STUDIES ON THE OVERWINTERING OF THE UREDOSPORE OF THE BLACK STEM RUST OF WHEAT IN THE VICINITY OF LARIMER AND WELD COUNTIES, COLORADO. WINTERS OF 1921-1922-1923

by

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INTRODUCTION

There is a problem presented to the people in Colorado as to whether the uredo stage of the black stem rust (*Puccinia graminis* Pers.) can overwinter and cause spring infection without the common barberry (*Berberis vulgaris*) as an alternate host.

In order to meet this problem the author has carried on experiments at the Colorado Agricultural College during the winters of 1921, 1922 and 1923. Field observations have also been made during the early spring and summer months of 1921 and 1922. A review of literature on black stem rust is given and also the results obtained on the overwintering of the urediniospores.

OVERWINTERING OF THE UREDINIOSPORE

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HISTORY OF DISEASE

The cereal rusts have been known for several thousand years. In the bible it is spoken of as"mildew"which is the term applied to rust in England. In those bibical times it was thought to be a pestilence as a judgement of God for the peoples' sins. About 1000 B. C., Solomon prayed to God for clemency, "If there be in the land famine, if there be pestilence mildews, etc." I Kings 8:37.

The Greeks and Romans also feared the rusts. Aristotle described the disease about 350 B. C. Pliny, a Roman, said "wheat was more susceptible to mildew attacks than barley." He also stated that it was the most destructive disease of cereal crops and recommended that the grain be sown early so as to ripen before the attack came.

There were also many ficticious beliefs as to the source of rust. Many believing that certain stars exerted an especially injurious influence from which the so-called secret evil arose, among which are the rusts and mildews.

The first law toward destruction of barberries was passed in Ouren France, in 1660. This was done as they were supposed to have held some mysterious relation to epidemics of wheat rust.

In 1726 Connecticut passed a law restricting cultivation of barberry bushes as it was observed the rust was heavy where the barberries were located.

In 1797 Person found the fungus causing the disease and gave it the name of Puccinia graminis.

The first definite observations on rusts as diseases were published by DeBary in 1865. He proved that the rust was heteroecious and the barberry was the aecial host of Puccinia graminis. Teliospores of Puccinia graminis were germinated and the sporidia placed on the barberry leaf producing aecia and pycnia. With the aecidiospores, wheat was inoculated which produced the red pustule containing the uredinia.

De Bary opened the scientific field on rust investigations and a more complete study of this organism has been made. Pathologists of today are continuing the research on other disease as well as the rusts trying to find a way of combatting them.

DAMAGE DONE BY BLACK STEM RUST.

According to Dr. E. C. Stakman (1) the black stem rust is the limiting factor in grain production in many sections of the United States. It is very destructive on spring wheat and will sometimes cause great loss to winter wheat.

Through a period of years it has been observed that the rust destruction has occurred at irregular intervals. In 1904 the loss caused by rust in Minnesota and the two Dakotas was estimated at $20,000,000.00. In 1916 it was estimated that South Dakota had prospects of 150 million bushels, but in this same year there was an epidemic of rust and the crop run less than 40 million bushels. A conservative estimate of loss due to black stem rust in 1916 was 180 million bushels. These points bring out the importance of the disease in this country.

KINDS OF GRAIN RUSTS IN THE UNITED STATES.

There are four important grain rusts in the United States, the black stem rust (*Puccinia graminis*) which will attack our grains and several of the wild grasses. This is the most important rust.

The orange leaf rust (*P. triticina*), attacking the seed leaves of wheat. Yellow stripe rust (*P. glumarium*) attacking the stem and leaves, and crown rust of oats (*P. coronata*).

The black stem rust develops on the common barberry. The uredinial stage occurs on the stems and leaves of the cereals in reddish sori which are long or ovate in shape. It occurs mostly on the stems but can

also be found on the leaves. It can readily be distinguished by the naked eye. It may also occur on other hosts.

Stakman (1):

Hordeum jubatum	Elymus sp.
Agropyron repens	Festuca sp.
Agropyron smithii	Koleria custata
Agropyron caninum	Anthoxanthum puelli
Hystrix patula	Bromus sp.

All of those listed above can be infected with Puccinia graminis, although there are forms of this rust which act somewhat differently. For examples, one form will grow on wheat and also on barley but normally will not attack oats or rye. There is also a form which attacks rye and barley but will not attack wheat or oats. All the races or forms can live on several of the wild grasses but not all of them can attack the same grasses. There are thirty-eight different forms of black stem rust and each race has a particular host which it attacks.

The early orange leaf rust, Puccinia triticina attacks the leaves of the plant when they first appear above the ground. The attack takes place in the spring sown grain and in the fall on winter wheat. It can be readily distinguished from the stem rust by the rounded orange colored pustules. Microscopically the spores are

round or circular while those of graminis are ovid or egg shape. (See Plate I).

This rust seems to be continually producing uredospores or summer spores, and live over the winter as uredinial mycelium. Some pathologists consider the damage caused by this rust very slight, only slight delay in maturity, while others say that there are no injurious effects.

The uellow stripe rust, Puccinia glumarium, was found in Arizona in 1915 on wheat and in the western United States on barley, rye and many wild grasses. The pustules can be determined from the graminis species by being very long and yellow in color. The spores are much longer than those of graminis. Recently Dr. Stakman has found considerable stripe in Mexico. Aside from Arizona it was found in Wyoming. It has never been found in Colorado.

Crown rust of oats, Puccinia coronata, has a similar life history to that of graminis. The spore stages are the same but the shape of the teliospore can readily be distinguished by the crown shaped apex.

The sporidia go to the buckthorn or Rhamnus sp. and develop the aecia stage. Epidemics of crown rust have occurred in areas where the Rhamnus is grown. The

spores germinate spreading very rapidly from wheat to wheat. Berberis spp. and Mahonia spp. shrubs susceptible to rust.

DESCRIPTION OF PUCCINIA TRITICINA (ORANGE LEAF RUST)

Uredinia, generally on under side of leaf, spores somewhat small, oblong, black and covered by the epidermis. Spores are oblong, obtusely and somewhat pointed above. According to Jackson and Mains (3) the aecial stage has been found. The report is as follows: In the spring of 1919, ten specimens of wintered telia of Puccinia triticina were germinated and sown on 48 species included in 19 genera of the families Ranunculaceae, Boraginaceae and Hydropyllaceae. The results were negative, except in the case of two species of Thalictrum repens where pycnia were produced. In the spring of 1920, 37 collections of wintered telia were germinated and sown upon 14 species of Thalictrum. Infection resulting in the development of pycnia or aecia was obtained in 84 instances upon 12 of these species. The most vigorous development of aecia was obtained on four exotic species. Infection was only occasionally obtained on the native species used with but a weak development of aecia. The collection of telia giving infection were from Pennsylvania, West Virginia, North Carolina, South Carolina, Alabama, Georgia,

Mississippi, Tennessee, Kentucky, Indiana, Michigan, Iowa, Minnesota, Iowa, Missouri, Louisiana, Texas, Arizona, California, Washington, and Idaho. Aeciodiospores obtained from 20 of these cultures were sown back upon seedling wheat producing in every case uredinia typical of Puccinia triticina.

DESCRIPTION OF PUCCINIA GLUMARIUM (YELLOW STRIPE RUST)

Abundance on both surface of leaves and also occurring on the stems. The pustules are arranged in long lines being yellow in color, frequently occupying half of the leaf blade. Uredospores are globose to broadly illipsoid.

Teliospores occur on underside of leaf or on the stem arranged in long lines with a few scattered on the inflorescence. They are oblong and rather club shaped being dark brown or black in color.

Beside the cereals they are found on several of the wild grasses, such as Agropyron spp., Bromus, Elymus and Hordeum.

Puccinia glumarium has no known aecial. It is called spring rust on account of its early appearance, and yellow stripe on account of the sulphur yellow color. The sori are as long as 7 cm. and found on the upper side of the leaf. The uredinio are abundant as early as the beginning of May and it is known to

overwinter easily.

Morphology of Puccinia graminis.

The species Puccinia graminis, has been divided into a number of different forms or races by Ericksson and Henning. Morphologically the races or forms appear nearly identical but differ physiologcially in the manner in which they infect hosts of different genera or even of different species. The names of different forms are: Puccinia graminis tritici, Puccinia graminis secales, Puccinia avenae, Puccinia graminis tritici compacti Puccinia graminis phlei-pratensis

They may be classified as the following:

Class -- Basidiomycetes
Sub-class --Protobasidiomycetes
Order -- Uredinales
Genus - Puccinia
Species -- Graminis
Variety -- tritici
tritici compacti
secalis
avenae
agrostis
phlei-pratensis

Stakman (2), states that size and shape of urediniospores are similar; however, if a large number of spores are measured and the arithmatical mean or biometrical mode determined, it becomes apparent that there is some difference.

Puccinia graminis tritici, spores are nearly constant in shape, size and color. They are long, but in width are about the same as those of Puccinia graminis

avenae. Shape is eliptical to ovate, color bright yellow. Mode 32.64 u x 19.71 u.

Puccinia graminis tritici compacti. Quite similar to Puccinia graminis tritici. Color practically the same. Spores slightly longer, shape ovate to ellipsoid, Mode 31.76 u x 19.52 u.

Puccinia graminis secales, uniform in size, shape and color. Shape elongate - elliptic, color dull yellow to grayish, mode 27.23 u x 16.93 u.

Puccinia graminis avenae, color bright cadmium yellow, size and shape very variable, shape ellipsoid or globose. Mode 28.64 x 19.49 u.

Puccinia graminis agrostis spores similar to form above. Somewhat smaller. Mode 22.72 x 16.16 u.

Biological forms	Size Limits	Modes
P. graminis tritici	23.04-40.96 x 15.04-24.96	32.64x19.71
P. graminis avenae	19.20-37.12 x 13.76-25.60	28.64x19.49
P. graminis phlei-pratensis	16.00-29.76 x 12.80-21.12	23.40x17.31
P. graminis secalis	17.92-38.72 x 13.44-21.44	27.23x16.93
P. graminis tritici compacti	24.96 -38.08 x 14.40-25.28	31.76x19.52

Stakman and Piemeisel worked with the various strains or races to determine the hosts for various biologic forms of Puccinia graminis. The work was carried on in the greenhouse . Inoculations were made on different grasses, especially cereals and the results tabulated.

Agropyron caninum is the host for both P. graminis tritici and P. graminis secales.

Agropyron smithii both P. graminis tritici and secales were present.

Agrostis fatua can easily be infected with P. graminis avenae, also P. graminis coronata.

Avena sativa is infected with P. graminis avenae.

Dactylis glomerata may be infected with either P. graminis avenae or P. graminis phlei-pratensis.

Elymus canadensis can be attacked with ease by the following forms: P. graminis tritici, P. graminis tritici compacti, P. graminis secales.

Cultivated rye (secales) is infected by P. graminis tritici, P. graminis secales, the latter can not infect wheat.

Festuca elatior contained P. graminis phlei-pratensis, oats, barley and rye may be weakly infected.

Deer successfully infected oats with P. graminis tritici, taken directly from wheat.

Freman and Johnson also succeeded in infecting rye more easily with barley rust than with wheat rust.

On field observations the author has noted several cases where the above could be used for explanation. For example, a rusted rye field may be near barberries heavily rusted. The strain could be P. graminis secales. The next year wheat was planted

on the same field, very little rust appeared, while the bushes were heavily rusted. The P. graminis secales form produced the aecidia on the bushes but this form will not attack wheat.

PHYSIOLOGY

The incubation period of the various forms of Puccinia graminis varies considerable on the same host according to Stakman and Peimeisel (2). The age of the plant, the temperature, the light intensity may effect the rate of development of the rust materially. The cereals are usually susceptible at any age up to the ripening time. The susceptibility of some grasses under greenhouse conditions seems to be greater. Species of Agropyron and Elymus seem to to be extremely susceptible when young and much less when older. Although under natural conditions the plants may be older and become infected. Phleum pratensis and Agrostis alba seem to increase their susceptibility with age. They found other grasses such as Dactylis glomerata to be equally susceptible at all ages. He believes that if such observations were carried on an extensive scale under various conditions and with a large number of species of plants, and different forms of rust, it would seem quite possible to explain any conflicting results obtained by investigators.

