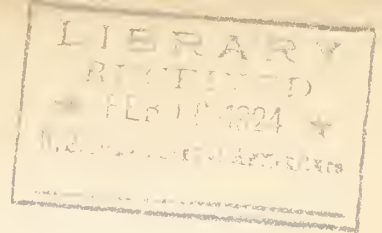


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PROJECT REPORTS

RUST INVESTIGATIONS

(Dr. H. B. Humphrey, Pathologist in Charge)

Barberry Eradication, (Dr. F. E. Kempton, Pathologist in Charge)

PROGRESS OF BARBERRY ERADICATION, 1923

On December 31, 1923, the original property-to-property survey had covered 662 counties out of 894 requiring survey. These 662 counties contained 545,984 square miles, or 75.4 per cent of the 721,831 square miles in the 894 counties originally requiring survey. In the calendar year January 1 to December 31, 1923, approximately 190½ counties, or 177,058 square miles, have been covered in the original survey, at an approximate cost of \$2.20 a square mile. In addition, 42½ counties, containing approximately 36,000 square miles, have been covered in a second complete survey, and 361 counties have been covered in resurvey. During the year a total of 4,005,342 bushes, seedlings, and sprouting bushes were found and 3,967,738 destroyed in all surveys (See Table 1). The record for the six years to December 31, 1923, shows the enormous total of 10,073,667 bushes, seedlings, and sprouting bushes found and 9,379,774 destroyed.

Cooperation

The campaign is organized in cooperation with 13 north-central wheat-growing States, namely, Colorado, Illinois, Indiana, Iowa, Michigan, Minnesota, Montana, Nebraska, North Dakota, Ohio, South Dakota, Wisconsin, and Wyoming. There is formal cooperation with the colleges of agriculture, extension divisions, and other State organizations. Interested agencies cooperate closely.

For the fiscal year 1924, \$425,000 was appropriated, of which \$125,000 was to be available only when met by funds from the States and other cooperating agencies. The entire amount became available. The funds or value of services rendered by State organizations and other cooperating agencies within the 13 States, as certified to the Department of Agriculture to meet the provisions of the appropriation, are shown in Table 2. In addition, much valuable service was rendered by State, county, township, and other local organizations as well as many civic and farmers' organizations in support of the campaign and in the distribution of publicity materials.

Table 1. - Summarized data from all surveys showing, by States, the numbers of properties on which barberry bushes, seedlings, and sprouting bushes were found and removed, and the numbers of bushes, seedlings, and sprouting bushes found and removed in the barberry eradication campaign from January 1 to December 31, 1923.

State	On which bushes were-:		On which seedlings were-:		On which sprout-:		Buses		Seedlings		Sprouting Bushes	
	Found	Destroyed	Found	Destroyed	Found	Destroyed	Found	Destroyed	Found	Destroyed	Found	Destroyed
Colorado	54	56	30	128	125	223	401	1,119	1,119	1,226	1,222	
Illinois	1,298	1,347	236	627	627	38,505	38,920	1,546,798	1,546,798	5,441	5,441	
Indiana	457	435	38	155	161	49,032	23,284	3,506	3,506	2,422	2,117	
Iowa	914	934	81	377	375	22,940	25,074	9,022	9,022	8,115	7,764	
Michigan	1,064	1,818	359	236	236	83,563	91,457	706,644	706,644	1,873	1,873	
Minnesota	216	237	121	291	291	3,351	5,525	19,051	19,151	7,080	7,080	
Montana	17	24	2	17	17	824	515	1,290	1,290	219	119	
Nebraska	265	597	29	259	289	4,371	4,848	4,690	4,690	3,940	3,940	
N. Dakota	70	70	1	98	98	2,384	2,384	6	6	188	188	
Ohio	1,758	2,076	84	599	599	12,260	23,429	171,382	171,382	4,846	4,846	
S. Dakota	114	114	19	106	106	4,016	4,016	3,849	3,849	6,651	6,651	
Wisconsin	1,141	1,468	190	432	437	11,690	31,033	1,198,088	1,143,188	64,560	64,722	
Wyoming	1	7	2	14	12	2	127	36	36	139	81	
Total	7,371	9,183	1,192	3,379	3,373	233,161	251,013	3,665,481	3,610,681	106,700	106,044	

Grand total of bushes, seedlings, and sprouting bushes found, - 4,005,342; destroyed, - 3,967,738.



Table 2 - Aid furnished for barberry eradication by State and other co-operating agencies for the fiscal year beginning July 1, 1923.

