4-1920

Barberry Eradication

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Extension Circular No. 33 April 1920

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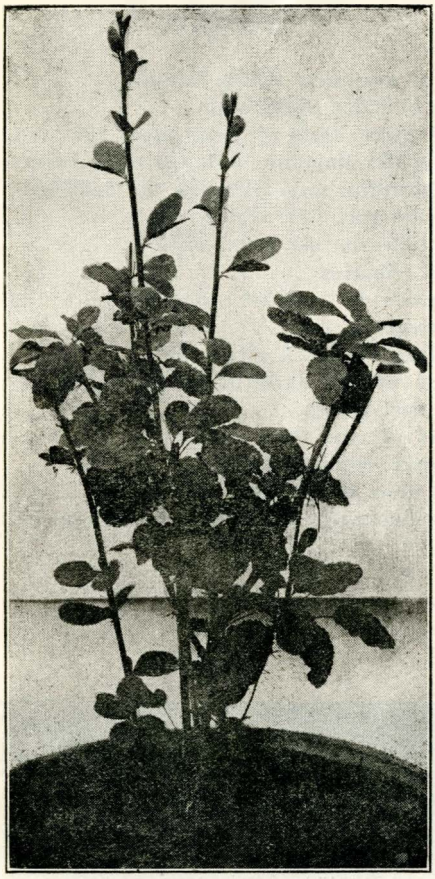

Japanese Barberry

EXTENSION DIVISION
SOUTH DAKOTA STATE COLLEGE OF AGRICULTURE AND MECHANIC ARTS
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Cooperative Extension Work in Agriculture and Home Economics, South Dakota. State College and U. S. Department of Agriculture Cooperating

BROOKINGS, SOUTH DAKOTA

BARBERRY ERADICATION

By

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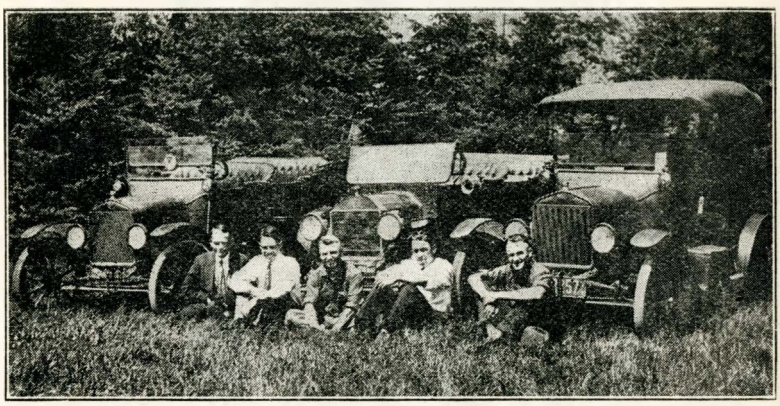

Men in Barberry Eradication With the Machines Used in Scouting and Rural Survey Work. From Left to Right: R. O. Helland, H. C. Gilbert, Lynn Hutton, Harold Hoover and J. F. Holmes, 1919.

BARBERRY ERADICATION

The work of barberry eradication has been carried on for two years. This circular is a report on the work done, with notes on the black stem rust. The work is cooperative between the United States Department of Agriculture, Office of Cereal Investigations, and the South Dakota State College Extension Division and Agronomy Department.

The statements and figures given herein are for the state of South Dakota unless otherwise noted. They are well founded on accurate observations, experiments or other sources of information. More detailed information will be given gladly to those who desire it.

The damage to the grain caused by the black stem rust is due to the fact that the diseased spots of the rust break through the outer layer of the wheat stems and also infect the channels in the stem of the grain through which the sap rises to the head of the grain. The food supply that the plant would normally use to mature sound plump kernels of grain is then taken from the stem by the rust and used to mature the rust spores. The grain is damaged slightly or severely according to the amount of rust which

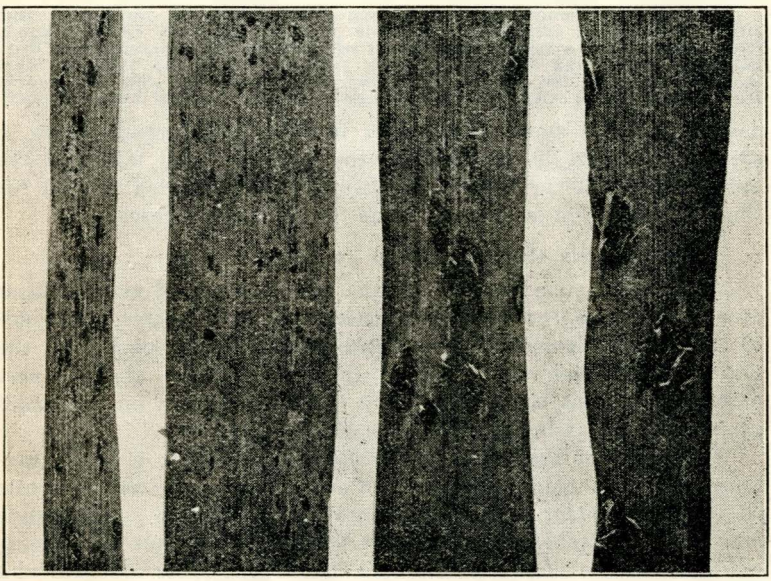

Plate 1. A Comparison of Orange Leaf Rust (Puccinia Tritiena) and Black Stem Rust (Puccinia Graminis Tritici) of Wheat. No, 1 and 2 Orange Leaf Rust of Wheat on the Leaves. The Pustules are small and the Spores Orange Colored. No. 3 and 4 Black Stem Rust of Wheat, The Pustules are Large and the Spores Red. Photographed July 7, 1919. Enlarged 3½ Times Natural Size. Original.

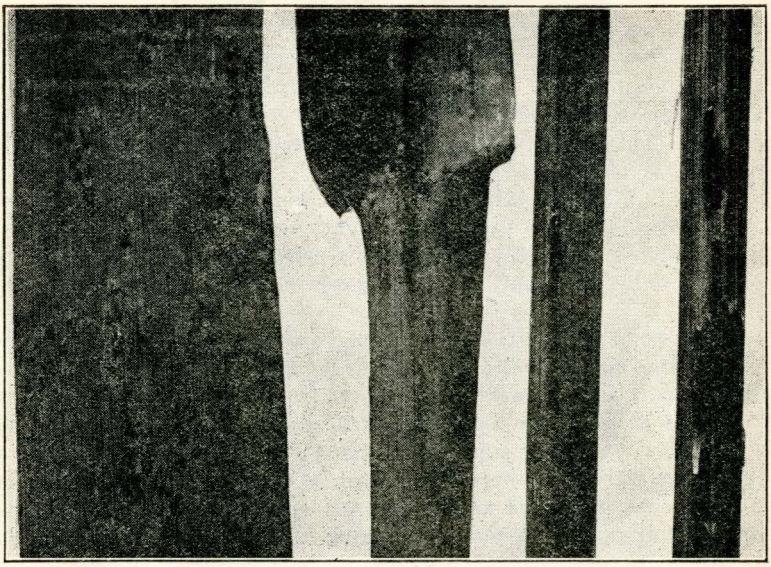

Plate 2. A Comparison of Crown Rust (Puccinia Coronata) and Black Stem Rust (Puccinia Graminis Avenae) of Oats (Avena Spp.). No, 1 and 2 Crown Rust (Leaf Rust) of Oats on the Leaves. The Pustules are Small and the Spores Dark Yellow. No. 3 and 4 Black Stem Rust of Oats on the Stems. The pustules are Large and the Spores Red. Photograph July 7, 1919. Enlarged 4 Times Natural Size. Original.

develops on the stem. The result is light-weight grain which in severe rust years is composed of the outer or bran layers of the kernel with little or none of the starchy center which is used for flour. Such grain is of little value for milling purposes.