Temperature is important in determining the rate

of development of the various biologic forms. No distinct differences were noted by Stakman between the different forms. He says that contrary to a fairly general belief, stem rust seems to develop best at fairly high temperatures, provided conditions have been favoragle for infection. The best infection usually results when the temperature is low enough to cause the condensation of moisture in a very fine film on the leaves. This usually occurs at night. Then infection having taken place, the urediospores seem to develop more rapidly at higher temperatures up to a certain point, probably about 75 degrees F. During extremely hot weather, it is difficult to secure heavy infection, probably on account of the difficulty of inducing a film of water to form. Low temperatures below 65 degrees F. inhibit the development of the rust because of the effect of heat on the vigor of the plant. Considerable amount of sunlight is also necessary for development of rust. Cloudy weather may lengthen the incubation period a week or more.

Stakman and Piemeisel (2) inoculated plants, placing them under bell jars for equal lengths of time, keeping them side by side. Some being partially shaded and others kept in direct sunlight. The shade plants

were weakly infected. Plants where the light was completely excluded, developed no rust.

LIFE HISTORY

Puccinia graminis has two stages on barberry, the spermogonial and the aecidial, and two on the grasses; the uredinial and telia. The first appearance on the barberry is the latter part of April or the first of May. In the summer of 1922, the first infected bushes found in Colorado were found on May 8, on sprouts east of Denver. This was the pycnial stage, occurring on the upper surface of the leaves. The spots are round and convex above the surface ranging from 3-4 mm. in diameter. On ripening they turn orange in color due to the development of the spermogenes which are the small bodies walled in by a large number of orange-like cells, the spermatia. These small oblong to roundish bodies do not germinate freely and their exact function is not known. They are supposedly gametes which have lost their function.

On the lower surface of the leaf just below the epidermis a large mass of hyphae arise, causing a rounded dome appearance. The hyphae within are shorter giving rise to parallel chains of spores known as aeciospores. They are gradullay pushed up each new spore formed below the older ones. The epidermis is soon ruptured, the edges of which revolute and there is formed an orange cup full of chains of aecidiospores.

The older spores at the top are blown away and are replenished by the new produced. The spores germinate readily with long germ tubes. The spore has one well defined germ pore. It is not resistant to drouth.

The aecidiospore is carried by the wind to the grain and here lodges on the stem or leaves. On germinating, the germ tube grows over the surface of the plant and soon finds a stomatal pore. On entering it works its way through the intercellular spaces occasionally sending haustorium into the mesophyll cells.

After several hours this mycelium begins to form a third spore, the urediniospore. Aknot-like hypha is formed just beneath the epidermis some of the branches turning upward forming layers or rows running parallel to the surface. The hyphae then divides into two daughter cells, the lower of which develops a stalk and the upper becomes a urediniospore.

The spore is oval in shape containing a double cell wall the outer being cutinized, containing spines. Two nuclei are present and four germ pores. Anumber of spores forming bursts the epidermis forming a pustule. Several pustules on the stem constitutes a sorus.

It is very easy for the urediniospore to break from the pedicel and be carried by the wind to adjoining plants or other susceptible grains. Here they will

germinate producing mycelium which will penetrate the epidermis and in turn form more fresh uredo material. This can be repeated indefinitely as long as conditions remain favorable. It is also very easy for the mycelium to go up and down the leaf producing fresh sori. The linear pustule can be accounted for by the movement of this mycelium.

Urediniospores may retain their viability for several months depending on the environmental conditions. Drying or freezing conditions they are able to live for about three months. Alternate freezing and thawing kills them in a short time.

Due to the former drying conditions which occur, the mycelium which had produced the urediniospores now begins to produce (at first in the same, afterwards in separate sori) the fourth kind of spore, the teliospore. In P. graminis there are two cells formed, each being a spore and capable of independent germination.

This spore is also formed on a pedicel being club-shaped. The walls are heavy, the contents appearing brown, granular and at first oily. One large nucleus is the center.

The function of the teliospore is to act as a resting spore, tiding the rust over the winter. Due to the heavy cutinized wall it is able to withstand severe conditions.

Each cell has one germ pore and when conditions are favorable in the spring, there protrudes through it a rather long tube which divides twice forming four separate cells called the basidium. Each cell under ordinary conditions produces a small stalk on the end of which a basidiospore or sporidia is formed. This spore can germinate indefinitely and form a conidium resembling basidiospore. If one of the detached basidiospores or conidium are carried to the surface of the common barberry leaf its germ tube bores through the cuticle entering the tissues forming mycelium which in turn gives rise to the spermogenes and aecidia.

In connection with the aecial stage it is interesting to know of the number of spores produced which has been worked out by Christman at St. Paul. One aecidium contains 8000 aeciospores. There are on an average 36 aecidiums to one cluster cup. An average of 8 cups on a leaf. Eighty per cent of the leaves were infected on a bush containing 35,000 leaves. From the former there would be 23 million aeciospores on one leaf and for a bush 7 feet tall, 2½ feet in diameter there would be 64 billion, 512 million aeciospores. At this rate it would not take many bushes to saturate the air with spores in the near vicinity.

STEM RUST EPIDEMIOLOGY

The relation of Barberry rust to the propagation of Black Stem Rust.

Stem rust epidemiology takes up the work of the study of overwintering of the urediniospore and observations of the rust in the field. In finding rust one should be able to account for its presence and obtain the evidence for proof. It is often done by tracing the rust to infected barberries or by finding the uredinia to overwinter, or a study by the use of slides exposed at different elevations to see it the spores are blowing into the area from adjoining territories.

We have been able to trace the rust to infected barberries in several cases. The spread is illustrated by the maps (See Plate 3), one of the property of D.E. Bliss, Greeley, Colorado, the other of P. Dines at Berthoud, Colorado. The rust in the surrounding territory must be accounted for by the presence of these bushes.

Another striking example is the one which was found at Burlington, Colorado, in June, 1922. In the town there were three properties on which 12 heavily infected barberries were growing. It was found that the rust from these bushes had spread for a distance of ten miles or more. It was also noticed that the rust was heavier near the bushes than it was further away. There were several wild grasses such as Agropyron

sp., Elymus spp., and Hordeum spp. heavily infected with the rust which indicated that it can pass from the bushes to wild grasses and in turn to the wheat. This was a local epidemic, rust only existed in the area near the bushes.

In Minnesota, when tracing the spread from infected bushes they find that they can only trace them a short distance before running into a spread from other bushes. This is due to the large number of barberries growing in this State. A number of small local epidemicswithin a short time leads to a large epidemic which may cover a great territory.

OBSERVATIONS ON UREDINIAL OVERWINTERING AT SELECTED STATIONS IN THE FIELD.

If rust is present and no barberries can be found for several miles, the problem is then a case of overwintering or blowing in from infected areas. The author has made a series of observations on overwintering by selecting various stations in the northern part of the State where rust occurred in 1921.

The substratum of the rust was selected on the volunteer grains, fall sown grains, wild grasses and straw or sutbble. The varieties and locations are tabulated on the result sheet. Each plot contained an abundance of fresh viable uredinia in the fall.

After locating the plots it is necessary to make notes on the conditions of the host. The fall sown and volunteer grains were vigorous and contained plenty of rust. Some plots were seedlings while others were grain which had been planted late in the summer. The stubble was selected from rusted fields after the grain had been cut. An abundance of material was available so as to have plenty for tests throughout the season.

IMMEDIATE TOPOGRAPHY

The plots were located in protected places from animals to avoid any destruction. The stations listed from 1 to 6 were exposed to weather without protection. The material on the stubble was exposed in one plot, another covered with leaves and another placed in a hole and covered. Rusted material was also set out on a ditch bank, one on a south slope and one on a north slope. It is necessary to see if the slope affected the life of the spores.

METHODS OF GERMINATING SPORES.

After the material was located and all notations made, it was then necessary to collect material from each plot at different intervals throughout the year and make germination tests. Two methods were tried the

latter being the better. Take a glass slide and fasten a glass ring to it by the use of vaseline. Place in a few drops of distilled water, sow the spores over this and invert it over the ring. Place the slide in a moist chamber and allow to stand for 48 hours, then make counts. The second method is by taking a slide and placing a small circle of vaseline in the middle. Place on a drop of distilled water and sow the spores on this. Place the slide in a petri dish and the petri dish in the germinator. The germinators used were those in the Colorado Seed Laboratory which are kept at a constant temperature of 20 degrees C., which is the optimum for the best germination of the spores. Counts were made at 48 and 72 hour intervals, before being taken out. The percentage of germination was made by marking off half or fourth of the field and counting the number of spores present; also the number that germinated, and in this way a percentage was obtained.

TABLE I

LIST OF STATIONS WHERE THE PLOTS WERE LOCATED GIVING HOST, STAGE AND DATE COLLECTED

No.	Location	Host	Stage	Date Located
1	3 mi. S. of Fort Collins	Oats	Volunteer	Sept.5,1921
2	South of City Park	"	"	Oct.1, 1921
2_1	" " " "	Barley	"	" " "
3	Experiment Station	Wheat	Heading out	Sept.15,1921
4	2 mi. N.of Greeley	Wheat	Volunteer	Oct.3, 1921
4_1	" " " "	Oats	"	" " "
5	3 mi. N.of Loveland	Timothy	Mature	Oct.8, 1921
5_1	" " " "	Barley (wild)	"	" " "
6	1 Mi. E.ofBerthoud	Oats	Volunteer	" " "
6_1	" " " "	Barley	"	" " "

The following gives the data concerning the collection of spores and the percentages of germination. The preparation date is given, that is, the date the spores were collected and placed in the germinators. They were immediately brought in from the field and placed in the germinator by the method already explained. The stations are indicated, the percentage of germination, the germination test and the temperature at date of collection. The date of germination test is the date on which the counts were made. A thermometer was carried to the station when spores were collected. The collections and tests were made at the given intervals from September, 1921 when first collections were made until

the spores failed to germinate, several check tests were made after no germination was obtained. The tests were then dropped.

Table II.