State or agency	Appropriation or Value of Service
Colorado	\$ 700.00
Illinois	10,200.00
Indiana	5,250.00
Iowa	5,800.00
Michigan	7,060.00
Minnesota	14,750.00
Montana	725.00
Nebraska	2,168.00
North Dakota	13,600.00
Ohio	7,650.00
South Dakota	5,597.00
Wisconsin	5,000.00
Wyoming	500.00
The Rust Prevention Association	46,000.00
Total	\$ 125,000.00

The Conference for the Prevention of Grain Rust

Valuable cooperation has been received from this organization, composed of the Governor, the Commissioner of Agriculture, a representative of the State agricultural experiment station, and the President of the State Farm Bureau Federation or corresponding farmers' organization of each of the 13 States interested, and an additional membership at large comprising representatives of milling associations, railroads, implement dealers, bankers, national farmers' organizations, and other business interests. Much assistance has been given by them in furnishing publicity material to all classes of people in the barberry-eradication area. This included a circular intended especially for farmers, the total distribution of which reached approximately one million copies, and a poster illustrating the rock-salt method of killing barberries, 80,000 of which were distributed and displayed in banks, railroad stations, schools, post offices, and stores. Several other publications were issued to call the attention of various groups to the campaign. These included special statements to bankers, charts for use in schools, and samples of the common barberry in small envelopes for use in identifying the bush. All told, since the beginning of its activities, the Conference has distributed approximately two million pieces of literature.

In cooperation with the leaders in 10 of the 13 States, a publicity man from among the field assistants was designated to take care of educational phases of the campaign in the State. In some cases, either salary or expenses was paid by the Conference. Posters and literature mentioned above, panel exhibits, and moving picture reels were furnished supplementary to material furnished by the U. S. Department of Agriculture. Demonstrations were placed at 255 State and county fairs and 261 meetings of various kinds. A department devoted exclusively to handling newspaper publicity has sent out 1,700 different stories to 6,000 publications in the 13 States during the past year. The Federal leaders in the States and the publicity men designated by them furnished about an equal number of articles to local papers.

Federal Publicity

In addition to the publicity activities carried on in cooperation with the Conference for the Prevention of Grain Rust, there has been distributed in 1923, through the offices of the State Leaders and by field assistants, a total of 237,860 copies of Department bulletins and circulars. These include 17,000 copies of Farmers' Bulletin 1058 (revised), entitled "Destroy the Common Barberry;" 21,125 copies of Department Circular 188, entitled "Progress of Barberry Eradication;" 87,108 copies of Department Circular 268, entitled "Kill the Common Barberry with Chemicals;" 87,108 copies of Department Circular 269, entitled "Barberry Eradication Prevents Black Stem Rust in Western Europe;" and 25,525 copies of a poster, - "Destroy the Common Barberry."

Since the campaign began a total of 1,493,902 pieces of timely publicity material has been distributed through Federal channels. Thousands of circular letters to property owners and special groups have been distributed by the leaders in each State. One or more editions of State bulletins or circulars have been distributed in each of the 13 States and valuable publicity has been given through all State extension facilities.

Original Survey

The original survey includes a property-by-property survey in cities and villages and a farm-by-farm survey in the country.

The 13 States included contain 976 counties, an area of approximately 967,232 square miles. Of this area, survey was required in the equivalent of 894 counties, containing 721,831 square miles, or about 75 per cent of the total area. The remainder is unsettled, mountainous, or sandy country. The total area contains about 1,880,000 farms and other millions of properties in cities, towns, and villages.

In the earlier years of the campaign, a property-by-property survey of practically all cities and villages was made. The few not surveyed are being covered as they are reached in the farm-to-farm survey.

In 1923 approximately $190\frac{1}{2}$ counties, or 177,058 square miles, were covered at an average approximate cost of \$2.20 per square mile. The square-mile cost varied from a few cents in thinly settled unwooded areas with few barberry bushes to about \$50.00 in some portions of counties where many escaped bushes were found and eradicated. During the year 233,161 bushes were found on 7,371 properties, and in the same period 251,013 bushes were eradicated from 9,183 properties. The bushes eradicated in excess of bushes found were bushes found but not destroyed in previous years. In addition, 1,727,335 seedlings were found and 1,722,535 destroyed on this survey. A total of 26,475 man days was spent in actual survey and eradication. The field assistants traveled by automobile, a total distance of more than 605,636 miles.

Second Survey

In 1923 the early appearance of severe local epidemics of stem rust, which were traced to barberry bushes remaining in certain counties previously surveyed and thought to be clean, made it seem advisable to make a second complete survey of several counties. Counties and parts of counties totaling $42\frac{1}{2}$ counties were covered. In this area 3,762 bushes on 269 properties, and 476 seedlings on 7 properties were found and destroyed. These results show that in spite of the care used in the original survey, in which every property was visited, all barberries were not found.