Six Rusts of Grains in South Dakota

The black stem rust is but one of a number of rust diseases of grains. It is the most destructive and best known. Because of this fact many people have called all of the rust on any of the grains black stem rust. This is incorrect. There are five rust diseases of grains commonly found in South Dakota on the small grains which may be confused with black stem rust.

Orange leaf rust **(Puccinia triticina)** on wheat is often confused with the black stem rust **(Puccinia graminis tritici)** while as a matter of fact it is an entirely different disease. The orange leaf rust appears on the leaves of the wheat in June in orange-red spots. (See plate I Fig. 1 and 2). These spots are oval and often very abundant. They differ from the black stem rust in that the spots are much smaller and lighter in color. They are on the leaves while the black stem rust appears on the stems or sheaths and seldom on the leaves.

Crown rust of oats (**Puccinia coronata**) is another of the rust diseases. It attacks only oats and causes orange colored spots chiefly on the leaves. (See Plate 2 Fig. 1 and 2). Like the orange leaf rust of wheat this disease differs from the black stem rust in that the spots or pustules are smaller and lighter in color. They are also on the leaves and not the stems. Crown rust will not attack wheat nor will orange leaf rust attack oats.

The yellow stripe rust (**Puccinia glumarum**) of wheat, barley, and rye, the brown leaf rust (**Puccinia dispersa**) of rye (See plate 3), and the dwarf leaf rust (**Puccinia simplex**) of barley are others of the group of rust diseases which are found in South Dakota. These are not as abundant or important as the other rust diseases mentioned above.

Life Story of the Black Stem Rust

There are three stages in the life story of black stem rust. During the summer the disease develops in the grain plant and breaks out on the stems or leaves in small spots (pustules), as shown in plate 4. The spores of the disease develop in these pustules on the stem or leaf. The spores which develop in the summer are red and are dust-like, so that they may be blown in the wind for many miles. This stage of the disease will reproduce

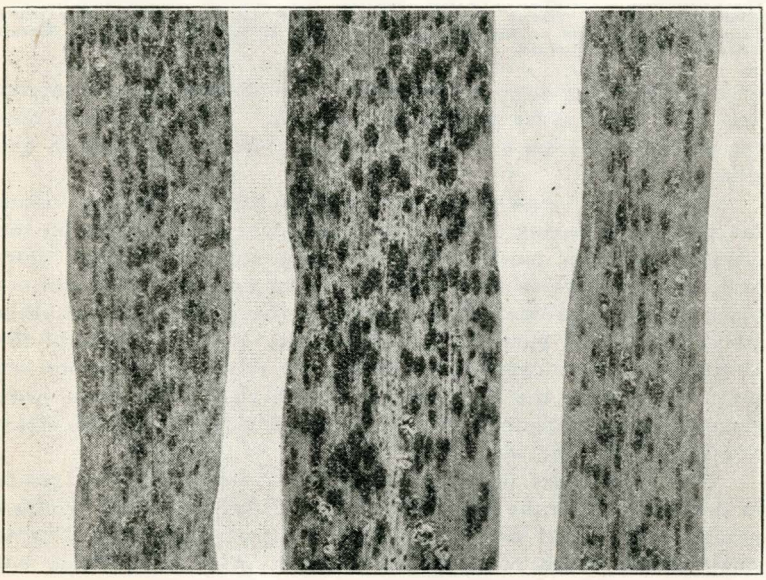

Plate 3. Brown Leaf Rust (Puccinia Dispersa) of Rye. This Rust is Often Very Abundant on the Leaves of Rye. It is often Mistaken for Black Stem Rust, Photograph July 25, 1919. Enlarged 5 Times Natural Size. Original.

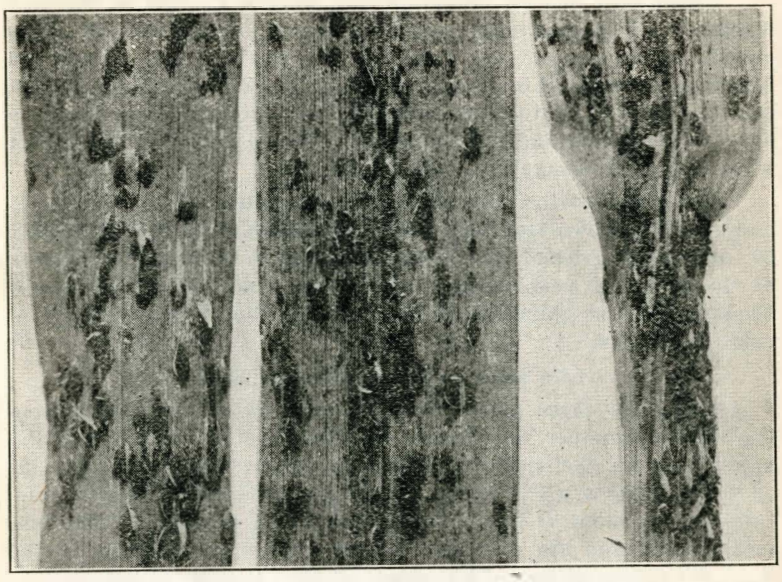

Plate 4. Black Stem Rust (Puccinis Graminis Tritici) Uredinial Infection on Arnautka Wheat. Notice the Masses of Spores in the Diseased Spots. These Spores are Carried in the Wind to Other Plants and Fields. Photograph July 25, 1919. Enlarged 5 Times Natural Size. Original.

once in every ten days or two weeks. The disease spreads quickly and over great areas during the summer. The red spores may spread the rust from a single locality over the entire state in one season.

The second stage in the life cycle of the rust develops when the grain is maturing. This stage appears in broken areas on the stems of the grain much like the red spore stage of the rust. However, the spores which develop in the second stage of the disease are black and not dustlike. They remain in the pustules on the grain stems and do not blow about in the wind. It is this stage of the disease that is so conspicuous at harvest time and therefore has given the disease the name of black stem rust. The black spore stage is shown in plate 5, Fig. 1. These black spores on the straw or stubble live over winter.

The third stage in the development of black stem rust comes in the spring when the black spores from the grain stubble or straw produce other small spores which infect the barberry plant. These small spores which come from the black stage of the rust are blown in the wind from the stubble or straw and will develop only when they fall on the leaf or young stem of a barberry plant. It seems unnatural that a disease of grains should live one stage of

its life on such a plant as the barberry, but this is just what happens. On the barberry the disease appears in swollen yellow spots, usually on the leaves. On the under side of the leaves small cup-like growths develop in the diseased spots. These are yellow and the spores in them are dust-like, so that they may be blown in the wind to the young grain. The infection which develops on the grain from these yellow spores is the summer or red spore stage of the rust. Plate 6 shows the cluster-cup stage of the black stem rust as it appears on the barberry.