PERCENTAGE GERMINATION OF UREDINIOSPORE OF PUCCINIA GRAMINIS DURING THE WINTER 1921-1922

Preparation Date	Date Germination Test	Station Number	% of Germination Test	Condition	Temperature at date of Collection
9/16/21	9/20/21	1	94	Fair	Fair
9/16/21	9/19/21				"
9/16/21	9/19/21	2	84	"	"
9/16/21	9/19/21	3	89	"	"
9/23/21	9/28/21	1	84	"	"
9/24/21	9/28/21	2	50	"	"
9/24/21	9/28/21				
	8 A. M.	3	94	"	"
10/1/21	10/3/21				
	8 A. M.	1	45	"	"
10/1/21	10/3/21				
	8 A.M.	2	75 Barley	"	"
10/1/21	10/3/21				
	8 A.M.	3	45 Oats	"	"
10/5/21	10/6/21	4Wheat	40	"	73°F.
10/5/21	10/6/21	4 Oats	85	Good	73 F.
10/7/21	10/10/21				
	A. M.	2 Oats	no	"	65 F.
10/7/21	10/10/21				
	A. M.	2 Barley	87	"	80 F.
10/8/21	10/11/21				
	A. M.	6 Barley	97	"	80 F.
10/8/21	10/11/21				
	A.M.	6 Oats	50	Dried	80 F.
10/11/21	10/13/21				
	A. M.	3 Wheat	96	Good	63 F.
10/15/21	10/17/21				
	A. M.	1	98	"	62 F.
10/15/21	10/17/21				
	A. M.	3	98	"	62 F.
10/15/21	10/17/21				
	A. M.	2 Oats	95	"	62.F
10/15/21	10/17/21				
	A. M.	2 Barley	95	"	62 F.
10/15/21	10/17/21	6 Oats	93	"	62.F.
10/18/21	10/20/21				
	A. M.	4	75	"	Warm

Table II conintued

10/18/21 P. M.	10/20/21 A. M.	4'	Low	Dried	Warm
10/21/21 P. M.	10/24/21 A. M.	1	Low	Dried	84 F.
10/21/21 A. M.	10/24/21 A. M.	2 Hordei	50	Fair	79 F.
10/21/21 A. M.	10/24/21	2 Avenae	50	Fair	79 F.
10/21/21	10/24/21	2 avenae telia			79 F.
10/21/21	10/24/21	2 philei-pratensis	no	Good	79 F.
10/21/21	10/24/21	3 P.g. tritici	93	Good	79 F.
10/26/21	10/28/21	6 Avenea	78	Good	79 F.Clear
10/28/21	10/31/21	2 phlei-pratensis	25	Good	67 F. "
10/28/21 P.M.	10/31/21 A.M.	1 P.g. aveneae	15 (low)	Good	67 F. "
10/28/21 P M.	10/31/21 A. M.	3 P.g. tritici	74	Good	64 F. "
10/31/21	11/2/21 A. M.	4'	Low	Good	no
10/31/21	11/2/21 A. M.	4	Low	Good	no
11/5/21 P. M.	11/7/21 A. M.	5	20	Good	73.5 F.
11/5/21 P. M.	11/7/21 A. M.	5'	40	Good	73.5 F.
11/5/21 A.M.	11/7/21 A. M.	1	75	Good	73.5 F.
11/5/21 A. M.	11/9/21 A. M.	3	90	Good	73.5 F.
11/7/21 A. M.	11/9/21 A. M.	6	70	Good	71.5 F.
11/7/21 A. M.	11/9/21 A. M.	2	50	Good	
11/7/21 A. M.	11/8/21 A. M.	Timothy Lake	25	Good	73.5 F.
11/12/21		1	75	Good	73.5 F.
11/12/21 P. M.	11/14/21 A. M.	6	50	Good	64. F.
11/12/21	11/14/21 A. M.	Brigh-ton	50	Good	65. F.

Table II continued

11/15/21 A. M.	11/17/21	Greeley 4'			
11/21/21 A. M.	11/25/21	3	19	20°C.K.	63. F.
11/21/21 A. M.	11/25/21	1	6	20 C.K.	63. F.
11/28/21 A. M.	11/30/21	6Berth. Barley	22	20 C.K.	63. F.
11/28/21 A. M.	11/30/31	Oats Berth	30	20 C.K.	58. F.
12/2/21	12/5/21	5	No	20 C.K.	43. F.
12/2/21	12/5/21	5'	No	20 C.K.	43. F.
12/2/21	12/5/21	3	No	20 C.K.	43. F.
12/2/21	12/5/21	3 leaf Rust	No	20 C.K.	43. F.
12/2/21	12/5/21	5'	No	20 C.K.	43. F.
12/9/21	12/12/21 A.M.	3	Low 10	20	43. F.
10/9/21	12/12/21	1	No	20	43. F.
10/9/21	12/12/21	1' tritici	30%	20	43. F.
1/3/22	1/5/22	3	10%	20	58 F.
1/3/22	1/5/22 A. M.	3 "	30%	20	58. F.
1/3/22	1/5/22	8 Barn	no	20	58. F.
1/3/22	1/5/22	9 Hole	no	20	58. F.
1/13/22 P.M.	1 /16/22	5'	25%	20	48. F.
1/13/22 P. M.	1/16/22	5'Elmis	no	20	48. F.
1/13/22 P.M.	1 /16/22	5'Agro-pyron	1%	20	48. F.
1/13/22 P.M.	1/16/22	5'	30%	20	48. F.
1/13/22 P.M.	1/16/22 A. M.	5'H.j.	10%	20	48. F.
1/13/22	1/16/22	5'triti-cina	10%	20	48. F.
1/13/22	1/16/22	5'h.j. graminis	10%	20	48. F.
1/13/22 A. M.	1/16/22	5'wheat grass	no	20	48. F.
1/13/22 A. M.	1/16/22	3	no	20	48. F.
1/13/22	1/16/22	3	5%	20	48. F.

Table II continued

2/11/22	2/13/22	5'hordei J. no	20	42. F.
2/11/22	1/13/22	5'h. jubatum no	20	42. F.
2/11/22	2/13/22	5' " no	20	42. F.
2/11/22	2/13/22	5'phelum 20	20	42. F.
2/19/22	2/21/22	5'h. jubatum no	20	36. F.
2/19/22	2/21/22	5 H. jubatum no	20	36. F.
2/19/22	2/21/22	5 h. jubatum no	20	36. F.
2/28/22	3/2/22	5 h. jubatum 5%	20	40. F.
3/10/22 A. M.	3/12/22	5 h. jubatum no	20	34. F.
3/10/22	3.12/22	5 h. jubatum no	20	34. F.
4/20/22	4/23/22	5 h. jubatum no	20	40. F.

Table III indicates the date of first germination and the percentage of viable spores; also the date when no spore germination could be obtained. One can compare the time elapsed from high germination to zero for the different hosts.

It can be noted by this data that the longest viable urenidiospore was on Hordeum jubatum.

TABLE III.

Sta. No.	Host	Date of First Germination Test	% viability of Spores	Final Date of Germination Test	% Viable
1	Oats	September 15, 1921	94	December 12, 1921	0
2	Oats	October 1, 1921	84	January 12, 1922	0
2_1	Barley	October 1, 1921	75	January 13, 1922	0
3	Wheat	September 15, 1921	89	January 16, 1922	0
4	Wheat	October 3, 1921	40		
4_1	Oats	October 3, 1921	85	November 2, 1921	0
5	Timothy	October 8, 1921	20	December 2, 1921	0
5_1	Barley (wild)	October 8, 1921	40	March 12, 1922	0
6	Oats	October 8, 1921	50	January 16, 1922	0

The graph indicates the highest germination of urediniospore from any one plot by months from September 1921 to April, 1922.

The following chart indicates the test made on the uredo material collected on stubble. Ten small bunches were made containing several stems to a bundle. These were placed in an erect position out in an open field exposed to all weather conditions, protected by an open screen.

The plot was established September 15, 1921 and tests made at intervals until no germination was obtained.

The results are tabulated as to date of collection, and placing the spores in the germinator, date on which the counts were made, percentage germination, remarks and temperatures at time of collection.

TABLE IV.
STATION NO. 4 NEAR BOTANY
ANNEX STUBBLE TEST III.

No.	Date Placed in	Date of Germi-nation	% Germi-nation	Remarks	Temperature on Collection
604	9/27/21	9/30/21	No	Dried	
538	"	9/29/21 A. M.	15		
537	"	" A.M.	65		
614	"	" A. M.	45		
431	"	9/30/21 A.M.	75	Warm	
237	"	9/29/21 A.M.	25		
416	"	9/30/21 A.M.	10		
245	"	9/30/21 A.M.	35	Cool	
435	"	9/30/21 A. M.	60		
434	"	9/30/21 A. M.	no	Dried	
574	10/3/21 P.M.	10/5/21 A.M.	no	Poor slide	Cool in 8:45A.M.
604	10/3/21 P.M.	10/5/21 A.M.	Fair	Dry	"
538	10/3/21 P.M.	10/5/21 A.M.	75	Good	"
537	10/3/21 P.M.	10/5/21 A.M.	Fair	On Plate	"
615	10/3/21 P.M.	10/5/21 A.M.	35	Fair germ.	"
431	10/3/21 P.M.	10/5/21 A.M.	85	Good	"
237	10/3/21 P.M.	10/5/21 A.M.	25	Dry	"
416	10/3/21	10/5/21 A. M.	Fair	Dried out	"
245	10/3/21	10/5/21 A.M.	Low	" "	"

Table IV continued

435	10/3/21	10/5/21 A. M.	no		Clear
434	10/3/21	10/5/21	87	Very Good	"
574	10/13/21	10/7/21	no	Dried	64
604	"	"	Low	Good	"
538	"	"	"	"	"
537	"	"	No	Dried	"
615	"	"	"	Conditions Good	"
431	"	"	Low	Good	"
237	"	"	"	"	"
416	"	"	"	"	"
245	"	"	20	Dried	"
435	"	"	Low	Good	"
434	"	"	45	"	"
435	11/3/21 3 P.M.	11/6/21 A. M.	No	Good	68
416	11/3/21	11/6/21	"	"	"
604	11/3/21	11/6/21	"	" "	
615	11/3/21	11/6/21	10	"	"
574	11/3/21	11/6/21	15	"	"
431	11/3/21	11/6/21	no	"	"
434	11/3/21	11/6/21	"	"	"
237	11/3/21	11/6/21	"	"	"
245	11/3/21	11/6/21	"	Dried	"
537	11/3/21	11/6/21	Low	Dried	"
538	11/3/21	11/6/21	"	Good	"
574	9/27/21	9/30/21	No	Poor culture Dry	
537	12/20/21	12/22/21	"	32.5	32.5
604	12/20/21	12/22/21	"	32.5	32.5
431	12/20/21	12/22/21	"	32.5	32.5
237	12/20/21	12/22/21	Low 1%		32.5
538	12/20/21	12/22/21	No		32.5
435	12/20/21	12/22/21	Low 2%		32.5
537	12/20/21	12/22/21	No		32.5
574	12/20/21	12/22/21	"		32.5
416	12/20/21	12/22/21	"		32.5
434	12/20/21	12/22/21	"		32.5
245	12/20/21	12/22/21	"		32.5
574	12/25/22	12/27/22	"		28
416	12/25/22	12/27/22	"		28
537	12/25/22	12/27/22	"		28
604	12/25/22	12/27/22	"		28

Table IV. continued

435	12/25/22	12/27/22	No		28
431	12/25/22	12/27/22	"		28
343	12/25/22	12/27/22	"		28
538	12/25/22	12/27/22	"		28
237	12/25/22	12/27/22	"		28

A bundle of stubble was placed in a hole and covered with straw. It was protected from winds and extreme cold weather. It was found to contain fresh uredo material January 27, and no spores were found viable.

A similar test was made on fresh material placed on the ground and covered with leaves. The results were the same as the above. A test was made also of spores on stubble which was placed in a small shed protected from all moisture and wind. No germination was to be had.

Plots containing rusted material were placed on the side of a ditch, one on the north side and the other on the south. The plot on the south side of the ditch retained viable spores longer than did the one on the north. The tabulated results are as follows:

TABLE V. STUBBLE PLACED IN HOLE
Date placed in, November 8, 1921

Date of Collection	Date of Germination Test	% Germination	Temperature on date of Collection
1/25/22	11/28/22	No	28°

TABLE VI. STUBBLE WHICH HAD BEEN IN BARN
Date placed in, November 8, 1921

Date of Collection	Date of Germination test	Percentage Germination	Temperature on date of Collection
1/25/22	1/27/22	No	28°

TABLE VII. PLOTS EXPOSED ON DITCH BANK
Date set out, November 7, 1921

	Date Collected	Date Germination Test	% Germination	Temperature on date of Collection
South Pot	11/28/21	11/30/21	45	58° F.
" "	11/28/21	11/30/21	no	58 F.
North pot	12/20/21	12/22/21	"	32 F.
South pot	12/20/21	12/22/21	"	32 F.

INOCULATION EXPERIMENTS

A series of pots were planted in the greenhouse with different varieties of grasses and inoculations made to establish rusted material for field purposes, and to observe rust development.

The material received for inoculum was of the following nature.

Host	From	Kind	Collector	Date Collected
Wheat	Lincoln, Nebr.	P.g.	Peltier	9/26/21
"	St.Paul, Minn.	P.g.	O.S.Ammodt	10/7/21
Erickson	Pullman, Wash.	P.g.	Humphrey	10/7/21
Wheat	Manhattan, Kan,	P.g.	C.O.Johnston	11/9/21

TABLE VII.