Some of the bushes found in the second survey were those cut down early in the campaign by property owners or tenants and which had since grown again. The State officers had no records of these bushes, and it is probable that these have developed and remained unobserved for several seasons. Others were bushes overlooked in the first survey.

It probably will be necessary to make a second survey in all counties in which many fruiting bushes have been found, as numerous seedlings may be expected to develop from the scattered seeds. It probably will be advisable to survey a secondtime all counties in which wheat is the principal crop. It is obvious that there remains a vast amount of work to be done before the area already surveyed once can be said to be completely cleared of barberry bushes.

Resurvey

In 1923 the resurvey included 361 counties. Over 10,000 man days were spent and 270,000 miles were traveled by field assistants in this phase of the campaign. In the year, 106,700 sprouting bushes were found and 106,044 destroyed. Of these, 13,075 were dug and 92,969 were treated with chemicals. In addition, 1,938,146 seedlings were found in resurvey and 1,833,146 were destroyed. Of these, 631,573 were dug and 1,256,573 were treated with chemicals.

Resurveys are made of only those properties upon which barberries have been found. It has become evident that several resurveys may be necessary. This is especially true of properties where seedlings continue to appear and where sprouts keep coming up from portions of root systems not properly removed in the first digging. If no sprouting bushes or seedlings are found on either the first or second resurvey, the property usually is checked as clear. It is almost impossible to remove all roots which have become entwined with roots of trees and shrubbery or which may have grown into the crevices of rocks. Chemicals give promise of more effective eradication and no doubt will reduce the number and extent of resurveys. However, where chemicals have been used some resurveys are necessary to see that all bushes have been killed and to eradicate seedlings that have appeared.

Escaped Barberry Bushes

The spread of escaped barberries to open woodlands, fence rows, rocky ledges, brushy pastures, and stream banks is the most serious problem of the campaign. Not all bushes are found among undergrowth and weeds on the original survey and some may be overlooked on the first resurvey. Seedlings continue to appear each spring for a number of years after all fruiting bushes are destroyed. In 1923, a total of 162,335 escaped bushes has been found on 1,345 properties. In addition, most of the 3,665,481 seedlings found on original survey and resurveys were in areas of escaped bushes.

The greater number of properties on which escaped bushes were found in 1923 were in the more humid States of Wisconsin, Illinois, Iowa, and Michigan, in the order named. However, a few escaped bushes were found along a stream bank in Fergus County, Montana, at least 5 miles from any habitation.

The eradication of all bushes and seedlings from areas of escaped bushes is progressing as rapidly as possible. Many small areas appear to be cleaned up. The complete clean-up of many larger areas is in sight because of the general use of crushed rock salt as a killing agent during the past season. In areas where there are many escaped bushes, numerous seedlings may appear even as long as three or four years after all fruiting bushes are destroyed. Of course it will be a number of years before every seedling is found and eradicated from the larger areas of escaped bushes.

Killing Bushes with Chemicals.

Experiments on chemical methods of eradication begun in September, 1921, have given excellent results. About 40 different chemicals were used on large barberry bushes in the field; many experiments also were carried out in the laboratory and greenhouse. A number of chemicals proved effective. Two were found to give uniformly good results. These were crushed rock salt and a sodium arsenite solution. The sodium arsenite solution proved dangerous to livestock and poultry and its use has been discontinued. Crushed rock salt and flake or packers' salt have proved effective and may be applied at any time of year. One or the other usually is available or can be procured in a reasonable length of time.



For the common barberry bush of average size 10 pounds of salt piled carefully around and over the base of the bush means certain death. It does not take so much to kill smaller bushes but no bush should receive less than 5 pounds. Shoots arising at a little distance from the crown must be treated separately. Care should be taken that livestock or poultry do not eat excessive quantities of salt.

Experiments are still in progress with 5 other chemicals. Since beginning chemical treatments, 498 tons of salt, 704 gallons of a concentrated solution of sodium arsenite, 1,495 gallons of kerosene, 158 gallons of water-gas drip oil, and a few gallons of other chemicals that showed promise as killing agents, have been used. Over 3,000,000 bushes, seedlings, and sprouting bushes were treated.

Investigations are being carried forward by Noel F. Thompson on the best method of chemical eradication of barberry seedlings. The morphology of the common barberry plant also is being studied. Areas of escaped barberries are studied in 10 States to determine methods of seed distribution, as well as soil and climatic relationships.