The three stages in the life story of the black stem rust then, are as follows: (1) The red summer spore stage which spreads the disease rapidly in the summer, (2) the black winter spore stage which carries the disease throughout the winter but cannot infect the grain in the spring. From the barberry the disease spreads to the grain fields and again develops the red summer spore stage, thus completing the life cycle of the disease.

Grain and Grass Hosts of Black Stem Rust in South Dakota

The fact that there are different strains of black stem rust which are limited to different kinds of grain, has been definitely proved. For instance the strain of black stem rust which attacks wheat will not attack oats or rye. This explains why a wheat

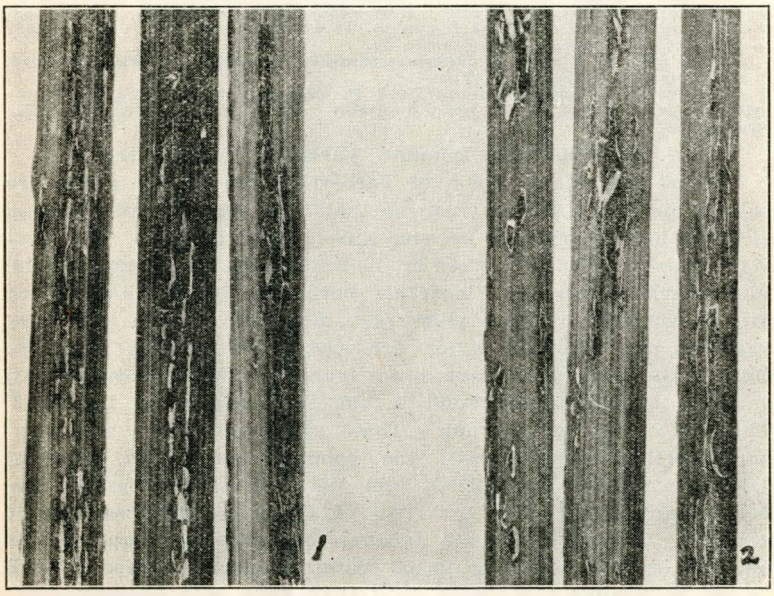

Plate 5. Black Stem Rust (Puccinia Graminis), (1) Telial Infection on Old Stem of Rye Grass (Elymus Canadensis), and (2) Uredinial Infection on Young Stems. Photograph July 25, 1919. Enlarged 5 Times Natural Size. Original.

field may be severely rusted and adjacent fields of oats and rye only slightly rusted. These different strains of the same disease are called "biologic forms."

The hosts of the five biologic forms of the black stem rust given in the following list are abundant in South Dakota. Many other plants not abundant in the state are also hosts for the black stem rust.

LIST 1

Biologic Forms of Black Stem Rust and Their Hosts Commonly Found in South Dakota

1. Black stem rust **(Puccinia graminis tritici)** on wheat. This biologic form is very abundant. The common varieties of wheat grown, Marquis, Velvet Chaff or Preston, and the durums are all very susceptible. Acme, a durum variety recently developed at Highmore substation has so far proved very resistant to the rust in South Dakota. Wild barley **(Hordeum jubatum)** (See plate 7), western wheat grass **(Agropyron smithii),** and slender wheat grass **(Agropyron tenerum)** are all susceptible to **P. graminis tritici** and very abundant over the state. The rye grasses **(Elymus spp.)** are also commonly infected but are not abundant over the state.
2. Black stem rust **(Puccinia graminis secalis)** on rye is common but not abundant. The most susceptible grass host is quack grass **(Agropyron repens)** which is very common over the state. Wild barley and the wheat and rye grasses given above are also susceptible to **P. graminis secalis.**
3. Black stem rust **(Puccinia graminis avenae)** on oats is common and sometimes abundant. The wild hosts which may carry this form of the rust are wild oats, mostly **Avena fatua,** and orchard grass **(Dactylis glomerata).** Wild oats is abundant all over the state. Orchard grass is common but not often rusted.
4. Black stem rust **(Puccinia graminis phlei-pratense)** on timothy is common all over the state and sometimes abundant. Its most common other host is orchard grass. It is known to live over winter in the uredinial stage. (See plate 8).
5. Black stem rust **(Puccinia graminis agrostis)** on **Agrostis spp.** is not common in South Dakota.
6. Barley is susceptible to both **P. graminis tritici** and **P. graminis secalis.** Odessa is the most common variety grown and is usually rusted.

Susceptible and Immune Varieties of Barberry

There are many kinds of barberries not all of which are susceptible to black stem rust, so that it is not right to condemn all varieties of barberries because some harbor the rust. This fact is recognized in the law passed by the last session of the state legislature which defines the "harmful" barberries as all those which are susceptible to black stem rust infection. There are many varieties of barberries which are susceptible to rust infection. Only a few of these have been found in South Dakota. All varieties of barberries found in the state are given in list 2. Three of these are common. These are the common green-leaf barberry **(Berberis vulgaris),** the common purple-leaf barberry **(Berberis vulgaris purpurea),** and the Japanese barberry **(Berberis thunbergii.)** The first two of these are very susceptible and very harmful while the Japanese barberry is immune. The one should be carefully protected while a constant warfare should be waged against the others until they have been entirely eradicated.

There is but one species of barberry that is native in South Dakota. This is the Oregon grape or Mahonia **(Berberis repens),**

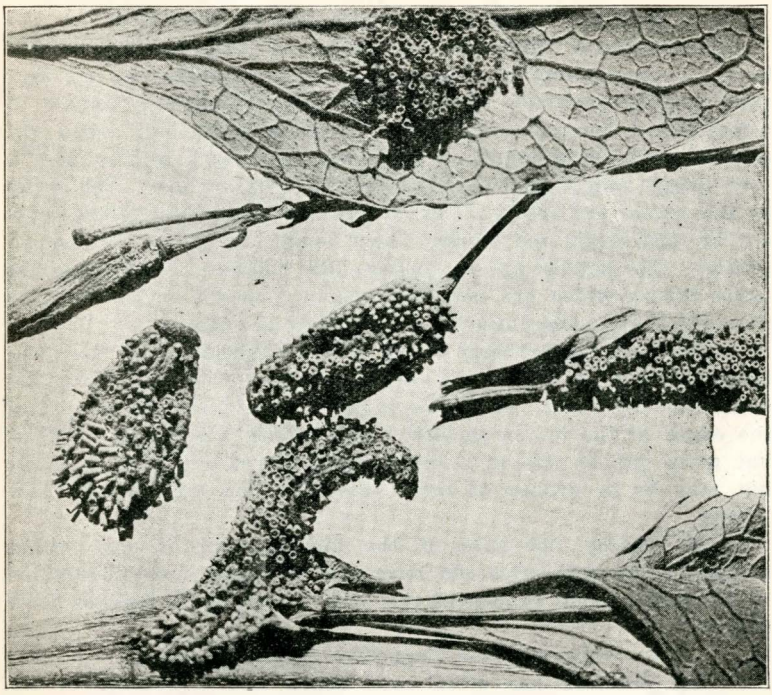

Plate 6. Black Stem Rust (Puccinia Graminis), Aecidial Infection on the Leaves, Thorn and Fruit of Common Barberry (Barberis Vulgaris). Photograph July 2, 1919. Enlarged 3½ Times Natural Size. Original.

which is found only in the Black Hills. This species has been infected under artificial conditions in a greenhouse but has not been found infected under natural conditions so that there seems to be no necessity for eradicating the species at the present time. Further observations or experiments may prove this species to rightly belong to the list of susceptible or harmful varieties.

