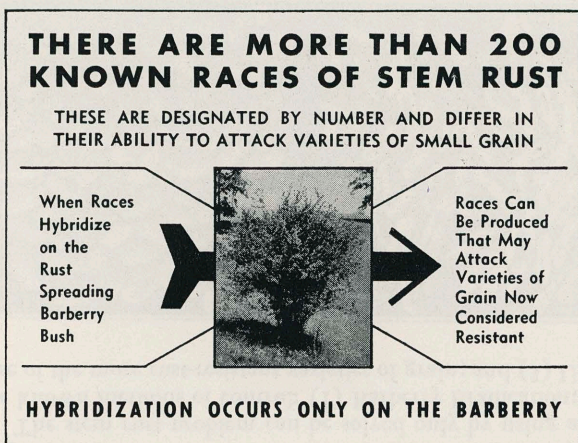
THE BARBERRY



THE SOUTH



# Important To You



spores produced on the newly infected grain are carried still farther north by the wind, and in this manner the rust may increase to damaging proportions. Wind, moisture, temperature, and the condition of the grain must all be favorable at the right time for the development and spread of stem rust.

## New Stem Rust Strains Originate On Rust-Infected Barberry Leaves

Just as there are many varieties of wheat, oats, barley, and rye, there likewise are many varieties and strains\* of stem rust. Certain varieties of grain are highly resistant to some of these strains, but very susceptible to others. Experiments have shown that the origin of these strains is almost exclusively traced to rust infection on the barberry. New strains of stem rust are produced when two existing strains of the organism cross following infection of the barberry leaf.

It has been shown repeatedly that a greater number of strains are found on grains and grasses close to barberry bushes than in areas where there are no barberries. In areas where barberries are infected, new strains of rust are often found which do not exist elsewhere. Considered on a world-wide basis, more than 200 different strains of stem rust have been identified that infect wheat, 13 that infect oats, and 14 that infect rye. Some of the wheat and rye strains also infect barley.

The presence of many strains of stem rust and the increase or decrease of these strains accounts partly for the difference in stem rust resistance of small grain varieties from season to season. It explains, too, why a small grain variety that is resistant in one locality may be attacked by stem rust in another region.

This situation is well illustrated by the increase in the amount of the rust spores of "Strain 56" and the serious stem rust damage caused to Ceres wheat in the eastern South Dakota spring wheat area in 1935. Further, the crop was virtually a

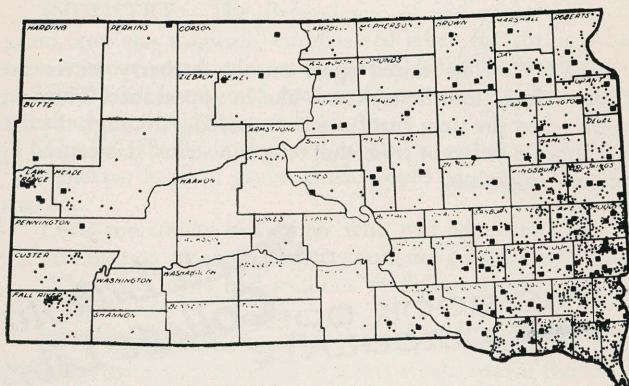
*\*For purposes of clarity, the word "strain" is being substituted in this publication for the more technical term, "race."*



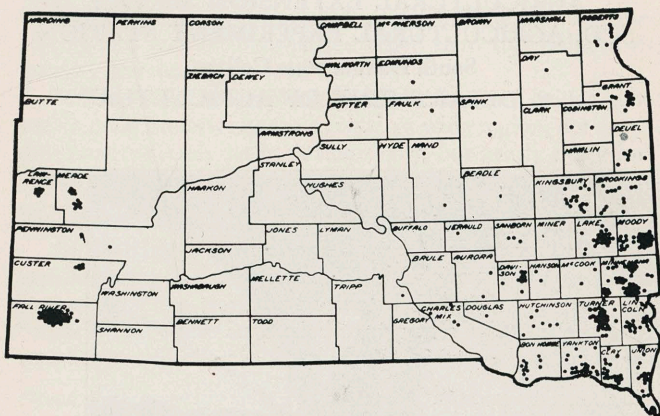
failure for the same reason in many regions in the Upper Mississippi Valley states.

Strain 56 was first identified from wheat stem rust collected near barberries in Nebraska and Iowa in 1928. This new strain of rust apparently increased and spread in the northern states for at least five years before it appeared in Texas and became established in northern Mexico. By 1934 Strain 56 had become generally common. In 1935 it was the most abundant strain and was largely responsible for cutting the South Dakota wheat crop an estimated 29 per cent and the North Dakota crop by more than 50 per cent. In 1935 Ceres wheat was a failure in eastern South Dakota because of stem rust; before 1935 it had been stem rust resistant. From 1935 to 1947 Strain 56 continued to be the most abundant strain of stem rust attacking wheat in South Dakota.

