

BARBERY ERADICATION IN ILLINOIS.¹

F. E. KEMPTON, PATHOLOGIST IN CHARGE, G. C. CURRAN,
STATE LEADER, ILLINOIS, E. D. GRIFFIN, ASST. STATE
LEADER, ILLINOIS

Introduction.

Progress of Eradication.

Problem of Escaped Barberries in Illinois.

The Gurnee Area.

The Galena Area.

The Ogle County Area.

Chemical Eradication.

Rust Epidemiology Studies.

Airplane Studies of the Dissemination of Spores of
Puccinia graminis.

Method Used in Collecting and Examining the
Spores.²

Results from Series 1 and 2.

Results of Series 3.

Results of Series 4.

Summary.

INTRODUCTION

The barberry eradication campaign in Illinois was begun in the spring of 1918 as a part of the campaign organized by the United States Department of Agriculture 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.

This campaign in the United States followed the severe black rust epidemic in 1916 which produced a shortage of wheat that seriously affected the nation's flour supply during the period of the world war. Through the agitation of scientists and the results of preliminary surveys in Minnesota and Iowa, conferences were held in 1917

¹Office of Cereal Investigations, Bureau of Plant Industry, U. S. Department of Agriculture, and the Illinois University, College of Agriculture, cooperating.

²Thanks are due to S. P. Harter, field assistant, who made observations, counts, and germinations of aeciospores on the exposed slides,

and 1918 which brought about the organization of the present barberry eradication campaign by the Office of Cereal Investigations of the United States Department of Agriculture in March, 1918. Field work was begun in April, 1918, under an emergency appropriation for stimulating agriculture. An annual appropriation of approximately \$150,000 was provided by Congress from July 1, 1918, to June 30, 1921, after which it was increased to \$350,000. During this time, practically all cities and towns were surveyed for barberry bushes and a farm-to-farm survey was begun in 1919. By December 31, 1922, all properties in 472 counties had been surveyed.

Because of the desire of interested commercial and agricultural organizations to further the campaign and shorten the time necessary to complete the survey, a conference was called by them at Minneapolis in March, 1922, to consider further measures that might be adopted as a means of rust control. Representatives of commercial interests, the farm bureaus, the State departments of agriculture, and the State experiment stations formed a permanent organization, and indorsed the barberry eradication campaign as the feasible measure to be used in rust control. Largely through effective presentation by this organization Congress increased the appropriations for barberry eradication, and some of the States likewise provided extra funds.

PROGRESS OF ERADICATION

The entire State of Illinois is included in the eradication area. Due to a wide range of temperature and latitude within the State there is a marked difference in the type and variety of cereals and grasses in the northern and southern areas. Experimental data show that spring wheat is subject to greater damage from stem rust than winter wheat, and, as spring wheat is grown successfully only in northern Illinois, it was decided to begin barberry eradication in that section.

From April 1, 1918, to December 31, 1922, 762 cities and towns were surveyed for barberry and 15 counties were covered in the farm-to-farm survey with the result that 142, 882 bushes were located, and, in most instances,

eradicated. Owing to a large increase in the Federal appropriation more men were employed for survey and eradication during the summer of 1922 than in previous years. As a result six counties were completed in 1922 alone, in addition to a considerable portion of the city of Chicago.

More properties infested with common barberries have been found in Illinois than in any of the other twelve States within the barberry eradication area. During the five-year campaign, 9,478 properties on which barberry was growing have been located. Iowa ranks second with 8,390 and Michigan third with 8,325. Although Illinois has the highest number of properties with barberry, in the total number of bushes found the State ranks fifth.

Thus far about twice as many bushes have been found in the towns as in the country, probably due to the fact that the urban survey has been nearly State-wide while the farm-to-farm survey has been confined to fifteen counties in northern Illinois.

At the rate of progress in Illinois during 1922, the best year of the campaign, at least five more years will be necessary to complete the original survey. Illinois received \$20,000 of the Congressional appropriation of \$350,000 in 1922. To date less than a quarter of the total area of the State has been covered in the farm-to-farm survey. Either the annual Federal allotment will have to be increased considerably or the State will have to give generous financial aid to the movement if Illinois is to be cleared of barberry by the time the other 12 States are covered.

PROBLEM OF ESCAPED BARBERRIES

One of the difficult problems encountered in the eradication campaign in Illinois is the widespread occurrence of escaped bushes that have grown from seeds scattered from cultivated bushes. Of the bushes found in the country, 27,463 were escaped bushes on 458 properties distributed in every county of the surveyed area.