LIST 2
Species and Varieties of Barberries Found in South Dakota in the Barberry Eradication Campaign

Berberis amurensis (siaboldii)	susceptible
Berberis caroliniana	susceptible
Berberis heteropoda	susceptible
Berberis cretica	susceptible
Berberis laciflora	susceptible
Berberis vulgaris	susceptible
Berberis vulgaris amurensis	susceptible
Berberis vulgaris purpurea	susceptible
Berberis vulgaris emarginata	susceptible
Berberis vulgaris spathulata	susceptible
Berberis vulgaris japonica	susceptible
Berberis thunbergii	immune
*Berberis sibirica?	immune?
**Berberis repens (Mahonia repens)	immune?

*No infection has been found on these barberries in South Dakota, although they have been reported susceptible in other states.
**See notes above.

How the Harmful Barberries Can Be Identified

The harmful barberries can easily be identified by the following distinguishing characters. The harmful barberries are tall, erect bushes sometimes 10 to 12 feet high, but usually only 3 to 6 feet high. The leaves are green or purple, often both green and purple leaves being found on one bush. The bark is gray with a very bright yellow inner bark under the gray surface. The edges of the leaves are spiny. The flowers are small and yellow, producing long bright red berries which usually hang on the bush all winter. The berries are in clusters like currants. The bush has many thorns which are usually three in a group but often more than three and sometimes less than three in a group.

The Japanese barberry is easily distinguished from the common barberry. It is a small shrub, usually 2 or 3 feet high, and spreading, not erect. The bark is red. The leaves are small and the edges of the leaves smooth. The berries are not in clusters, but grow one or two in a place. The thorns are usually single but may be in groups of three like those on the harmful barberries.

Any person not sure of the identification of any bushes thought to be barberries can have the suspected bushes identified by sending a small branch of the bush to the South Dakota State College.

How May the Rust Live Over Winter?

This question has often been asked and a number of answers suggested. For the state of South Dakota there seems to be but one answer. It can live over winter in the black spore stage and cause infection on the barberry the following spring as described in the life story of the rust on page 5. For some time it was believed that the rust could live over winter in the red spore stage. It does live over winter in the red spore stage in the southern states and California, but in the northern states it does not ordinarily, as has been shown by many experiments and observations.

The presence of rust in the south brings up the question of the rust blowing north as the season advances and thereby causing epidemics in the northern states. This old theory has been disproved. The rust in the southern states cannot infect the hard spring wheats or many of the hard winter wheats in the north.

That there may be another host which will serve equally as well as the barberry for the cluster-cup stage of the disease is another question often brought forward. The relation of the barberry to black stem rust was definitely proved in 1865. Since that time there has been constant search in Europe and America for another host for the cluster-cup stage of the black stem rust. No other such host has been found. The barberry seems to be the only hope of the rust in the northern states.

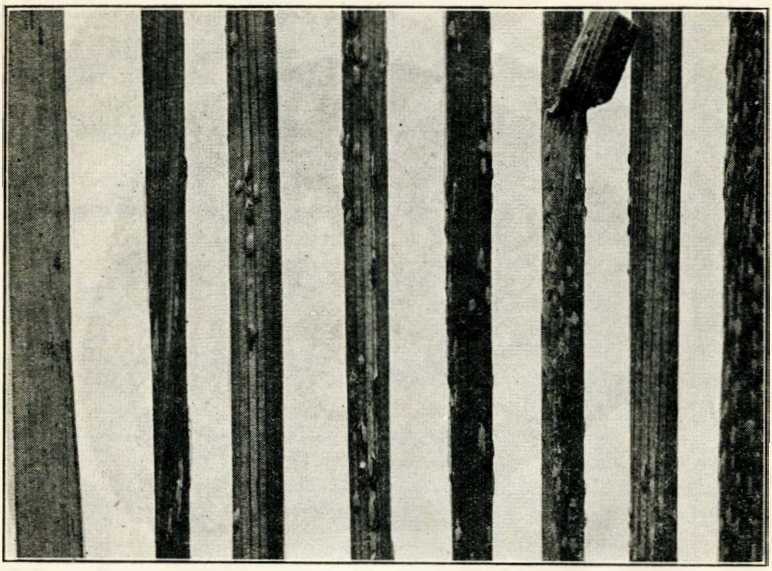

Plate 7. Black Stem Rust (Puccinia Graminis) on Wild Barley (Hordeum Jubatum). This Grass is Very Abundant in South Dakota. It Rusts Severely with the Biologic Forms of the Rust that Attack Wheat and Rye. Photographed July 5, 1919. Enlarged 3½ Times Natural Size. Original.

Methods of Preventing Rust Losses

There are definite methods for controlling many plant diseases. The use of formaldehyde to control stinking smut of wheat is one of these. For other plant diseases such as scab of grains, there is no measure which will completely control the disease. Early sowing, the use of resistant varieties of grain, clean cultivation, destroying the weed-grass hosts, and eradication of the barberries will help reduce black stem rust. Of these methods the eradication of the barberries is the only one which promises to prevent serious rust epidemics, and perhaps even reduce the black stem rust to a negligible disease in the grain fields. If this is to be accomplished the work of eradication must be thorough and the other spring wheat states bordering on South Dakota must also eradicate their barberries. All of these states are at present eradicating barberries in a similar way to the work being done in South Dakota. There are thirteen states carrying on barberry eradication work at the present time. It will require several years more to complete the work.

False Rust Theories

Among the many explanations given for the presence of rust on grains the belief that fogs or muggy weather cause the dis-

Table 1

Table of the Barberry Plantings and Bushes Found in 1918 and 1919

	NUMBER OF PLANTINGS							NUMBER OF BUSHES						
	In Town		In Country			Total		In Town		In Country			Total	
	Number Found	Number Infected	Number Found	Number Infected	Running Wild	Number Found	Number Removed	Number Found	Number Infected	Number Found	Number Infected	Running Wild	Number Found	Number Removed
Armstrong	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Aurora	1	0	0	0	0	1	1	20	0	0	0	0	20	20
Beadle	15	3	1	0	0	16	16	919	14	100	0	0	1019	1019
Bennett	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bone Homme	13	1	2	0	0	15	14	545	200	6	0	0	551	550
Brookings	22	6	3	2	1	25	25	942	868	40	25	720	982	982
Brown	15	0	2	0	0	17	17	268	0	72	0	0	340	340
Brule	4	3	0	0	0	4	4	13	3	0	0	0	13	13
Buffalo	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Butte	5	3	0	0	0	5	3	52	12	0	0	0	52	42
Campbell	0	0	2	0	0	2	2	0	0	47	0	0	47	47
Charles Mix	6	1	1	0	0	7	7	482	50	20	0	0	502	502
Clark	3	2	0	0	0	3	3	252	2	0	0	0	252	252
Clay	7	1	1	0	0	8	6	362	150	40	0	0	402	371
Codington	10	7	0	0	0	10	9	782	575	0	0	0	782	767
Corson	2	1	0	0	0	2	2	12	7	0	0	0	12	12
Custer	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Davison	14	11	0	0	0	14	14	207	115	0	0	0	207	207
Day	9	5	3	0	0	12	7	139	105	122	0	0	261	91
Deuel	1	1	0	0	0	1	1	8	8	0	0	0	8	8
Dewey	1	0	0	0	0	1	1	8	0	0	0	0	8	8
Douglas	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Edmunds	2	1	0	0	0	2	2	58	3	0	0	0	58	58
Fall River	7	2	1	0	0	8	8	238	128	6	0	0	244	244
Faulk	1	0	0	0	0	1	1	10	0	0	0	0	10	10
Grant	8	1	1	0	0	9	9	951	15	200	0	0	1151	1151
Gregory	2	0	0	0	0	2	1	18	0	0	0	0	18	9
Haakon	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hamlin	1	1	0	0	0	1	1	1	1	0	0	0	1	1