Dr. E. R. Schulz is carrying on chemical studies. These include: (1) the relation of seasonal storage of reserve food products in the different parts of the barberry plant to the time of year for effective treating with chemicals, (2) studies of the effects of sodium arsenite on various plants and on the soil; (3) the action of salt on plant tissues with special reference to the common barberry; (4) the sterilizing effects of salt on soil; and (5) analyses of barberry tissues for alkaloids, such as berberine and hydrastine, and for glucosides, with methods for their extraction.

Native Barberries

There are in the United States several species of native barberries. Most of these do not carry the stem rust of grains. Berberis (Mahonia) aquifolium, while not known to spread rust in its native habitat, is susceptible under greenhouse conditions. It should not be planted in the more humid wheat-growing areas.

A native barberry (Barberis canadensis Miller) was found by early settlers in the Appalachian Mountains in southwestern Virginia, southern West Virginia, and in western North Carolina. It is susceptible in nature and spreads stem rust to grains. In some localities at least it is as much a menace to the growing of grain as the common barberry, Berberis vulgaris L. In 1923, numerous clumps of bushes of this species were found in Pulaski, White, and Carroll counties, Indiana. They were scattered here and there for over 50 miles along the Tippecanoe River, on gravelly and sandy banks or limestone cliffs within a few rods of the stream. It is rather remarkable that neither bushes nor seedlings were found scattered in woodlands and fence rows of nearby farms. The occurrence of this species also has been reported from southern Missouri and northern Arkansas. Limited experiments in methods of eradication are in progress in both Indiana and Virginia.



Rhamnus Survey

State leaders and field assistants cooperated with the pathologist in charge of crown-rust investigations by reporting the location of all Rhamnus cathartica coming to their notice in the course of their regular work.

Relation of Barberries to Rust

The barberry eradication campaign is based upon studies of the methods of spread of rust and its control. While these studies are carried on under the direction of Dr. E. C. Stakman, pathologist (and agent) in charge, and Edmund B. Lambert, assistant pathologist, in connection with research on stem rust, much of the administration and most of the field work necessarily is accomplished under barberry-eradication funds, and through the cooperation of the State leaders in barberry eradication and their field assistants.

The leaders in most of the 13 States conduct over-wintering studies in various parts of their States. The leaders and field assistants report the presence of stem rust, estimate prevalence and severity, and in some cases, estimate resultant losses. They prepare maps of the spread of rust from infected barberry bushes and find bushes through rust surveys. It is only through continued cooperation of every one directly affected in reporting all local outbreaks of stem rust and in studying each local outbreak to see if it can be traced to a barberry bush, sprouting bush, or seedling, that the last barberry can be found and destroyed in these 13 wheat-growing States.

Climatic conditions in the summer of 1923 were exceptionally favorable for the rapid development and spread of stem rust. The preliminary estimate of losses from stem rust of wheat are much lower than those for 1919 and 1920, and is in no way comparable with the enormous losses of 1916, as shown by Table 3. Had the 5,000,000 bushes eradicated prior to 1923 still been in existence in the summer of 1923, there is reason to believe that the stem-rust epidemic of 1923, which became very severe locally, might have become as generally severe and as tremendously destructive as the epidemics of 1904 and 1916.

In the areas where local epidemics became severe, numerous sprouting bushes and seedlings were found as well as a few scattered plantings overlooked in the first survey. In most cases these were spreading stem rust and were sufficiently numerous to account for all rust occurring this year.

Species of *Berberis* not definitely known to be susceptible to stem rust are being procured and their susceptibility to stem rust investigated by E. B. Lambert. The susceptibility of certain hybrids of *Berberis vulgaris* and *Berberis thunbergii* to stem rust is being studied by L. W. Melander.

Table 3. - Estimated losses of wheat from black stem rust in the United States for the 8-year period from 1916 to 1923, inclusive.

Year	Wheat production and losses from black stem rust.	
	Production	Losses ^{a/}
	Bushels	Bushels
1916-----	636,312,000	180,000,000
1917-----	650,828,000	16,203,000
1918-----	917,100,00	304,000
1919-----	940,987,000	71,417,000
1920-----	737,128,000	54,903,000
1921-----	814,905,000	22,293,000
1922-----	856,211,000	21,004,000
1923-----	785,741,000 ^{b/}	29,378,000 ^{b/}
Total -----	6,189,118,000	396,042,000

^{a/}Data obtained in cooperation with the Plant-Disease Survey of the Bureau of Plant Industry, U. S. Department of Agriculture.

^{b/}Estimates of December, 1923.