GREENHOUSE PLANTINGS

Pot No.	Variety	Date Planted
1	Marquis	9/16/21
2	Turkey Red	"
3	Kanred	"
4	Marquis R.R.	"
5	Calif. Pearl (Barley)	"
C1	Defiance (10922)	10/7/21
C2	" "	"
C3	" "	"
C4	" "	"
D1	" "	"
D2	" "	"
D3	" "	"
D4	" "	"
E1	Oats	"
E2	"	"
F1	Timothy	"
F2	"	"

TABLE IX.

INOCULATIONS

Pot No.	Variety	Inoculum	From	Date
D1	Defiance	P.g.	Nebraska	10/6/21
C1	Defiance	"	"	"
3	Kanred	"	P. Davies	"
5	Calif. Pearl (Barley)	"	Sta. No. 2_1	"
4	Marquis R.R.	"	Sta. No. 4	"

TABLE X.

RESULTS OF INOCUATIONS.

Date Inoculated	Stage of Host and Varieties	Kind of Rust	From	Date of Earliest Infection	Degree of Infection
10/6/21	Seedling (Defiance)	P.g	Lincoln, Nebraska	no	no
"	Seedling (Marquis)	"	Greeley	"	"
"	Seedling (Calif. Pearl Barley)	"	Fort Collins	"	"
"	Seedling (Defiance)	"	Fort Collins	"	"
"	Seedling (Kanred)	"	P.A.Davies	"	"

The results were negative due to a blight which attacked the plants after they had been in the germinator. The results of the 1923 inoculation experiments were very successful as you will see later.

METHOD OF MAKING AN INOCULATION TEST.

Plant the grain or seed in pots preferable 3 inches. After the seedlings have grown to 4 or 5 inches it is then time for inoculation. Obtain fresh uredo material and place several spores on a flat needle. Moisten the leaves with distilled water, run the needle with the spores down over theleaf and in this way establish a thin film of moisture with the spores suspended. Then place plants in incubator. Another successful method is to apply, or push spores on the moistened leaf and with the thumb and forefinger run

over the leaf. This is all right when one is working with but one strain. If several strains are used the other method is best as one can take care and not mix the forms.

The pots are then incubated for 48-72 hours in a glass covered incubator or moist chamber. After this place them out on a bench until the pustules begin to form. Then place out of doors during the daytime in good weather to harden. It takes about 6 days for rust to form after incubation.

TABLE XI.

WEATHER REPORT

Date of Collection	Station 1	Station 2
9/15/21	Fair	Fair
9/16/21	Fair	Fair
9/17/21	Fair	Fair
9/18/21	Fair rain in P.M.	Fair
9/19/21	Fair	Fair - rain
9/20/21	Windy - frost (night)	Windy - frost
9/21/21	Fair	Fair
9/22/21	Fair	Fair
9/23/21	Fair	Fair
9/24/21	Fair - windy	Fair - windy
9/25/21	Fair	Fair
9/26/21	Fair	Fair
9/27/21	Fair	Fair
9/28/21	Fair	Fair
9/29/21	Cool	Cool
9/30/21	Fair	Fair
10/1/21	Cloudy	Cloudy
10/2/21	Fair	Fair
10/3/21	Fair	Fair
10/4/21	Warm	Warm
10/5/21	Warm	Warm
10/6/21	Cloudy all day rain in A.M.	Cloudy - rain in A.M.

TABLE XI continued

10/7/21	Cool in A.m. clear	Cool in A. M. clear
10/8/21	Warm	Warm
10/9/21	"	"
10/10/21	Clear - windy in A. M.	"
10/11/21	Warm	"
10/13/21	Clear P.M. cloudy wind P.M.	Cloudy wind 64° F.P.M.
10/14/21	Cloudy 52 degrees	F. 65 F. P.M.
10/15/21	Cloudy 63	73 F. P.M.
10/16/21	Clear 70	63 F. P.M.
10/17/21	Clear 65	
10/18/21	Clear 60	75 F. cloudy
10/19/21	Clear 52	70 F. clear
10/20/21	Clear 70	73 F. "
10/21/21	Clear 56	71 F. "
10/22/21	Clear 58	75 F. "
10/23/21	Clear 55	68 F. "
10/24/21	Cloudy 52 F.	70 windy - rain in P.M.
10/25/21	Cloudy - windy 49 F.	54 F. windy - clear
10/26/21	Clear 48 F.	63 F. clear
10/27/21	" 55 F.	66 F. cloudy
10/28/21	" 49. F.	62 F. clear
10/29/21	" 64 F.	65.8 F. "
10/30/21	" 62 F.	65 F. "
10/31/21	" 46.3 F.	67 F. "
11/1/21	" 53 F.	64 F. "
11/2/21	Clear 58.5 F.	70 F. clear
11/3/21	" 10 A.M. 68 F.	68 F. " 3 P.M.
11/4/21	" 9:30 A.M. 55 F.	68 F. " 2 P.M.
11/5/21	55 F.	58 F. " 3 P.M.
11/6/21	57 F.	58 F. 3 P.M.
11/7/21	53.5 F.	51.5 F. cloudy 4 P.M.
11/8/21	Cloudy rain 38.5 F.	48. F. "
11/9/21	" 34 F.	53 F. clear
11/10/21	Clear 42 F.	63 F. "
11/11/21	" 64 F.	64 F. Cloudy
12/1/21	Clear windy 42.5F	44 F. windy
12/2/21	" 45.5 F.	43 F. windy
12/3/21	Snow 4 in. 45 F.	43 F. "
12/4/21	Snow .70pp. 45 F.	43 F. "
12/5/21	----------	----------
12/7/21	Clear - 39 F.	42.5 F. clear
12/8/21	" 38 F.	Clear

TABLE XI. continued

12/10/21	----------	----------
12/11/21	----------	----------
12/12/21	Clear 65 F.	Clear 73 F.
12/13/21	" 53.5 F.	" 54 F.
12/14/21	" 48.5F.	" 60 F.
12/15/21	" 51 F.	" 67.5 F.
12/16/21	" - windy 22.5 F.	"23.5 F. windy
12/17/21	" 23 F.	30 F.
12/18/21	" 25 F.	28.5 F.
12/19/21	" 30 F.	29.5 F.
12/20/21	Cloudy 32.5 F.	Cloudy - dew 32.5 F.
12/21/21	" heavy dew 30 F.	Cloudy - 32.5 F.
12/22/21	30 F.	32.5 F.
12/23/21	Snow - cloudy 20 F.	Snow - cloudy 17 F.
12/24/21	" " 21 F.	" " 17 F.
12/25/21	" " 25 F.	" " 18 F.
12/26/21	" " 20 F.	" " 25 F.
12/27/21	Clear 23 F.	Clear 29 F.
12/28/21	" 22 F.	" 30 F.
12/29/21	" 28 F.	" 35 F.
12/30/21	" 27 F.	" 30 F.
12/31/21	" 30 F.	" 40 F.
1/1/22	" 30 F.	" 55 F.
1/2/22	Cloudy, snow 2 in. pp. .24, 31.5 F.	Snow 34 F.
1/4/22	Clear - snow 12 F.	Clear 33 F.
1/5/22	" 15 F.	" 32 F.
1/6/22	" 17 F.	" 30.5 F.
1/7/22	" 20. F.	"33 F.
1/8/22	" 25 F.	" 45 F.
1/9/22	" 29 F.	" 38 F.
1/10/22	" 40 F.	C 37.5 F.
1/11/22	" - windy 32 F.	" 38.5 F.
1/12/22	32 F.	38.5 F.
1/13/22	Clear 48.5 F.	38.5 F.
1/14/22	" 30 F.	56 F.
1/14/22	Clear 30 F.	45 F.
1/15/22	----------	----------
1/16/22	Clear 32.5 F.	38.5 F.
1/17/22	Snow 20 F.	18.5 F.
1/18/22	" 14 F.	10 F. snow
1/19/22	25 F.	14 F. "
1/20/22	Clear 12 F.	26 F. clear
1/21/22	" 20 F.	38 F. "
1/22/22	" 18 F.	40 F. "
1/23/22	" 30 F.	44 F. "

TABLE XI. continued

1/24/22	Clear 28 F.	36 F. clear
1/25/22	" 30 F.	40 F. "
1/26/22	"	
1/27/22	"	
1/28/22	"	
1/29/22	"	
1/30/22	"	
1/31/22	"	
2/1/22	"	
2/2/22	"	
2/3/22	"	
2/4/22	"	
2/5/22	Snow	
2/6/22	"	

SPRING OBSERVATIONS

Observations were made inthe early spring of 1922 to find the first appearance of rust on grasses. No stem rust was found until June 5, 1921, south of Wray, Colorado. Leaf rust was found May 28, 1922 and June 3, 1921 at Sterling , Colorado. Other reports of leaf rust were sent in later by county agents.

The map indicates the locations of stem rust in the State, observations were made during the summer of 1922. The largest epidemics were traced to the barberry.

OVERWINTERING OF UREDINIOSPORE 1922 - 1923

No field plots could be located in this section due to the scarcity of rust. The work for the year was devoted largely to inoculation tests as well as overwintering.

Germination of rust P. graminis tritici collected the summer of 1922.

TABLE XII

	% germination	Temperature
December 8, 1922 set in germinator	no	
December 10, 1922 set in germinator	"	20 F.
December 11, 1922 set in germinator	"	"
December 15, 1922 set in germinator	"	"

No germination could be obtained from this material.

A TEST OF STUBBLE COLLECTED IN 1922 GAVE THE FOLLOWING RESULTS.

Light petri dishes each containing red spores on distilled water medium; 20 degrees and 30 degress. Set in germinator December 15, 1922

TABLE XIII.

No.	December 18 A.M. % germination	December 20, 1922 % germination	Temperature
1	no	no	20°
2	"	"	"
3	"	"	"
4	"	"	"
5	"	"	30°
6	"	"	"
7	"	"	"
8	"	"	"

TABLE XIV
WHEAT PLANTED IN SIX INCH POTS IN GREENHOUSE
NOVEMBER 2, 1922

2 Pots	13274	Certified	Marquis
" "	13408	"	Kanred
" "	13407	"	"
" "	13409	"	"
" "	1310	"	"

These pots were inoculated December 28, with P. graminis from St. Paul. Set in incubator 48 hours and then set out on bench. January 3, 1923 flecks appearing, and rust starting to develop on the two pots containing Marquis. Plants were set out in daytime to harden.

January 12, 1923, the rusted pots were exposed to out of door conditions. The spores of inoculated material lived only a short time. The results are given below:

TABLE XV.

Date set in Germinator	Date of Germination	Percentage Germination	Temperature
January 19, 1923	January 22,1923	85	20
January 26,1923	January 29,1923	30	"
January 26,1923	January 30,1923	40	"
February 21,1923	February 23,1923	no	"
February 24,1923	February 26,1923	"	"

January 30, 1923, Marquis wheat was planted in one large plot in the greenhouse for further inoculations.

February 18, 1923, the wheat was ready for inoculation. The inoculation was by the thumb and finger method, already described.

My March 5, every leaf of the plots was covered with rust. It was set out on this date one half being exposed and the other part covered. Material was collected on March 9, 1923, and thespores were found to

germinate 30 per cent. On a revisit to the plot it was found to have been destroyed so no other tests were made.

SUMMARY OF WORK DONE

(1) From the enormous losses caused by black stem rust as shown in the past, compared to the rate of growth of our present population, it is necessary to apply some problem for the destruction of this disease, no matter what the sacrifice may be.

(2) The black stem rust is most common and the most destructive of all the rusts.

Orange leaf rust attacks the plants when they are very young and does very little damage.

Yellow stripe rust is characterized by the long pustules and sulphur color. It does not occur in Colorado but where it does occur there is some loss from it.

Corwn rust on oats. The telia spore names this rust by the crown shaped apex. Where you find this rust you find the Rhamnus spp. of shrub which is the alternate host. Severe attacks in the east have caused much damage.