Hand	1	0	0	0	0	1	1	8	0	0	0	0	8	8
Hanson	2	1	0	0	0	2	2	13	1	0	0	0	13	13
Harding	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hughes	8	0	0	0	0	8	8	61	0	0	0	0	61	61
Hutchinson	7	2	0	0	0	7	7	82	65	0	0	0	82	82
Hyde	1	1	0	0	0	1	0	40	40	0	0	0	40	40
Jackson	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Jerauld	1	0	0	0	0	1	1	100	0	0	0	0	100	100
Jones	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Kingsbury	12	6	4	3	2	16	15	275	100	617	605	400	892	842
Lake	16	0	24	5	11	40	29	356	0	2351	261	1546	2707	2023
Lawrence	3	0	0	0	0	3	3	251	0	0	0	0	251	251
Lincoln	8	0	0	0	0	8	8	804	0	0	0	0	804	804
Lyman	0	0	0	0	0	0	0	0	0	0	0	0	0	0
McCook	7	0	1	1	0	8	8	437	0	400	400	0	837	837
McPherson	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Marshall	2	0	0	0	0	2	2	13	0	0	0	0	13	13
Meade	1	0	1	0	0	2	0	125	0	4	0	0	129	0
Mellette	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Miner	6	0	0	0	0	6	6	58	0	0	0	0	58	58
Minnehaha	91	14	1	0	0	92	81	5652	3593	125	0	0	5777	5530
Moody	9	0	5	0	2	14	11	264	0	353	0	55	617	277
Pennington	1	0	0	0	0	1	0	100	0	0	0	0	100	0
Perkins	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Potter	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Roberts	2	1	1	1	0	3	3	109	100	200	200	0	309	309
Sanborn	7	1	0	0	0	7	7	96	6	0	0	0	96	96
Shannon	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Spink	3	0	1	0	0	4	4	179	0	150	0	0	329	329
Stanley	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sully	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Todd	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tripp	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Turner	4	0	0	0	0	4	3	206	0	0	0	0	206	205
Union	1	0	0	0	0	1	1	5	0	0	0	0	5	5
Walworth	2	0	0	0	0	0	2	2	10	0	0	0	10	10
Washabaugh	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Washington	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Yankton	22	0	5	0	0	27	23	6379	0	520	0	0	6899	6636
Ziebach	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTALS	366	76	60	12	16	426	388	21910	6161	5373	1491	2722	27283	25233

ease is most prevalent. The true explanation for this is not that the fogs cause the disease but rather that fogs and muggy weather are very favorable for the growth of the rust disease so that during such weather it develops rapidly. The rust will not develop without moisture any more than the grain will grow without the spring rains.

An older explanation, now disproved, offered for the presence of rust on grains was a chemical one. In this theory it was explained that sulphur trioxide fumes came up through the crevasses in the ground from the warmer regions below. These SO3 fumes were supposed to unite with the moisture in the air to make sulphuric acid which of course would burn any vegetation severely.

Other explanations based on incomplete or wrong data have been given for the presence of rust on the grains. None of these recognize the rust as a disease. The black stem rust is a disease of grains and must be treated as such.

The Influence of Weather Conditions on the Prevalence of Rust

The organism which causes the rust is dependent on favorable weather conditions before it can develop in sufficient abundance to cause a rust epidemic. An explanation of the weather conditions in the two widely different seasons of 1918 and 1919 will show how these conditions influence the growth of rust.

In the spring of 1918 the temperature and rains were about normal. The grains and the rust started normally. Had such favorable weather continued the rust would have been serious that year. However for a considerable period in late June and July there were few rains and no days of warm muggy weather which were favorable to the growth of the rust. During this time the rust spread but slowly. Then late in July rains and warm moist weather gave the rust favorable conditions for growth. The result was that in a very short time the black stem rust was abundant in all of the fields. The reason why the crops were not injured is because the grains matured early and the rust did not develop until too late to injure the grain seriously. The same weather conditions that caused the grain to mature early held back the development of the rust.

In 1919 the spring opened with a season of excessive rains and humid conditions very favorable for rust development. As a result the rust because abundant early in the year. The drier weather later in July checked somewhat the further rapid development of the rust but did not stop the rust which developed in June and the early part of July. The difference in the presence of rust in 1918 and 1919 was due primarily to the difference in the time of year in which the weather favorable for rust development occurred and to the number of days of favorable weather in the different seasons. From this it may be seen that weather conditions

greatly influence rust epidemics but it must be remembered that weather conditions do not cause the rust. It should further be said that the great loss in the grain crops in 1919 was not due entirely to black stem rust. Wheat scab and other injurious conditions in the fields caused a large part of the loss in 1919.

Damage Done by Black Stem Rust

Black stem rust is found practically everywhere that grain grows in the United States. It is also found in many other counties The losses caused by this one disease amount to millions of bushels annually. It is most destructive to wheat but also causes considerable loss to barley, oats, and rye. In South Dakota it is most serious on spring wheat. It causes serious annual losses and at irregular intervals causes very severe epidemics. The rust years of 1904 and 1916 will long be remembered. The average yield of wheat in South Dakota in 1916 was less than 7 bushels per acre as compared with 17 bushels in 1915. In 1916 the loss amounted to over 50 percent of the crop. In 1917 it was about 4 percent of the crop. While not all the loss in the grain fields, traceable to crop diseases is due to black stem rust, by far the greater part of the loss is due to this cause. Rust epidemics may cause food shortage and high prices. It is difficult to esti-

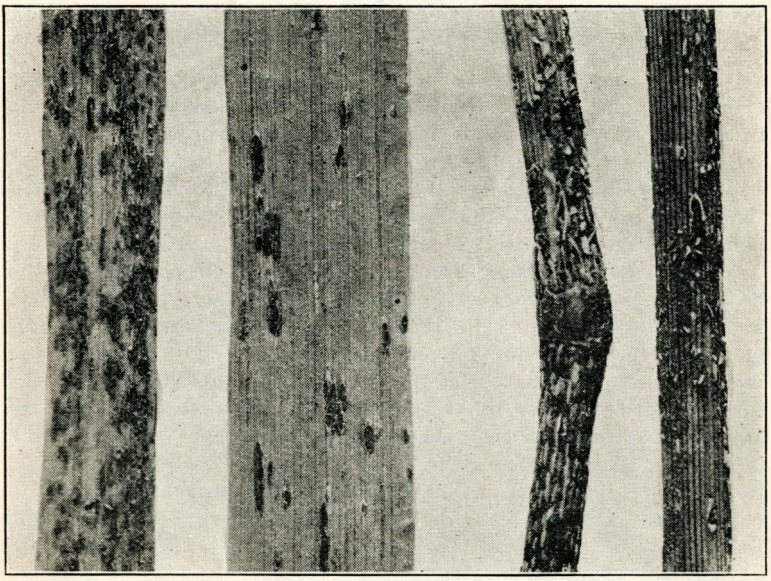

Plate 8. Black Stem Rust (Puccinia Graminis Phlei-Pratense) on Timothy (Phleum Pratense), This Biologic Form of Rust Does Not Attack Any of the Grains. Photograph July 25, 1919. Enlarged 5 Times Natural Size, Original.

mate accurately the loss due to rust. With a wheat crop for the state worth annually over $75,000,000 it is easily estimated that even such a light loss as occurred in 1917 of 4 percent means a loss of millions of dollars.