Because of the large number of escaped bushes, eradication has been retarded considerably. Usually these bushes were found growing in timber land, brushy pas-



Fig. 1. Escaped barberry bushes growing in the Galena area. The soil is extremely rocky and eradication by digging is impossible.

tures or on rocky hillsides, often of rugged topography. Survey of these areas made on foot and covering every square rod is a slow process. Three outstanding areas of escaped bushes have been found in the surveyed territory, namely, at Gurnee, Lake County; Galena, Jo Daviess County; and Chana, Ogle County. They are widely separated and possess different characteristics.

THE GURNEE AREA

The Gurnee area is located in Lake County and has the largest number of bushes. The number of bushes is estimated at 5,000 and there is a wide variation in size and age. Most of these bushes were growing in a 40-acre woodlot on the farm of a Mr. Lake. Other scattered plantings were found along highways, hedges, and fences for several miles around. Seedlings, sprouts, and large mature bushes were all growing together in timber forming a dense growth of underbrush. Unlike most areas, the escaped bushes were not closely associated with streams. The original source of these bushes was a hedge near the old homestead on the Lake farm. This hedge had been eradicated some years ago.

THE GALENA AREA

The Galena area was found during the summer of 1922 and is located about the city of Galena in Jo Daviess County. The topography is extremely rough due to its being unglaciated, and many difficulties were encountered by the field men. It was necessary to survey twelve sections on foot and considerable time was thus consumed. Unoccupied property offered another stumbling block to the efficient destruction of the barberry. There were approximately 1,500 bushes found within a radius of about two miles from the original planting. Many were growing against rocky cliffs (Fig. 1) and in ravines that were almost inaccessible to the scouts. Digging was a difficult process and sprouts invariably appeared after digging because the roots could not be entirely removed.

This area originated from a large hedge planted in Galena in 1844. In general the escapes are scattered along hillsides on both banks of the Galena river. Birds

probably were the principal disseminating agent, with water as a second factor.

THE OGLE COUNTY AREA

Three separate areas of escaped barberry were found in Ogle County during the summer of 1922. The total number of bushes in these areas was about 250 and in each instance they were associated with streams in timber lands. The topography is somewhat rough but not as rugged as that in the vicinity of Galena. Although the number of bushes in the Ogle County area would indicate that it was comparatively unimportant, there are several characteristics peculiar to it.

In the territory about the town of Chana, twenty bushes all about the same size were estimated to be 70 years old. One of the largest bushes found in Illinois was in this area (Fig. 2). Another unusual characteristic was that the escaped bushes grew separately, only a few on each farm.

In the area about Mt. Morris, the bushes were of all sizes and were widely scattered in small groups. The area is about six miles across and includes about 100 bushes originating from a single source. In the Polo area many of the bushes were found growing on the sides of rocky bluffs and eradication necessarily will be difficult.

CHEMICAL ERADICATION¹

The common barberry (*Berberis vulgaris* L.) when well established is a very difficult plant to kill. This is the conclusion reached after five years of effort to eradicate the common barberries from 13 of the North-Central States.

When the bushes are dug, even small fragments of roots left in the ground usually will sprout. This means that where the digging is difficult, as in rocky ground or around trees or stumps or when unusual care is not taken to remove all fragments of roots, sprouts are almost sure to develop. In lawns or gardens where a careful watch can be kept, the problem is not so serious,

¹Noel F. Thompson. Kill the Common Barberry with Chemicals. U. S. Dept. of Agriculture, Cir. 268, 4 p., 3 fig. March, 1923.