(3) We find several rust spores which appear to be alike but act differently to various hosts. This can be accounted for by having rust on barberries and no rust

The various races or strains have been analyzed by Dr. E. C. Stakman as to grains and wild grasses they attack.

The rust is heteroecious thus having an alternate host. In the case of graminis it is the Berberis spp. The aecial or cluster cup develops here producing aecia which attack the wheat and here starts the epidemic. In the fall the mycelium changes to the winter telia which rests over and the next spring germinates, making the new attack to the shrub; thus completing the cycle.

(4) The epidimiology studies brings out the importance of overwintering. There is convincing evidence of the spread of rust from barberries, but it has also been observed that some rust exists where no barberries are present. This leads to two problems; overwintering or blowing in from infected areas.

Field plots were selected for the overwintering experiment. Various grains and grasses were selected at different locations in the northern part of the state. Notes were taken as to the topography and condition of the host. Plots were exposed and some covered.

In germinating spores the best method was found by using the slides and Petri dishes. Spores germinated best at 20 degrees C.

From tests made at intervals throughout the season on all 9 plots there were no spores that retained their viability. The list below gives the number of months the spores lived in each plot.

TABLE XVI

Plot No.	Length of germination Period
1	Four months
2	Three months
2_1	Three months
3	Four months
4	One month
4_1	One month
5	Two months
5_1	Five months
6	Three months

It was also noticed that the percentage of germination decreased from one month to the next.

Hordeum jubatum contained P. graminis spores which reatined life the longest. They germinated 5 per cent March 2. Several check tests were taken later but no germination was to be had.

Red spores will not overwinter on stubble either exposed or protected.

Alternate freezing and thawing kills the urediniospores. Favorable conditions in the fall causes them to germinate and then die.

A south slope is more favorable for germination than a north slope.

Barberries become infected in this State as early as May 5.

Leaf rust appears around the first of May. Stem rust around the first of June.

Plants were successfully inoculated in 1923 and plenty of rust material was to be had. Inoculated material when exposed, contains viable spores for only a short time. No spores were found to germinate after March 19, 1923.

At present there has been 24,001 barberry bushes found on 1642 properties, out of which 23,822 bushes have been removed from 1639 properties. On the resurvey of 1922, 18 per cent of the bushes were found sprouting. Several of these have been treated with chemicals. Our recent spring resurvey shows that no sprouts are coming up so chemical eradication is very successful. The removal of the bushes has eliminated a great deal of rust and it is the author's opinion that complete eradication will aid to solve the rust problem.

If conditions were more favorable for the uredinial to live thru the month of March, the author believes that overwintering could be obtained. To answer this question exactly it would be necessary to run the experiment

thru a series of years. Stations should be located in each part of the state and tests made from each. It may be possible that there are certain sections where overwintering may be successful but as to the northern part of Colorado we conclude that the spores do not live through the winter of 1921 and 1922.

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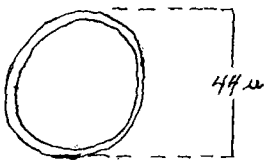
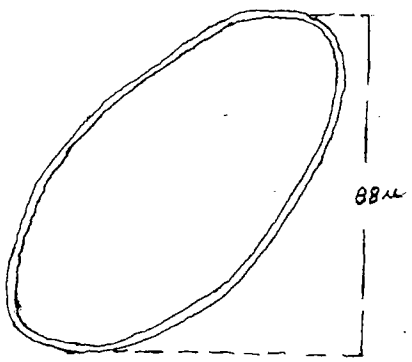
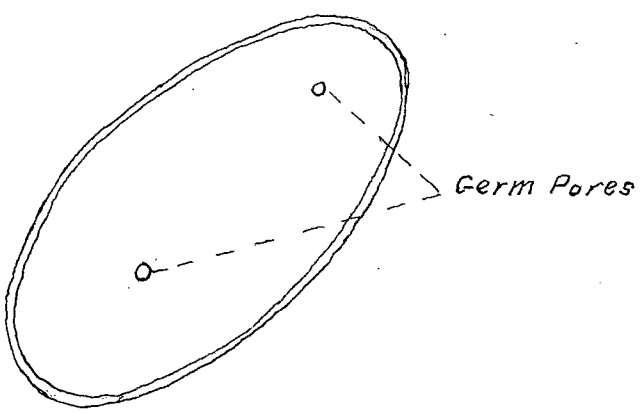
Plate No. I



Leaf Rust Uredinia L.P.



Stem Rust Uredinia H.P.



Stem Rust Uredinia in Lactic Acid H.P.

Plate II.
Cluster Cups on Barberry Leaves

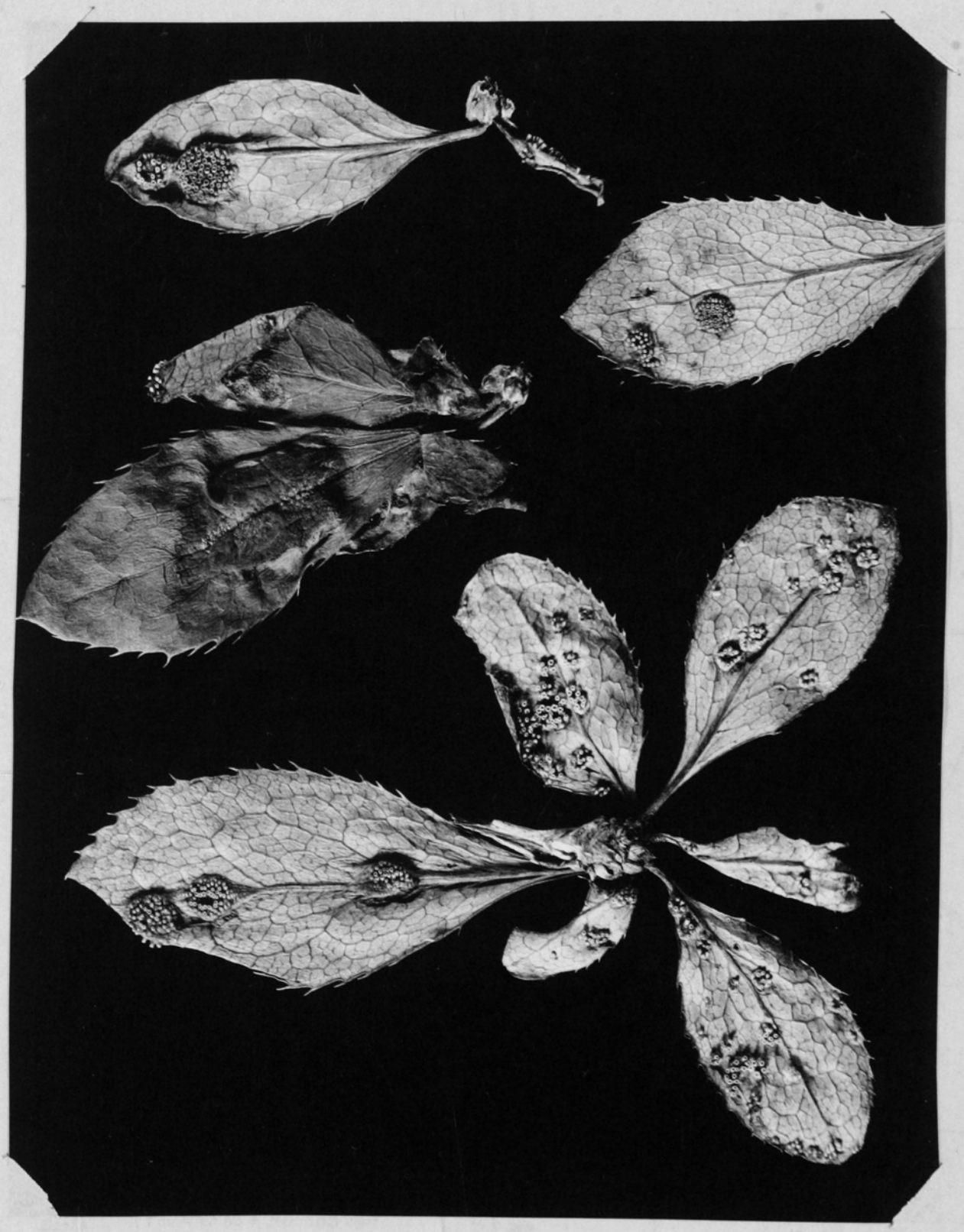


Plate III

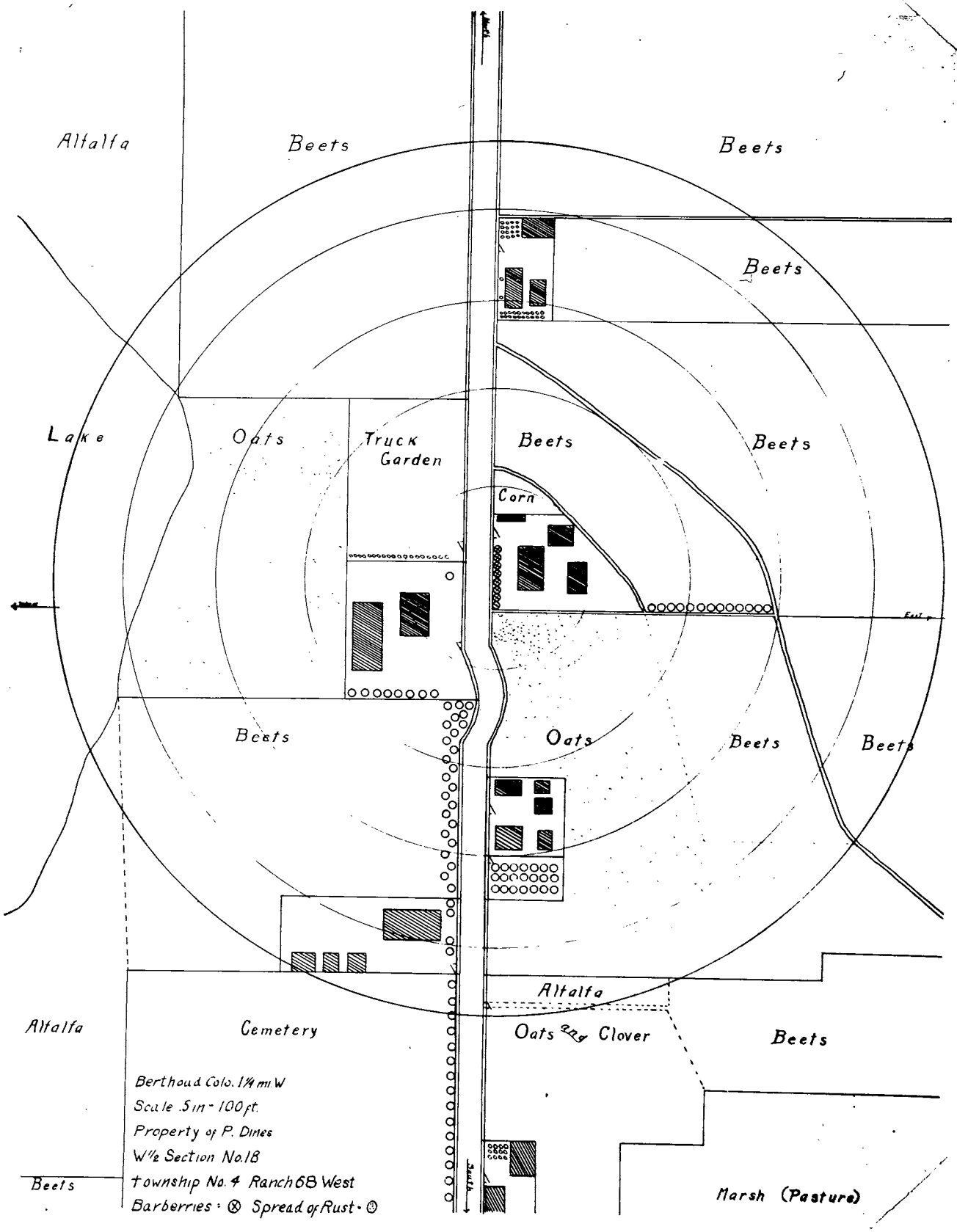

Altalfa
Beets
Beets
Beets
Lake
Oats
Truck Garden
Beets
Beets
Corn
Beets
Oats
Beets
Beets
Altalfa
Altalfa
Cemetery
Oats and Clover
Beets
Berthoud Colo. 1¼ mi. W
Scale .5in - 100ft.
Property of P. Dines
W½ Section No. 18
Township No. 4 Ranch 68 West
Barberries : ⊗ Spread of Rust : ⊙
Beets
Marsh (Pasture)