Eradication of the Harmful Barberries to Reduce Rust Losses

Barberry eradication is the most effective method known for controlling the black stem rust. Over half of all the barberries in the state rust every year. This gives the rust an abundant start early in May. The barberries have been the earliest and greatest source of rust infection each year. The eradication of all the harmful barberries may not entirely stop the rust but it will take away the wide-spread source of early and abundant infection which comes from them.

The Spread of Rust From Barberries

The information collected in the field work of the past two years shows that harmful barberries are widely distributed over the entire state. They have been found in 108 towns and on 60 farms. In the rural survey of Lake county it was found that every farm in the county was within 8½ miles of some barberry planting. Further data obtained shows that all of the barberries both in cities and rural districts may be infected every year. In the seasons of 1918 and 1919, 27,283 barberries have been found and the campaign is only about one-third completed.

Notes have been taken on the spread of rust from a number of barberry plantings which indicate that the relation of barberries to rust in the grain fields is direct. Observations on a few of these hedges are given below. Many reports from county agents and farmers have been received. A farmer at Northville reported that in many seasons the rust was very severe near a 150-foot hedge of barberries on his farm. The hedge has now been destroyed. Another farmer living at Rosholt often complained that he always had severe rust epidemics on his farm and sometimes his neighbors did not. In 1918 a hedge of barberries was found on his place. The county agent of Campbell county reported that in 1918 he found barberries on two farms in his county and that for a distance of five miles around these barberries the rust was abundant while over the rest of the county there was only light infection. Every farmer who finds severe black stem rust on his farm early in the season should inspect his groves and yard for barberries. If he does not know the barberry bush the South Dakota State College will be glad to identify any bushes which he may think are barberries.

The following brief accounts show how the rust has spread from three hedges found in 1918.

(1) **BROOKINGS.**—In the spring of 1918 there were about 100 barberries in the horticultural plots at the State College. These were quite severely rusted in May and June. On July 11, notes were taken on the spread of the rust from these bushes. The spring of 1918 was especially favorable for studying the spread of rust in South Dakota as the rust spread slowly until the latter part of July when rains caused more rapid development, The notes taken on July 11 are given in table 1.

Table 2

Spread of Rust from Barberry Bushes at Brookings to Wild Barley

Distance from barberries	Direction from barberries	Host	Severity of rust infection
25 feet	West	Wild barley	Very severe
50 feet	West	Wild barley	Severe
75 feet	West	Wild barley	Moderate
25 feet	Northwest	Wild barley	Severe
50 feet	Northwest	Wild barley	Severe
100 feet	Northwest	Wild barley	Moderate
200 feet	Northwest	Wild barley	Light

In 1919 the first rust infection found on barberry seedlings was on May 3. The infection was very light on the few shoots and seedlings that remained. The first red spore pustule was found on June 16 on wild barley on a plant only a few feet from the infected barberries. Later in June very favorable weather conditions for the development of the rust prevailed so that the spread of the rust was too rapid to be traced definitely from near the barberries to greater and greater distances.

(2) **SIOUX FALLS**—In 1918 the Woodlawn cemetery hedge of 3,500 plants was moderately infected in May and June. On July 22 notes were taken on the rust conditions near this hedge. As wild barley **(Hordeum jubatum)** was the only rust host that was abundant near the hedge most of the notes are on this grass. Table 2 gives the results of these observations.

Table 3

Spread of Rust from Barberry Plants at Sioux Falls to Grasses and to Wheat

Distance from barberries	Direction from barberries	Host	Severity of rust infection
50 feet	East	Agropyron sp.	Light
100 feet	East	Wild barley	Severe
300 feet	East	Wild barley	Severe
500 feet	East	Wild barley	Moderate
¾ mile	East	Wheat	Severe
100 feet	Northeast	Wild barley	Severe
25 feet	North	Wild barley	Very severe
150 feet	North	Wild barley	Very severe
200 feet	North	Wild barley	Very severe
400 feet	North	Wild barley	Severe
50 feet	North	Agropyron sp.	Light
1 mile	North	Wheat	Moderate
1 mile	Southeast	Wheat	Moderate

During the summer of 1918 this hedge was destroyed so that in 1919 it was not a source of infection. On July 29, 1919, this locality was again visited to take notes on rust conditions. At this time the wild barley was only slightly infected. The difference in amount of infection in these two seasons seems to be due to the absence of barberries in the second season.

(3) **LAKE PRESTON**—About one mile of old barberry hedge was found on two farms two and one-half miles south of town in the spring of 1918. Practically all of these barberries were infected with the black stem rust. Two visits were made to note rust conditions around them, The first visit was made on July 20 during a long spell of dry weather and the second on July 30 after several days of rain. Table 3 gives the results of these observations.

TABLE 4

Spread of Rust from Barberries at Lake Preston to Grains and Grasses

Distance from barberries	Direction from barberries	Host	Rust infection July 20, 1919	Rust infection July 30. 1919
½ mile	North	Wheat	Light	Severe
¾ mile	North	Wheat	Light	Severe
1 mile	North	Wheat	Light	Severe
2 miles	North	Wheat	Very light	Severe
½ mile	Northwest	Wheat	Moderate	Severe
5 miles	Northwest	Wheat	Moderate	Severe
400 feet	West	Barley	Severe	Severe
1000 feet	West	Wheat	Very severe	Severe
1000 feet	West	Wild barley		Very severe
1 mile	West	Wheat	Moderate	
¾ mile	Southwest	Wheat	Moderate	Severe
1¼ miles	Southwest	Wheat	Moderate	Severe
½ mile	South	Wheat	Moderate	
½ mile	East	Barley	Moderate	
1 mile	East	Wheat	Moderate	Severe
2½ miles	Northeast	Wheat	Light	Very severe

This hedge was dug during the spring of 1919 and was slightly infected at the time. On July 25, 1919, one of the men in barberry eradication examined this hedge to note rust conditions and reported as follows:

"Examined this hedge today and found numerous shoots from 1 to 12 inches. These shoots were all young and indicated that the hedge had been dug this season. I found only faint traces of past infection and no present infection. This hedge has probably been a small source of infection this year. Rust on grains and grasses in the vicinity gave no evidence of any relation to the hedge."

The Barberry Eradication Law

The state legislature of South Dakota passed a law compelling the eradication of "harmful" barberries, in February, 1919. This law provides that all species of Berberis or Mahonia which are susceptible to infection by black stem rust **(Puccinia graminis)** are "harmful," and that it is unlawful to have any of these species growing on or to propagate them on any property or to ship or sell any of them. It provides for a notice allowing thirty days to destroy any harmful barberries after which the owner is subject to a fine not to exceed $500 and the cost of destroying the barberries. The State Entomologist is made the police authority to enforce this law.