As the grain growing areas have been cleared of barberry bushes, the number of strains of stem rust has declined. As the strains become fewer in number and more stabilized, it will be less difficult to produce and maintain varieties of grain that are resistant to the stem rust fungus.

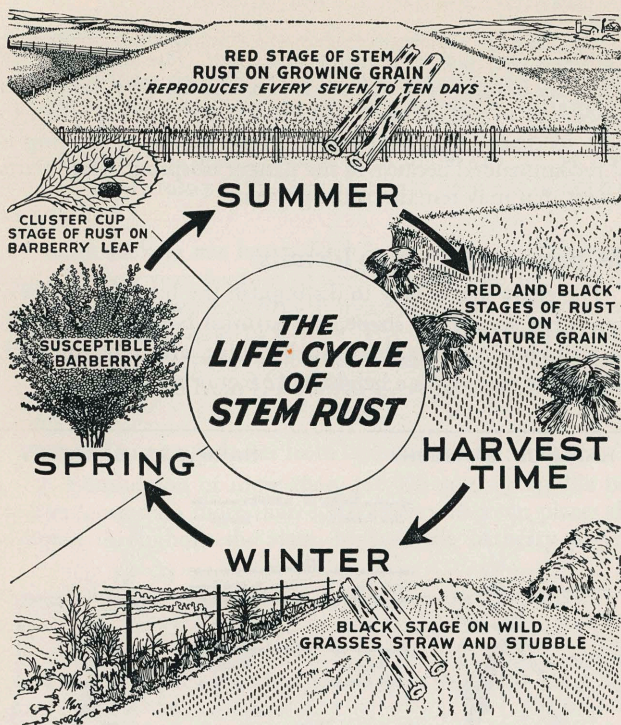


Where common barberry bushes were originally planted for ornamental, hedge or garden purposes



Each dot shows where "volunteer" common barberry bushes have been found. These were not planted by man. Seed from bushes planted as hedges was scattered by birds, animals and streams to start these volunteers





## Barberries Were Planted As Ornamental Shrubs

Early settlers brought the rust-spreading barberry to South Dakota for hedge, garden, and ornamental plantings as early as 1870. It was originally introduced to America from Europe by the Colonists. Plantings continued to be made in the state until as late as 1917. It was during World War I that the barberry eradication program was initiated as a cooperative project between 13 northern grain-producing states and the U. S. Department of Agriculture. It was established at that time to aid in controlling the stem rust menace which was cutting down yields of grain needed in World War I.

Ornamental and hedge plantings of barberries were most numerous in eastern South Dakota, and their growth was also most successful in that area.

Many barberries have been found in places where they obviously had not been planted. The older bushes produced berries and seed in abundance. The fruit is eaten by birds, and as a consequence, the seeds become widely scattered. Seeds may lie dormant in the soil for many years before germinating. In areas favorable to the development of new plants from seed, barberries become established as much as two miles or more from the parent seed-bearing bushes. All of the known rust-susceptible barberry bushes originally planted in South Dakota have been destroyed. All of the "escapes" or volunteer bushes thus far found, likewise have been destroyed.



## **YESTERDAY a Contrast with TODAY**

Down through the centuries diseases and insects have plagued plants and animals. As medical, veterinary, and plant research workers have learned one by one the true causes of the various diseases and their respective control measures, much progress has been made in reducing the hazards from such plagues.

The stem rust disease (commonly referred to as "black rust") which attacks wheat, oats, barley, rye and grasses, is one of the devastating plagues recorded in history. Thousands of barberry plantings similar to the one pictured here, and many larger ones, have been found in South Dakota and adjacent states. Before these plantings were destroyed they served to spread the stem rust fungus to small grain.

Instances where a single barberry bush caused extensive spread of stem rust were common before the barberry eradication program was started. The damage this caused frequently resulted in severe losses in grain yields.

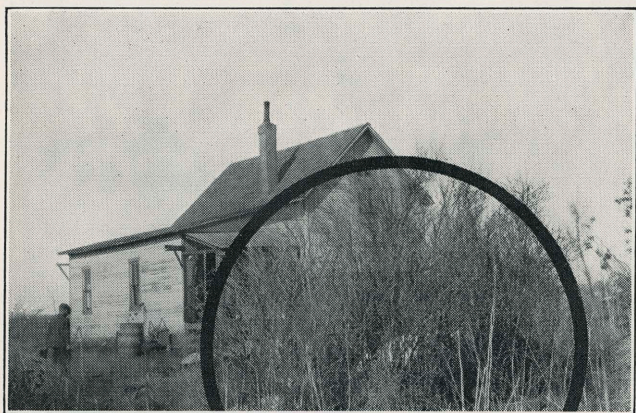
### **Progress Is Made In Destroying Stem Rust Susceptible Barberries**

Since the eradication program began in 1918, more than 136,000 barberry bushes, located on more than 1,500 farms and town places have been destroyed.