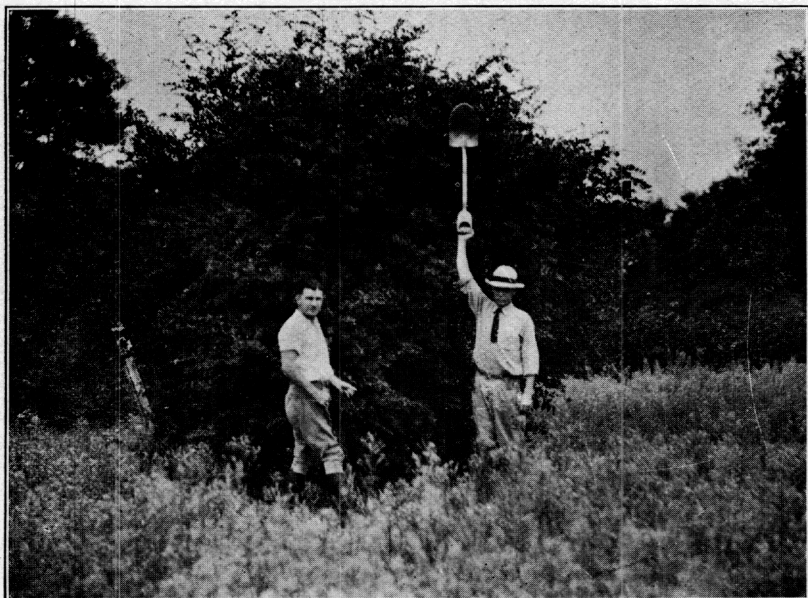


Fig. 2. Immense escaped barberry bush found in Ogle County. This is one of the largest bushes found in Illinois and is typical of the twenty large and widely separated bushes found in one escaped area.



Fig. 3. Barberry sprouts near Galena, Illinois, treated with crushed rock salt. The character of the soil makes chemical eradication necessary.

for in a year or two all roots left at the first digging will have sprouted and can be removed. With bushes growing wild in pastures and woodlots and along fences at a distance from the house, the situation is different, and other means of killing the bush are desirable.

In the past two years experiments have been carried on at Gurnee in Lake County in an effort to find some suitable chemical that would kill barberry bushes. A large area of escaped barberry was found at Gurnee in June, 1921, and the chemical experiments were begun in the autumn of the same year. Noel F. Thompson, who is now in charge of the experiments, has found that rock salt and a commercial compound containing sodium arsenite are the most effective compounds for killing the bushes.

Dr. W. W. Robbins conducted a series of experiments to determine a satisfactory method for killing barberry seedlings. He found that a number of chemicals are apparently equally toxic to barberry seedlings. Sodium arsenite was the most economical and effective compound used. A spring application was more effective than a fall application. Apparently the seedlings gain in reserve strength as the season advances. This fact suggests the advisability of spraying the young plants as soon as possible after the germination of the barberry seeds in the spring and summer.

Because of the danger to livestock resulting from the use of sodium arsenite, it has become necessary to discontinue using this chemical and to rely entirely upon salt.

There are many localities in Illinois where the soil is of such a character that effective digging of the bushes is impossible. An example of such a condition was encountered in the Galena district. The soil of the entire region is extremely rocky and where bushes were removed in July, sprouts appeared in September, thus demonstrating the absolute necessity of adopting the more efficient method of using chemicals in order to eradicate permanently every common barberry bush in the State (Fig. 3).

Even when the character of the soil would not interfere with eradication by digging, sprouts have been found

in many instances. For example, the 1922 survey in Oak Park, Cook County, showed that fully fifty per cent of the bushes eradicated in previous years had sprouted. However, it is not likely that chemicals can be used conveniently on every planting because of the injurious effect on the soil, retarding plant growth one or two years.

Crushed rock salt has been applied to a number of bushes in Jo Daviess County (Fig. 4). About ten pounds is the recommended application for the average-sized bush. It should be distributed over the crown. The bush may be left standing or the top cut off before applying the salt. The average cost per plant for treatment with crushed rock salt was from five to fifteen cents, depending upon the character of the bush. This included the cost for salt and labor.

RUST EPIDEMIOLOGY STUDIES

In connection with the barberry eradication campaign in Illinois numerous observations have been made in the spread of black stem rust from infected barberries. Several outstanding cases have been noted; one at Minooka, Grundy County, probably is best known because it was the first to be brought prominently to the attention of farmers. It was discovered in 1919 and showed the relationship so clearly that it was mapped and described in the annual report of the barberry eradication campaign of that year.

Much of the rust around Minooka originated in a large hedge of common barberry comprising some six hundred bushes. Directly east of this hedge was a field of winter wheat sheltered by an intervening orchard. This protection, together with the earlier development of winter wheat, prevented serious damage to this field. About a quarter of a mile southeast of the hedge was a field of spring wheat with no protection other than distance. Intervening was a pasture extending from the hedge to the wheat. In this pasture was considerable wild barley. Rust spread from the barberries to the grass and then spread rapidly through the pasture to the grain where it produced a 90 per cent infection. Directly across the