The Work Done in Barberry Eradication

In 1918, but one man was assigned to South Dakota by the Office of Cereal Investigations of the United States Department of Agriculture. His time was spent in various kinds of publicity work and in surveying some of the larger towns. In this way a considerable number of barberries were destroyed but most of the work was hurried and not thoroughly done. In the latter part of 1918 a second man was assigned to this state for about two months. In 1919, a considerably increased force was allowed so that from April 15 to October 1 there was an average force of five men in the field.

The second season of field work in barberry eradication has been completed. It was at first supposed that the great majority

TABLE 5
Rural Barberry Plantings Found in South Dakota

COUNTY	Year Located	PROPERTIES			BUSHES		
		Number Found	Number Removed	Number Infected	Number Found	Number Removed	Number Infected
Beadle	18	1	1	0	100	100	0
Bon Homme	19	2	2	0	6	6	0
Brookings	19	3	3	2	40	40	25
Brown	18–19	2	2	0	72	72	0
Campbell	18	2	2	0	47	47	0
Charles Mix	19	1	1	0	20	20	0
Clay	19	1	1	0	40	40	0
Day	18	3	2	0	122	22	0
Fall River	[illegible]	1	1	0	6	6	0
Grant	18	1	1	0	200	200	0
Kingsbury	18–19	4	4	3	617	617	605
Lake	19	24	16	5	2351	1753	261
McCook	18	1	1	1	400	400	400
Meade	19	1	0	0	4	0	0
Minnehaha	18	1	1	0	125	125	0
Moody	19	5	3	0	353	63	0
Roberts	18	1	1	1	200	200	200
Spink	18	1	1	0	150	150	0
Yankton	19	5	3	0	520	260	0
Total		60	46	12	5373	4121	1491

TABLE 6
Summary of Barberry Bushes in Lake County as Shown by the Rural Survey, 1919

TOWNSHIP	PROPERTIES			BUSHES		
	Total Number	Number Escaped	Number Infected	Total Number	Number Escaped	Infected
Farmington	3	1	0	48	8	0
Herman	1	0	0	40	0	0
Lakeview	4	1	0	492	300	0
LeRoy	2	2	0	1050	950	0
Orland	2	0	0	3	0	0
Rutland	5	3	1	232	175	100
Summit	2	1	1	400	80	100
Wentworth	5	3	3	86	33	61
Total	24	11	5	2351	1546	261

NOTES: No rural plantings were found in Chester, Franklin, Nunda, and Badus townships.

Wayne, Concord, Winfred, Clarno and the west one-third of the Orland townships have not been surveyed for barberries.

of barberries would be found in the towns rather than in the rural districts. Accordingly the first part of the survey work was done in the towns, beginning with the larger ones. Each town was carefully surveyed, inspecting every property on which barberries might be located. While surveying the larger towns the use of the railroads was satisfactory in going from town to town. However, in surveying the small towns a great deal of time was wasted in waiting for trains. For this part of the work automobiles were more efficient for travel so that from the latter part of July, 1919, they were used almost entirely. Two field men worked together, using one automobile. By the use of automobiles the field assistants often surveyed in a single day as many towns as they could have surveyed in a week by using the railroads as a means of travel.

The Survey of the Towns—During the first two seasons of field work all but a small amount of the work has been confined to a survey of the towns. Incidentally, in connection with the work in towns, a number of rural plantings of barberries have been located. There are 45 towns in which eradication of all the barberries found has not been completed. It will be necessary to revisit all of these in 1920. There are 52 towns that must be surveyed in 1920. These towns are all small and only two very small ones are in an area where much grain is grown or barberries are likely to be found. There are 129 towns in the western part of the state which will not have to be surveyed. Very little town work remains to be done in South Dakota.

LIST 3
Summary of the Barberry Survey by Towns

Total number of towns in South Dakota	814
Number of towns surveyed for barberries	633
Number of towns in which barberries were found	108
Number of towns in which all plantings have not been removed	45
Number of towns to be surveyed in 1920	52
Number of towns not to be surveyed	129

Barberries in the Rural Districts—In the first two years' work 60 rural plantings containing 5,373 bushes have been found. All but five or six of these are in the eastern part of the state. In this part of the state it will be necessary to survey all of the farms. A detailed survey has been started in Lake county and the results of the work are given under the subject "The Lake County Barberry Survey." The greater part of the work in 1920 will be rural survey work such as was done in Lake county.

The Lake County Barberry Survey—To test the value of a rural survey, Lake county was chosen as a fairly representative county and a farm-to-farm canvass made to locate as nearly as possible all the barberry plantings on farms.

The towns in the county had been canvassed before the rural

survey began. In Madison, 14 plantings containing 206 bushes were found; in Junius, one planting of 40 bushes; and in Ramona, several plantings containing 110 bushes. No barberries were found in other towns of Lake county.

The rural survey was started late in July, 1919, beginning work in Chester and Franklin townships. From this corner of the county the men worked north, canvassing every farm for barberries. They stopped long enough at each farm to survey thoroughly all groves and shrubbery plantings. The results of this survey are shown in table 5.

Influence of Rural Barberries—From the summary and map it will be seen that a large number of barberries are located in the rural districts and that they are widely distributed over the area surveyed. No farm in this area is over 8½ miles from the nearest barberry planting. Under favorable conditions of wind and weather these barberries could spread black stem rust over every grain field in the county in a week. When it is realized that the rust can spread in one season for at least 50 miles from each barberry bush, the great loss caused by these bushes in Lake county can be realized. Before this survey there was one barberry bush for every 5.7 acres of wheat in the county.

The Natural Spread of Barberries—One of the most surprising facts that the rural survey has revealed is the large number of seedling barberries which have come from the original plantings. Barberries were found on 24 farms in Lake county. On 11 of these, seedling barberries were found, and on four of the 11 all the barberries were seedlings. In these four cases the barberries must have been carried by birds from near-by farms on which old barberry plants were growing. In one of these four cases the barberry seeds had been carried three-fourths of a mile. The summary shows that the barberries have already spread so that there are many more seedlings than old plants. In ten years more these wild plantings would have become so large and well established as to make eradication a very difficult matter.

Escaped barberries is the term applied to those which have spread as seedlings from some ornamental planting. Barberries over 35 years old have been found. During the period since they were planted they may have contaminated considerable area. Up to the present time only small areas of escaped barberries have been found. Sixteen plantings have been found where seedlings were spreading from the original plantings. In some of these the seedlings had grown up and were producing fruit to be carried by the birds over larger areas. A summary of these areas is given in table 6. All of these escaped areas are on farms except the one in Brookings county.

TABLE 7
Summary of Escaped Barberries Found in South Dakota

COUNTY	PROPERTIES			BUSHES		
	Number Found	Number Removed	Number Infected	Number Found	Number Removed	Number Infected
Brookings	1	1	1	720	720	720
Kingsbury	2	2	2	400	400	400
Lake	11	7	4	1546	1087	196
Moody	2	1	0	55	30	0
Totals	16	11	7	2721	2237	1316

Revisiting Plantings—The work in 1918 and 1919 has shown that it is very necessary to revisit all plantings of barberries removed and that in many cases it is necessary to revisit several times. This is due in part to careless digging, leaving roots in the ground which produce new plants. Because of the difficulty in killing barberries, especially old, well-established plants, it has become the practice never to report a planting as eradicated until it has been so reported by one of the field men. Even in some of these cases the roots may not be entirely dead though appearing to be so. This will account for the large number which must be revisited in 1920. As a matter of fact, very few of the 27,283 barberries found have not been removed. Many large hedges are kept on the list of plantings to be revisited because a few sprouts from roots left in the ground have been found on revisiting the plantings.