First to be eradicated were bushes planted in large ornamental and hedge plantings, which obviously were spreading stem rust and producing great quantities of barberry seed.

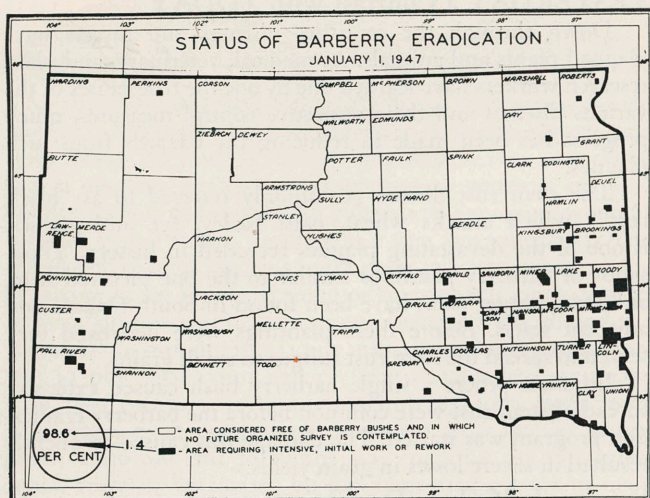
As a result of the eradication program, the number of rust-spreading barberry bushes within the state has been greatly reduced. Those that remain must be destroyed to prevent the reseeding of barberry-free territory and to provide greater protection from stem rust losses.

In many sections of the state there has been a close inspection of virtually every square rod of uncultivated territory where brush and trees were growing. Many barberries have been found as the result of this intensive type of inspection along fence rows, streams, ravines, river islands, timber claims, in canyons, and in other uncultivated places.



This planting of barberry was found in Charles Mix county. Although small in size, it was still an important source for spreading stem rust to nearby grain and grasses. It could also serve as a breeding place for new strains of stem rust





## Two Kinds of Barberry Originally Planted in South Dakota

1. The stem-rust-susceptible barberry (*Berberis vulgaris*).

The stem-rust-susceptible barberry was commonly planted until 1918. Since that date, its planting has been prohibited by state law.

2. The Japanese barberry (*Berberis thunbergii*).

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



Crushed rock salt, 10 pounds per square foot of crown (crown is where roots join the above ground parts) effectively destroys the entire barberry plant. In this picture the man is covering the salt with dirt to prevent livestock from eating it.

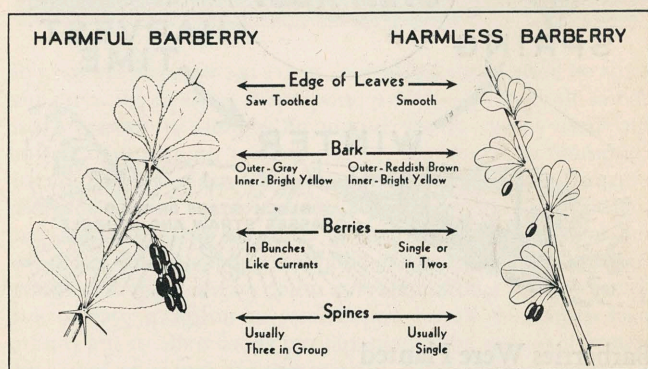


## It Is Easy To Eradicate If Done Correctly

The barberry has an abundance of underground stems that arise from the roots and from the crown. The underground stems may develop into new bushes. This characteristic makes it necessary to kill all the underground parts of the plant to assure its destruction. Eradication of the bushes by digging is not recommended because of the danger of sprouts from parts of roots that may remain in the ground.

## The Barberry Is Easy to Identify

The chart 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

Learn how to recognize this plant which spreads stem rust. It is responsible for losses of millions of dollars annually to farmers' crops. The rust-spreading barberry is a hazard to the production of wheat, oats, barley, rye and grasses.

## Where To Report The Location of Rust-Spreading Barberry Plants

The eradication of the rust-spreading barberry from all of the state is a cooperative effort involving the state of South Dakota and the U. S. Department of Agriculture. The individual may assume his share of responsibility in this work by reporting the presence of suspected bushes to the county agent or to the Department of Plant Pathology, South Dakota State College, Brookings.

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### COOPERATIVE EXTENSION WORK

*The United States Department of Agriculture and South Dakota State College, cooperating. Distributed in furtherance of Acts of Congress, May 8 and June 30, 1914.*—GEORGE I. GILBERTSON, Director