Plate III

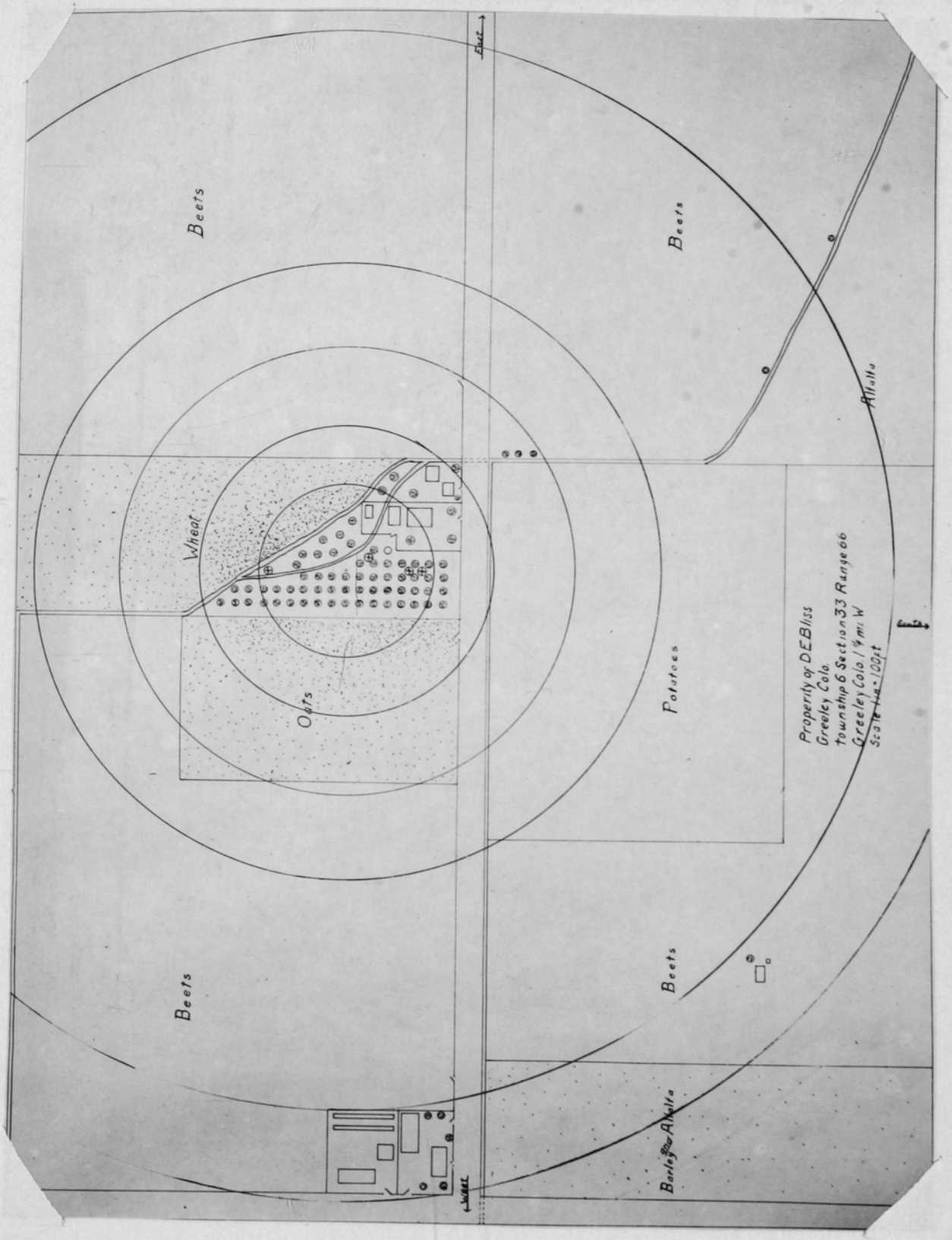
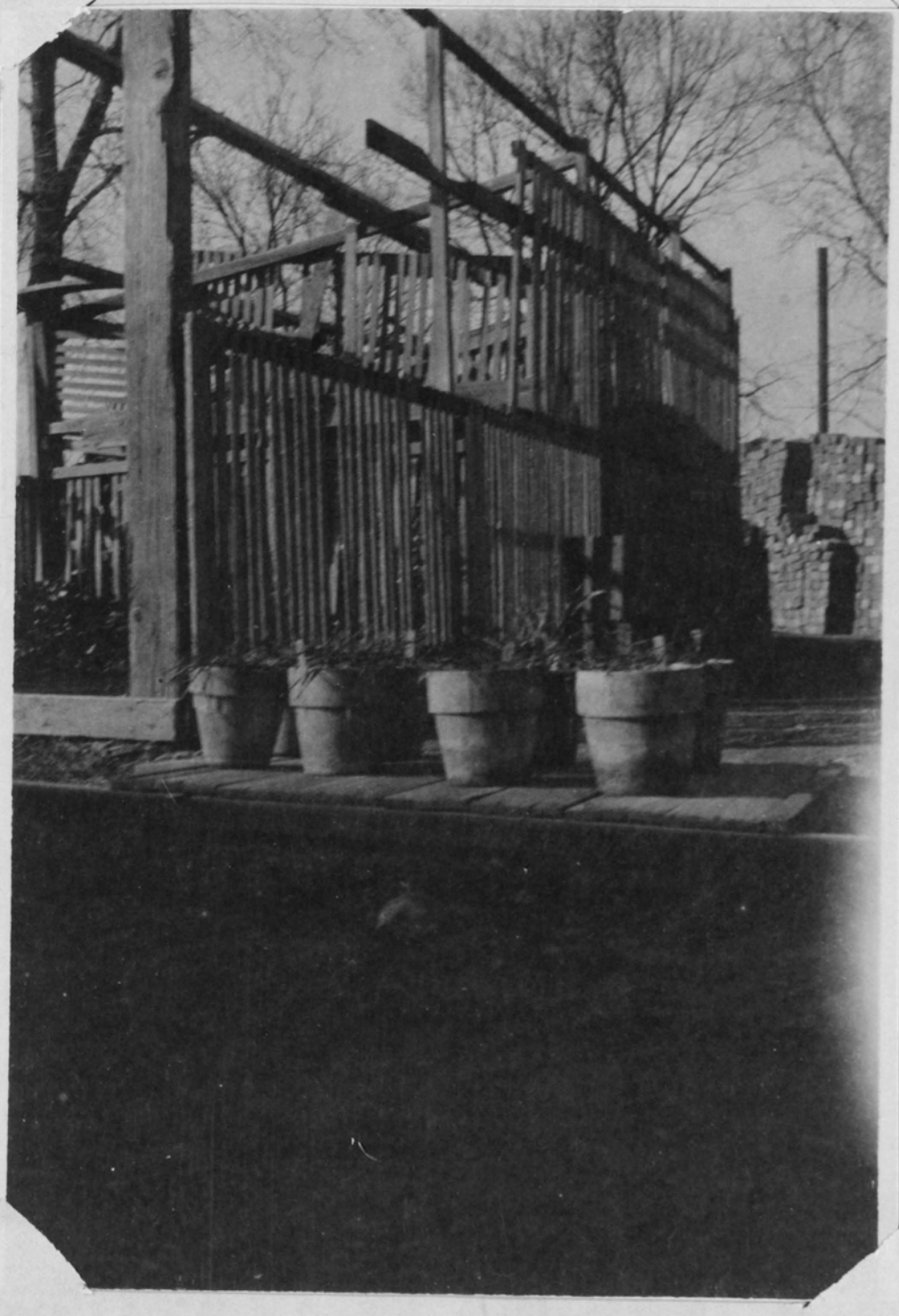

Beets
Beets
Wheat
Oats
Potatoes
Beets
Beets
Barley & Alfalfa
Alfalfa
Property of D.E. Bliss
Greeley Colo.
Township 6 Section 33 Range 66
Greeley Colo. 1/4 mi. W
Scale 1in.=100ft
East
West