Plans are under way, in cooperation with the Office of Horticultural Investigations, for the establishment of a Berberis garden near Washington, D.C. wherein all known species of Berberis can be assembled, propagated, studied, and described. This is necessary in connection with the studies of susceptibility to stem rust as well as to the establishment of quarantine measures against the distribution of susceptible species of Berberis to cleared areas.

Summary for Six Years

In the 6 years of the campaign, from April 1, 1918, to December 31, 1923, in the original survey, 6,062,529 bushes have been located on 63,215 properties and 1,762,764 seedlings on 862 properties. This includes a second survey of 42½ counties in which 3,762 bushes on 269 properties and 476 seedlings on 7 properties were found and destroyed. There have been found in addition on resurveys, 251,767 sprouting bushes on 2,965 properties and 1,996,607 seedlings on 2,829 properties. There has been destroyed a total of 5,424,500 bushes on

61,175 properties, 3,704,471 seedlings on 3,683 properties, and 250,743 sprouting bushes on 8,941 properties. These make a grand total of 10,073,667 bushes and seedlings found and 9,379,774 destroyed in all surveys (See Tables 4a and 4b). The remaining 693,893 bushes and seedlings will be eradicated as rapidly as arrangements with property owners can be made and as weather conditions permit.

In the 13 States included in this area there are 976 counties in which survey is required in an area approximately equal to 894 counties. In the original survey an area equivalent to approximately 662 counties has been covered. In the second survey 42 $\frac{1}{2}$ counties have been covered. There remains an area approximately the equivalent of 232 counties requiring an original farm-to-farm survey. In view of the results of the past season it seems advisable to survey a second time many of the counties in which wheat is the principal crop. All properties on which seedlings or sprouts may continue to appear must be resurveyed until they are known to be cleared of the last seedling. Much remains to be done, and eternal vigilance is necessary to see that the work already accomplished has not been in vain.

Table 4a. - Summarized data from all surveys showing, by States, the numbers of properties on which barberry bushes, seedlings, and sprouting bushes were found and removed in the barberry eradication campaign from April 1, 1918, to December 31, 1923, inclusive.

State	Numbers of Properties					
	On which bushes were -		On which seedlings were -		On which sprouting bushes were -	
	Found	Destroyed	Found	Destroyed	Found	Destroyed
Colorado	1,696	1,695	44	44	1,524	1,521
Illinois	10,776	10,432	236	236	627	627
Indiana	4,410	4,358	38	38	333	334
Iowa	9,304	9,299	103	103	682	681
Michigan	9,389	8,308	359	359	317	317
Minnesota	4,848	4,848	2,446	2,446	1,628	1,628
Montana	221	220	2	2	128	128
Nebraska	3,762	3,750	29	29	492	492
N. Dakota	801	801	2	2	288	288
Ohio	7,806	7,478	118	118	896	896
S. Dakota	953	853	118	118	587	587
Wisconsin	9,161	9,048	190	182	1,432	1,420
Wyoming	88	85	6	6	26	22
Total	63,215	61,175	3,691	3,683	8,965	8,941

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Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
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Table 4b. - Summarized data from all surveys showing, by States, the numbers of bushes, seedlings, and sprouting bushes found and removed in the barberry eradication campaign from April 1, 1918, to December 31, 1923, inclusive.

State	Numbers of -					
	Bushes		Seedlings		Sprouting Bushes	
	Found	Destroyed	Found	Destroyed	Found	Destroyed
Colorado	24,224	24,223	1,731	1,731	6,298	6,294
Illinois	181,387	168,706	1,546,798	1,546,798	8,806	8,806
Indiana	145,316	117,288	3,506	3,506	19,459	19,154
Iowa	787,036	786,301	30,522	30,522	15,349	14,999
Michigan	348,672	312,547	706,644	706,644	2,220	2,220
Minnesota	782,328	782,328	38,151	38,151	46,020	46,020
Montana	9,851	9,195	1,290	1,290	4,643	4,643
Nebraska	93,233	93,028	4,690	4,690	15,361	15,361
N. Dakota	21,822	21,822	156	156	292	292
Ohio	242,348	233,867	202,496	202,496	9,382	9,382
S. Dakota	56,325	51,318	25,247	25,247	42,477	42,477
Wisconsin	3,365,845	2,819,969	1,198,088	1,143,188	81,081	80,774
Wyoming	4,142	3,968	52	52	379	321
Total	6,062,529	5,424,560	3,759,371	3,704,471	251,767	250,743

Grand total of bushes, seedlings, and sprouting bushes:
 Found 10,073,667 Destroyed 9,379,774.