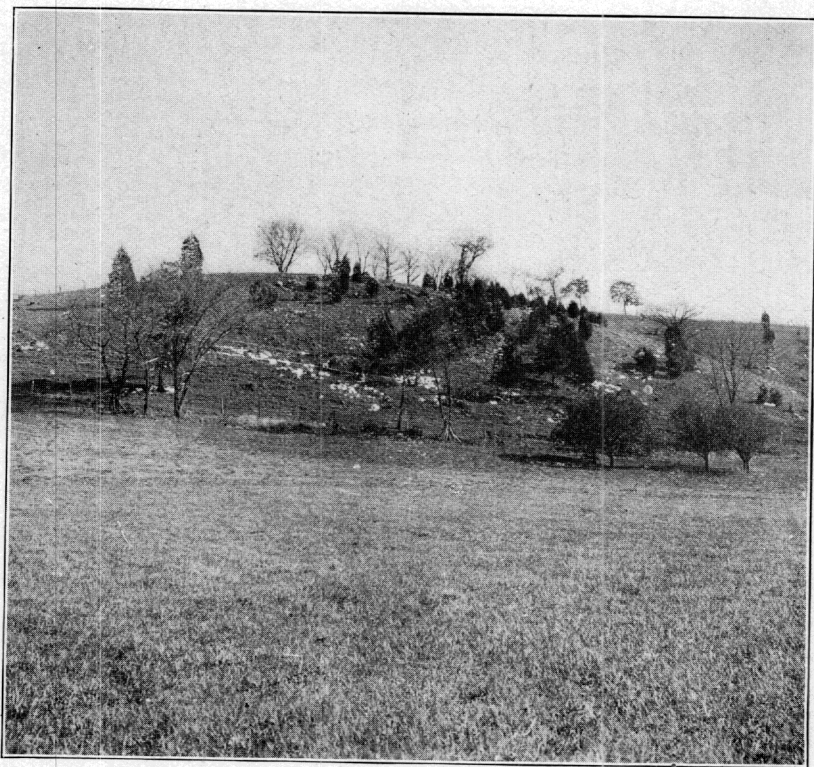


Fig. 4. An area of escaped barberries in Jo Daviess County. The tops of of the bushes have been cut off and the crowns treated with salt.

road, about 70 feet from the hedge, was a field of oats. Not a single stalk escaped the rust. A mile farther away was another field of oats which showed an infection of about 75 to 80 per cent. The removal of the hedge has decreased stem-rust losses in this neighborhood in subsequent years.

During the summer of 1922, no serious outbreaks of black stem rust were reported. Weather conditions in June were very unfavorable for the development of stem rust. The rainfall was light and the dry weather hindered the growth of the rust. However, the earliest infection of stem rust in northern Illinois in 1922 can be traced to barberry bushes, and, if weather conditions had favored stem-rust development, severe attacks with heavy losses might have occurred in that year.

The first spread of rust from barberries in 1922 was noticed in Lake, Livingston, and Will counties at about the same time. Mr. Thompson found quack grass and oats with a trace of infection near barberry bushes on June 10 in Lake County. In Livingston County on June 9, wild barley growing near a barberry hedge was found to be slightly infected. No rust could be found on this grass more than fifty yards away from the hedge. On June 23, barley growing near barberry in McHenry County was heavily rusted, while at a distance of fifty feet from the bushes the rust was extremely light. On the same date orchard grass and quack grass were found rusted near barberry in DuPage County. In almost every instance when infected barberry was found, stem rust was present on grasses or grains, and probably weather conditions alone were responsible for the absence of heavy infections.

AIRPLANE STUDIES OF THE DISSEMINATION OF STEM-RUST SPORES

Airplanes have been used in connection with studies of stem-rust spores in the air.

The purpose of these investigations was to determine general relations which might exist between height or distance from the infected material and the resulting dissemination of rust spores. It includes an attempt to

find a correlation between distance from infected barberries in the direction of prevailing winds and the number of aeciospores or urediniospores which might be found.

METHOD USED IN COLLECTING AND EXAMINING THE SPORES

The work of collecting the spores was made possible through a cooperative agreement between the United States Department of Agriculture and the Air Service of the War Department. Slides were exposed from Army airplanes stationed at Chanute Field, Rantoul, Illinois. The airplanes, piloted by U. S. Army officers, flew from Rantoul to Gurnee, a distance of 150 miles each time spore collections were made. The bushes in the Gurnee area, previously described, were rusted heavily in the spring of 1922 and it was during the period of rust infection on the barberry that most of the flights were made over this area.

The apparatus as described in another paper¹ consisted of ordinary glass slides 3"x1" in size coated with a very thin film of white vaseline or glycerine jelly. Each slide was fastened to a wooden handle and placed in a small glass bottle two inches in diameter and four inches high. With the use of a close-fitting cork stopper the bottle was made air tight. The glass slide was exposed by removing it from the bottle and holding the handle with the slide attached out in the air above the cockpit of the airplane for a definite time at definite altitudes. The microscopic examination of the slides and germination tests were made in the laboratory.