Will the Influence of Eradication be Noticed in 1920?

Two years' work has already been done in destroying barberries and about four years' work is still to be done in South Dakota before the campaign will be completed. Until the work has been completed a great decrease in black stem rust must not be expected. The people of Denmark passed a barberry eradication law and eradicated their barberries in 1903. Since then they have had no serious rust outbreaks. It is difficult to say whether the influence of eradication will be noticed this year or not. In case the spring is rather dry some influence, at least locally, where barberries have been destroyed may be noticed. However, there are undoubtedly a large number of barberries still remaining on farms which must be found and destroyed before eradication will show any marked result in seasons favorable for rust development.

In the tabulated report by counties a complete list of the work for both 1918 and 1919 is given. The figures given in this re-

port are as accurate as it is possible to give. One or two explanations of this table should be made. The percentage of the county covered is for the town survey only and does not include even the revisiting which will be necessary in 45 towns surveyed. The 720 escaped barberries in Brookings county are in a city planting, not a rural one.

It is well to remember that while considerable has been accomplished it is only a beginning and that even more effort and larger funds must be expended to finish thoroughly a rural canvass of as much of the eastern part of the state as is likely to have rural plantings of barberries. The field work in 1920 will be directed to this end.

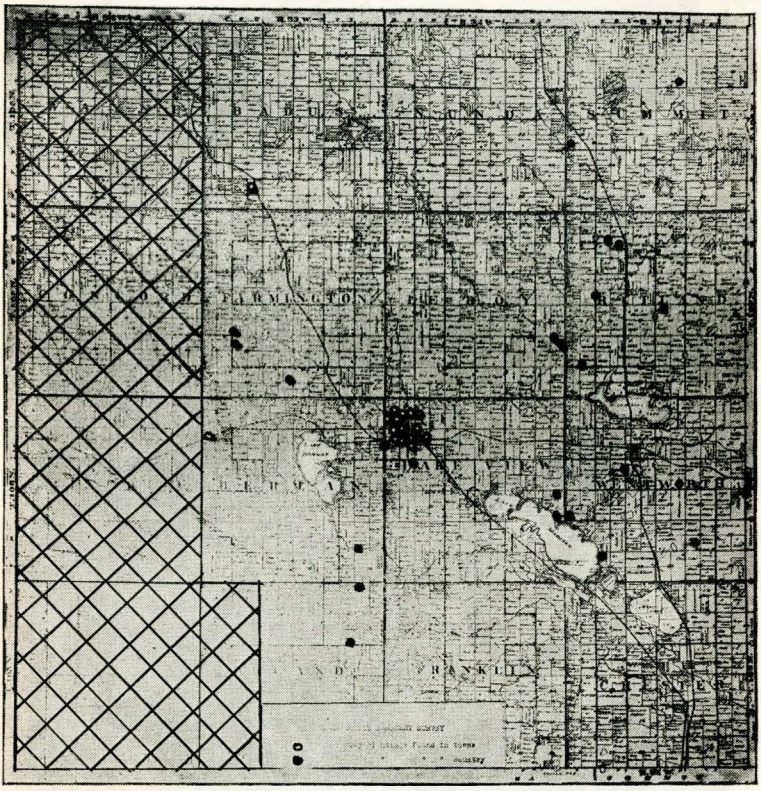

Plate 9. Map of Lake County, South Dakota. The black Dots with White Centers Show City Plantings of Barberries. The Solid Black Dots Show Rural Plantings of Barberries. The Farms in the Area Cross-Hatched Have Not Been Canvassed to Find Barberries. Original.

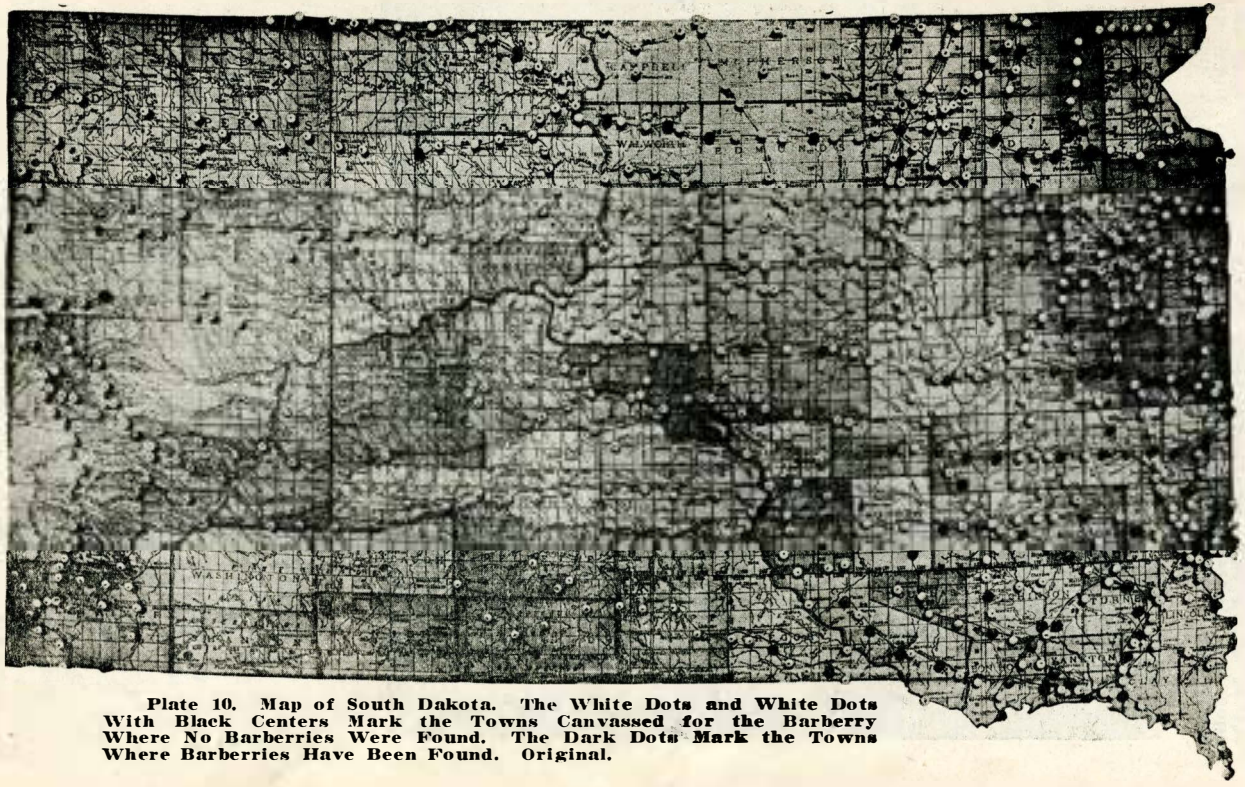

Plate 10. Map of South Dakota. The White Dots and White Dots With Black Centers Mark the Towns Canvassed for the Barberry Where No Barberries Were Found. The Dark Dots Mark the Towns Where Barberries Have Been Found. Original.

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