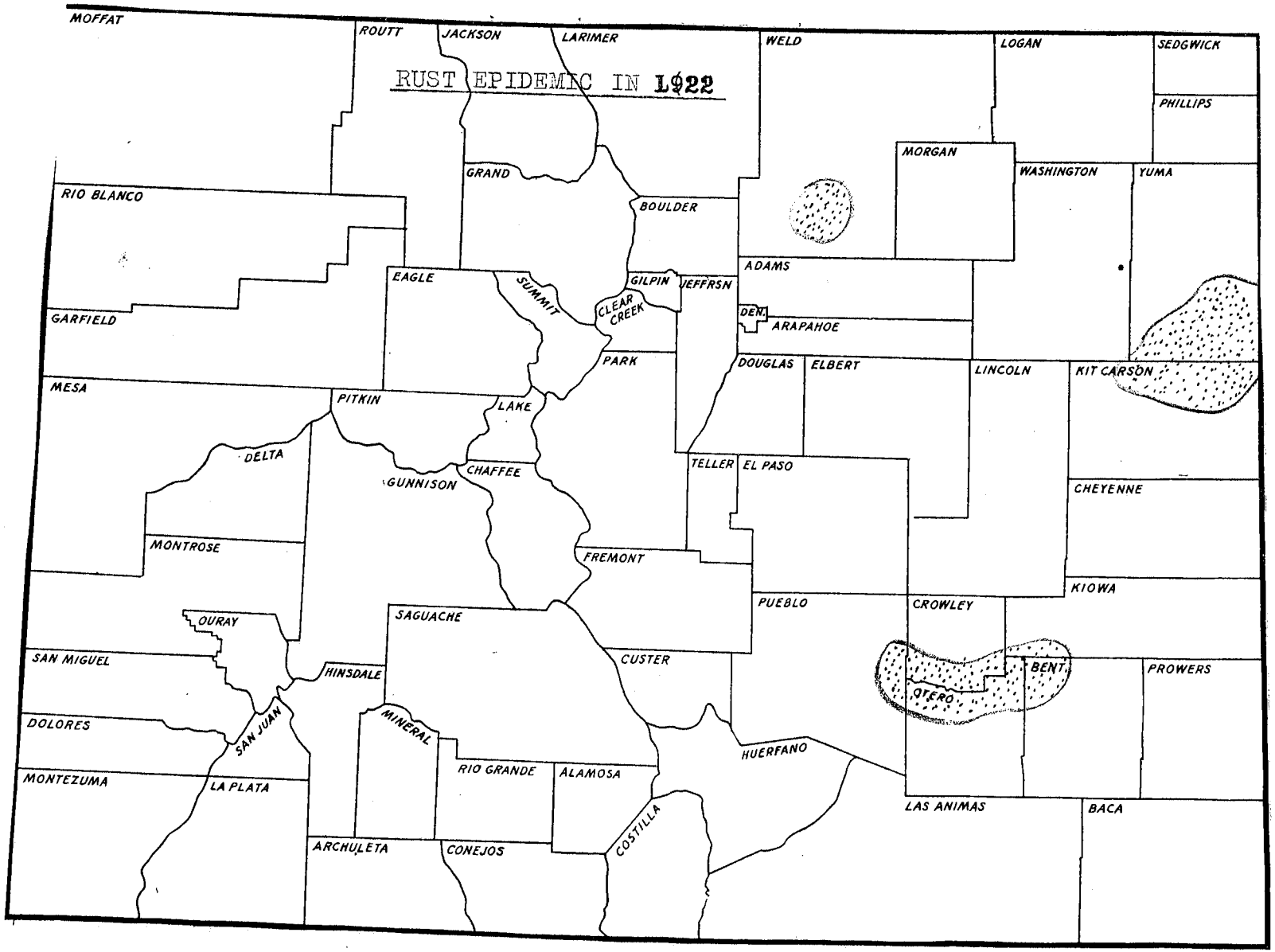
Plate IV

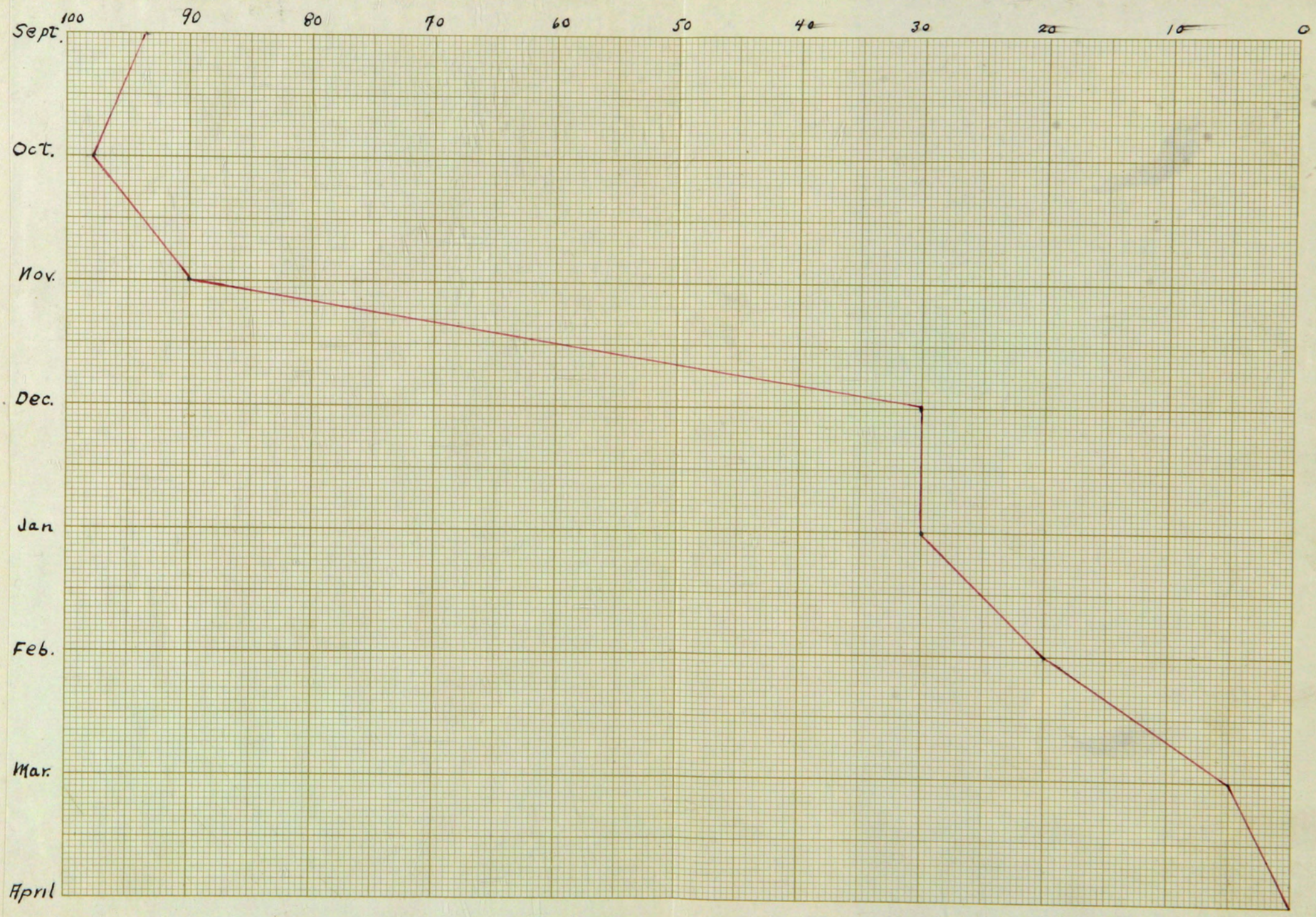
Germinators Used for Incubating Inoculated Material

Plate V

Rust on Inoculated Grain Set out to Harden




RUST EPIDEMIC IN 1922
MOFFAT
ROUTT
JACKSON
LARIMER
WELD
LOGAN
SEDGWICK
PHILLIPS
MORGAN
WASHINGTON
YUMA
GRAND
RIO BLANCO
BOULDER
ADAMS
EAGLE
SUMMIT
GILPIN
JEFFRSN
CLEAR CREEK
DEN.
ARAPAHOE
GARFIELD
PARK
DOUGLAS
ELBERT
LINCOLN
KIT CARSON
MESA
PITKIN
LAKE
DELTA
CHAFFEE
GUNNISON
TELLER
EL PASO
CHEYENNE
MONTROSE
FREMONT
KIOWA
PUEBLO
CROWLEY
OURAY
SAGUACHE
SAN MIGUEL
HINSDALE
CUSTER
BENT
PROWERS
OTERO
DOLORES
SAN JUAN
MINERAL
HUERFANO
RIO GRANDE
ALAMOSA
MONTEZUMA
LA PLATA
LAS ANIMAS
BACA
COSTILLA
ARCHULETA
CONEJOS



Highest Germination of Urediniospore from any one plot by Months from Sept. to April. 1921-1922

BARBERRY REPORT FROM BEGINNING OF
CAMPAIGN TO DECEMBER 31, 1922

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RESUME OF BARBERRY ERADICATION IN COLORADO FROM BEGINNING OF CAMPAIGN TO DECEMBER 31, 1921

Introduction

The first stepr were taken toward the eradication of the Common Barberry in the state of Colorado in the year 1918 thru the co-operation of the U. S. Bureau of Plant Industry, the Division of Extension of the Colorado Agricultural College, and the Department of Botany of the Colorado Agricultural College. At this time a general and rather hasty survey was made for the purpose of determining the number and general location of the bushes within the boundaries of the state and the magnitude of the task of permanently removing them. At this time, Dr. Gillette, of the Extension Department, declared the Common Barberry bush to be a pest and as such to come under the laws of the state concerning such pests. In conjunction with this act a quarantine was placed upon the shrub on January 20, 1918.

Thru the efforts of the Federal Office a man was placed in the field this first year. His duties consited of making inspections of properties and urging the removal of Barberry Bushes were found. He

succeeded in locating many bushes and also in having a great many of them removed. However, his greatest accomplishment was the paving of the way for his successors by bringing before the public the true character of Berberis vulgaris and educating the people as to the necessity of its complete removal from the small grain growing states. During this first season work was done in the counties of Boulder, Larimer and Weld.

Since the beginning of the campaign has been carried on in Colorado under three main heads: publicity, inspection and eradication.

The greatest efforts toward publicity were made early in the campaign as it was felt that the success of the work depended upon the co-operation of the people as gained thru a thoro understanding of the nature and object of the movement. Less has been done along this line with each succeeding year, the people becoming more familiar with the work as the campaign advanced. During the last two years publicity has been limited to the districution of bulletins and life cycle cards and an occasional news article in the town paper for the purpose of freshening the people's memory.

"Inspection" and "eradication" have gone hand in hand, especially during the later years of the campaign. At first the bushes were merely tagged and

left for owners to remove. After the majority of the bushes were removed in this way it was found to be more practical, except in the instances of hedges or other large findings, to remove the bush when found as this saved the expense and time involved in making a return trip, sometimes of many miles, perhaps to find the bush still in.

The greatest number of bushes were removed during the year 1919 when six men were placed in the field. They walked and used bicycles according to the nature of the territory in which they were working and during the latter part of the year they were honored with an automobile of rather doubtful vintage and still more doubtful characteristics. The area covered was comparatively small as most of the work was done in the cities and towns, some rural scouting was attempted in the counties of Bent, Crowly, Kiowa, and Prowers and also a small amount in Larimer and Weld.

The scouts wore arm bands to designate their calling and took care to have the people understand the nature of their visit. Scouts neglecting to do this in the early days of the campaign were known to have been taken as chicken thieves and otherwise placed in embarassing possitions.

During the year 1919, 17,919 bushes were found on 1330 properties. During the year 1919, 1,747

bushes were found on 158 properties. Thus a total of 19,666 bushes were found from the beginning of the campaign to December 31, 1919 and these on 1,488 properties. Up to this time the scouts had been successful in having 16,909 bushes removed from 1,239 properties.

Since July 1, 1919, the work has come under two sub-heads: original survey and resurvey. Resurvey is very important because of the fact that, regardless of the care exerted in removing the bushes, there are great possibilities of sprouts shooting up the following spring. This in fact presents a very real problem. In addition, resurvey often leads to the discovery of bushes missed the first time over.

The following summer of 1920 was marked by a scarcity of dependable men due to the high wages being paid in all fields of endeavor. As a result much difficulty was experienced in securing reliable scouts and for the greater part of the season the State Leader worked alone, covering the field in a car. An assistant was put on for a month working chiefly in the cities and towsn of Boulder and Larimer counties. During this season several large findings were made, 1976 bushes being located on 25 properties.

By June of the following year, there were four men in the field, forming two teams of two scouts each, each time having a car. Several rust epidemics

broke out during the season and prompt investigation was made in each instance. None of them were as serious as reported and only in a few places was the damage done of any great consequence and this on spring grain. Most of these out breaks seemed to be the result of wind blown urediniospores coming in from outside sources as no barberries could be found in the immediate vicinity. In a few instances the outbreaks were traced to barberry and the cause removed. Much of the work during 1921 was in regions where the farms were well scattered and considerable distances apart most of the ground being covered in cars. Also considerable resurvey was done. At the end of the season, 22548 bushes were reported found on 1596 properties and of these 22,457 were removed from all but three properties. Also 3226 sprouts were found and removed up to December 31, 1921.

By the end of the year 1921, the most important sections in Colorado had been given an original survey and a considerable part of this area resurveyed. The persistency of the bush was by this time well realized and very seldom did the scout feel sure that he would not be greeted by a sprout the following season. Especailly in rocky and wooded areas did the bush seem unconquerable for no amount of digging could reach all the roots. This problem will no doubt be successfully met in the future years thru chemical eradication a small amount .

of which was attempted in the state this season and with results. Next seasons' work will involve the use of chemicals to a considerable degree since it is much cheaper in the end than continued digging and much more effective.

STATE LAW IN COLORADO

Regarding the Common Berry.

Colorado's Amended Pest Law:

An Act to Provide for the Protection of Trees, Fruits, Crops and Pasturage against the Ravages of insects, Rodents, Weeds and Plant Diseases; to Provide for the Formation of Pest Inspection Districts, to be under the General Authority of the State Entomologist; and to Make an Appropriation for Carrying out the Provisions of this Act.

Be it Enacted by the General Assembly of the State of Colorado:

Section 6. Whenever the State Entomologist, his deputy, or county inspector, has reason to believe, or has been credibly informed, that within the State there exist lands infested by pests which are liable to spread to the injury of others, it shall be his duty to make investigation of the suspected premises, and if they are found so infested, shall notify the owner or persons in charge of control of such premises, in writing, of the nature, extent and location of the infection and demand that within a specified time certain specified work shall be done on the infested premises for the extermination.

of such pests, and if the occupant of the infested property refuses or fails to de effective work in the premises in accordance with the instructions of the officer in charge, such officer shall take possession of the infested premises, and do the work necessary for the extermination of said pests, as provided in this Act. The reasonable and necessary expenses for doing such shall be paid for by the county without unnecessary delay, upon filing with the county commissioners of the certificate of the State Entomologist showing the necessity for such work, the reasonable cost and expense thereof, and giving a description of the land or property upon which the work was done. And, upon filing such certificate, such charges shall become alien of the property treated, collected as real estate, or, in the event of personal property, it shall be effected by levy and sale after ten days advertising, as required by law upon the delivery of such certificate to any officer authorized by law to make levy and sale under execution. PROVIDED However, that either the State Entomologist or the County inspector may, where cause exists outside of any pest inspection district as above provided, pursue the same remedies in all respects as to such lands and owners of

lands outside of any such district the same as though embraced within a pest inspection district."