Four series of slides were exposed. Glycerine jelly, because it is quite transparent when examined under a microscope, was used in one series to determine its effectiveness in catching and holding spores. The time of exposure varied from three minutes in the first, second and fourth series to ten minutes in the third series.

In all cases the slides were examined under a microscope with a mechanical stage for the purpose of getting

¹ Elvin C. Stakman, Arthur W. Henry, Gordon C. Curran, and Warren N. Christopher. Spores in the Upper Air. In *Journal of Agricultural Research*, Vol. 24, No. 6, May 12, 1923.

a close estimate of the spores present on each slide. To insure positive identification of all spores, they were measured by means of an ocular micrometer and were compared directly with type slides which contained the various forms. Only spores which were whole and uninjured were counted. In addition to aeciospores, urediniospores and teliospores of *Puccinia graminis* Pers., which were the only spores counted, there were, in many instances, large numbers of smut spores, spores of other rusts, pollen grains and spores of a considerable number of other fungi such as *Alternaria*.

RESULTS FROM SERIES 1 AND 2

The slides of this series were exposed on June 14, 1922, from an Army airplane over and near the 40-acre area of escaped barberries on the H. C. Lake farm near Gurnee, Illinois. The barberry bushes were infected severely on this date. The wind was blowing from the northeast and the observations were made directly over the area of bushes, at distances of 10, 15, and 25 miles south of the area. Each slide was exposed for three minutes. A vaseline-coated slide was placed on one side of the wooden paddle and a slide coated with glycerine jelly on the other; thus, when the paddle was exposed, two slides were in position to catch spores from the air. Observations show that aeciospores were present in the air over the Lake farm at altitudes from 100 to 12,000 feet. Urediniospores were found at altitudes of 1,000 to 7,000 feet. Ten miles south of this infected area, both aeciospores and urediniospores were found at an altitude of 2,000 feet. Fifteen miles south, aeciospores were found at an altitude of 2,000 feet. Twenty-five miles south, only one aeciospore was found and this at an altitude of 2,000 feet.

RESULTS OF SERIES 3

Slides of this series were exposed from an Army airplane over and near the 40-acre area of escaped barberries on the H. C. Lake farm near Gurnee, Illinois, on July 5, 1922. The length of the exposure was ten minutes. All the slides were coated with vaseline and two slides

were exposed at the same time by attaching two slides to each paddle.

Observations made on this date show that approximately the same numbers of spores were present at elevations of 100 to 2,000 feet. At 6,000 feet there were about six-tenths as many spores as at 2,000 feet. At each elevation there were twice as many aeciospores as urediniospores and few teliospores were found from 100 to 2,000 feet.

RESULTS FROM SERIES 4

These slides were exposed on September 18, 1922, and the results are given to show the presence of the different spore forms late in the season. The exposure period was three minutes over an area free from any escaped barberries, and probably harboring few cultivated bushes. No aeciospores whatever were found on microscopic examination. A very large number of urediniospores were found and a decidedly increased number of teliospores, all of which is in direct keeping with the advanced season and the other conditions under which the exposures were made.

SUMMARY

The campaign for the eradication of the common barberry began in Illinois in the spring of 1918. Practically all of the cities and towns were surveyed during the first two years. The activities of the past three years have been devoted to the farm-to-farm survey of 15 counties in the northern part of the State and a resurvey of the city properties in these counties.

Illinois has an unusually large number of escaped barberries. In most cases, these escaped bushes are growing in timber land, brushy pastures, or on rocky hillsides which are of rough topography and present serious problems of successful eradication. The spread of escaped barberries is correlated with the type of soil and topography of the land over which they scatter. Results of experiments show that the most feasible method of killing barberry bushes in rocky situations is by the application of salt. An average-sized bush can be killed with 10 pounds of common crushed rock salt piled over the crown.

The cost per bush for the salt and application ranges from ten to fifteen cents.

Epidemiology studies show that barberry bushes are directly responsible for the early spread of black stem rust to fields of grain. The aecial stage of stem rust was found on barberry bushes in northern Illinois as early as June 10 in 1922.

Observations made by airplane flights show that in June and July aeciospores were present in the air over infected barberries. Also, these spores were caught in the direction of the prevailing winds from 15 to 20 miles from any known area of infected barberries. From flights made on September 12, 1922, no aeciospores were obtained in the air, but numerous teliospores were caught.