SECTION 7, Each and every violation of any of the provisions of this Act, or non-compliance with any motice or direction given by the inspector in charge under the provisions of this Act, shall render the offender liable in an action of debt for not less than Twenty-five dollars ($25.00) and not more than Three hundred dollars ($300.00) and each and every day that any person, firm or corporation shall fail to comply with any notice in writing received from the inspector in charge under the provisions of this Act, shall be deemed a separate offense. If the land in question be within or without a pest inspection district and the defendent be found guilty, the Court shall also render judgement against the defendent for the cost and expense."

An Act to Prevent the Introduction, Importation, or Spread of Injurious Insects and Plant Diseases in Colorado; to Provide for their Extermination when found in the State; to Require the Inspection of Nurseries, Nursery stock, and Orchards; to Make an appropriation for the Carrying out of this Act; To Regulate the sale of Insecticides, and to Repeal Chapter Fifty-five (55) for the Session Laws of 1897, and providing a Quarantine

for Nursery Stock, Potatoes, and Other Objects Infected with Insect pests or Plant Disease. Be it enacted by the General Assembly of the State of Colorado.

"SECTION 1. For the purpose of this Act, the Entomologist of the State Agricultural College is hereby declared to be State Entomologist, whose duty shall be directly or thru his deputies or Horticultural Inspectors, to carry out the provisions of this Act. The compenstaion of the State Entomologist shall be ------ etc."

"SECTION 4. It shall be the duty of the State Entomologist, directly or thru his deputies or Horticultural Inspectors, to inspect all the nurseries, orchards, and shade trees of the State each year, and when it seems necessary, to inspect potatoes, and other farm or garden crops or other articles whatsoever, for the purpose of determining whether or not any of them are infested with injurious insects of fungous or other plant diseases that are likely to be disseminated to the injury of others, and to determine the best methods of control for the pests and diseases with which he has to deal.

When a nursery, farm or otherpremises that has been inspected seems to be free from insect pests and plant diseases, the Entomologist shall, upon request,

issue to the owner, renter or occupant, a certificate stating these facts. But if any nursery stoc, orchard or shade trees, potatoes, or other farm or garden crops or any objects whatsoever, be found to be infested with any serious insect pest or fungous or other plant disease that is likely to be disseminated to the injury of others, the owner or renter or person in charge of the infested or diseased property or premises must disinfect or destroy the same under the direction and to the satisfaction of the State Entomologist, or his deputy or Horticultural Inspector in Charge, and at the owner's expense, unless the State Entomologist or Inspector in charge sees fit to remove, disinfect or destroy the infested or diseased articles himself."

"SECTION 6 ----------

Each and every violation of any of the provisions of this Act, and each and every non-compliance with any notice or direction given by the Horticultural Inspector in charge under the provisions of this Act, shall be punishable by a fine in the sum of not less than five dollars nor more than five hundred dollars, and each and every day that any person, form or corporation shall

fail to comply with any notice in writing received from the State Entomologist, or Horticultural Inspector, in charge under the provisions of this Act, shall be deemed a separate offense."

"SECTION 8 ----------

Whenever the State Entomologist, his deputy or the Horticultural Inspector in charge, in their investigations shall find a section or any portion of the State to be infected with a serious pest or plant disease, and in their judgement, the shipment of potatoes or other farm seeds, products or other articles from that district or section should be liable to spread the insect or disease into other sections, they, or any any of them, may declare a quarantine against such section to prevent the shipment of potatoes or other farm products or seeds or other articles, from the quarantine sections; also, whenever it is ascertained that infested potatoes or other farm seeds, products or other articles are being imported from another state or states, the State Entomologist may declare a quarantine against the importation of such infested potatoes or other farm seeds, products or other articles from such state or states."

STATE ENTOMOLOGIST QUARANTINE NO. 8.

On Account yf Black Stem Rust.

The fact has been determined and notice is hereby given, that the common barberry (Berberis vulgaris) and its horticultural varieties , as well as other species of berberis and Mahonia, are capable of harboring the Black stem rust of wheat, oats, barley, rye and many wild and cultivated grasses. Thru co-operation with the Department of Agricultura, Colorado Agricultural College, local organizations, and individuals, susceptible species of barberry have recently been largely eradicated from the State of Colorado.

NOW, THEREFORE, I, C. P. Gillette, State Entomologist, of the State of Colorado, by virtue of the authority vested in me by the Amended Horticultural Inspection Act, Chapter 131 of the Session Laws of 1917, and for the protection of the great food producing cereal crops of the State do hereby establish a quarantine forbidding of all plants of the following species, into the State of Colorado, or outside the State of Colorado.

Berberis aethenis, B. altiaca, B. amurensis, B. aristata, B. asiatica, B. atropurpurea, B. brachybotrys, B. brevipaniculata, B. buxifolia, B. canadensis,

B. caroliniana (carolina), B. coriaria, B. cretica, B. declinatum, B. fendleri, B. fischeri, B. fremontii, B. heterapoda, B. ilicifolia. B. integerrima, B. laciflora, B. lycium, B. macrophylla, B. neapalensis, B. neubertii, B. umbellata, B. vulgaris, including its subspecies and horticultural varieties, Mahonia aquifolia, M. diversifolia, M. glauca and M. repens.

Therefore, by authority vested in me by the Amended Horticultural Inspection Act, Chapter 131, of the Session Laws of Colorado for 1917, I also declare all the names species to be pests, harboring a serious disease to grains and grasses, and order their extermination wherever they occur in the State of Colorado.

This order supersedes Quarantine Order No. 6, issued July 20, 1918.

This order shall be in effect on and after July 25, 1919; and until further notice.

C. P. Gillette,
State Entomologist,
Fort Collins, Colorado.

Fort Collins, Colorado,
July 19, 1919.

RESOLUTION ON BARBERRY BY COLORADO COUNCIL OF DEFENSE.

"Whereas, it has been shown by the most accurate scientific work that the black stem rust of wheat and other cereals and grasses develops on both the green and purple varieties of common barberry (Berberis vulagris) bushes in the spring, producing countless numbers of minute spores which may be carried long distances by the wind to wheat, other cereals and grasses, and whereas the chief wheat producing states, under the encouragement of the U.S. Department of Agriculture, are engaged in the eradication of common barberry in order to increase food production; and whereas, it has been shown in this and certain European countries that black stem rust has disappeared gradually and contemporaneously with the barberry bush; and, whereas, we have in the Japanese barberry (Berberis thunbergii) a variety which is immune to rust and may be planted with safety; therefore, be it

RESOLVED, That we, the State Council of Defense, request that there be no further planting of any barberry (berberis spp.) bushes except the species and variety known as Japanese barberry (Berberis thunbergii), and that all barberry bushes except the immune variety above mentioned be destroyed on all premises within the

bounds of the State of Colorado. Further, we declare the barberry varieties which support black stem rust a pest, and we support the State Entomologist in his efforts to enforce the provisions of the Colorado Pest Inspection ACT ."

STATE FINANCIAL AID

No direct financial aid has been given by the State to the Barberry Eradication Campaign in Colorado. However, the Department of Botany of the Colorado Agricultural College has furnished office space for those carrying on the work and has permitted them the use of the Department's furniture, sotrage space, general laboratory and office equipment and conveniences and considerable amounts of various office supplies.

The use of the above mentioned things has saved the Campaign approximately three hundred dollars per year.

In addition to the financial aid those connected with the Department have given their hearty support to the Eradication owrk and have given much assistance in the form of advice and suggestions. Their co-operation has been much appreciated.

PUBLICITY

As stated in the introduction to this report the greatest efforts in the way of publicity were put forth during the early years of the campaign. Less was done each succeeding year in this connection as the continued advance of the work furnished its own advertising. Bulletins and descriptive circulars and aards are always carried by the scouts and a large number distributed in this manner. These and the articles printed in the different papers constitute the publicity agents being used in the state at this stage of the campaign.

The following list furnishes more definite date upon the nature and extent of the work done in getting the campaign before the people.

BULLETINS AND CIRCULARS.

Three extension bulletins have been published sinde the beginning of the campaign. They are:

"Eradicate the Common Barberry." Sept. 1918, Extension Bulletin Series 1, No. 147, 6000

"Destroy the Common Barberry" Feb. 1919, Extension Bulletin Series 1, No. 155-A 10,000

"Save the Wheat." June 1921, Extension Bulletin Series 1, No. 176-A, 8000.

The following bulletins and advertising matter were also distributed.

Farmers Bulletin No. 1058	6,000
Reprint (Year Book 1918) No. 796	5,000
Sheets of Story: "Banish the Barberry	3,000
Colored plate showing life cycle spores, etc.,	1,000
Life cycle cards	3,000
large colored posters	9,000
Copies of State Entomologist Quarantine No. 8	1,000
Form letters:	
A. mailed to every property owner on whose property common barberry had been found	
B. Mailed to all schools, rural news papers, and farmers	20,000
Arbor day poem, describing common barberry	1,000

NEWS PAPER PUBLICITY.

Great publisity was gained through the news papers, they for the most part being eager to assist the campaign by the donation of whatever space was desired. About 500 articles have been published many with descriptibe illustrations or cartoons. These have appeared in every paper in the state and thus have reached all the news paper reading inhabitants.

Some of the leading stories and their authors were:

"A Fungous Parasite and its Host." E.L. Sargent.

"First Scouting discloses Many barberries in Colorado ----------E. L. Sargent

"Eradicate the Common Barberry. It is an Enemy of Wheat ---------- Harry Newton.

"Waging War on Barberry" ---------- Harry Newton

"The common Barberry, The Farmer's Worst Enemy ---------- Walter J. Roth.

"Shall we have starvation for many and Common Barberries for Few?" ---------- Walter J. Roth.

"Stem Rust does more Damage than Enemy Incendiaries." ---------- E. L. Sargent.

"Pueblo Citizens must get Rid of Barberries. "---------- Reported

"The Barberry" ---------- Editorial in Pueblo Chiefton.

"Death Demanded for the Barberry" --------- Denver Post

"Campaign Waged on Barberry bush --------- Denver Times

"Entire Wheat Belt to Fight Stem Rust."---- E. L. Sargent

"There was Something Rotten in Denmark."--- E. L. Sargent

"Barberry Bushes Exterminated"---------- Walter J. Roth

"Barberry Eradication in Colorado." ----- Lord Ogilvy (Denver Post)

etc.

EDUCATIONAL EXHIBITS.

Many window displays have been placed before the curious eyes of the public in the course of their education. These have varied somewhat in design

but all have been planned with the same purpose in view; namely that of conveying to the people the nature of the common barberry, its characteristics, the object of the campaign , and thus thru their acquired knowledge to secure their co-operation in eradicating the bush. The usual exhibit consisted of bushes of both common and Japanese barberry bushes, samples of rusted grains, and different articles to attract attention, such as sacks of flour, bundles of grain, loaves of bread, and so on. Numerous placards were used to designate the different articles and also show in detail the essential facts concerning the rust and part played by the barberry. Many impressive statistics were printed on attractive cards and also worked into the display. Thes e exhibits were placed in every town of consequence and in the larger cities several were shown at the same time.

Similar exhibits were placed in the Post Offices of the larger cities where they were subjected to the inspection of many different classes of people.

Likewise the City Parks were used to advantage, large common barberry bushes being placed at the entrances with this sign in close proximity:

DESTROY THIS BUSH
THE COMMON BARBERRY SPREADS
STEM RUST OF WHEAT
DESTROY YOUR BUSH
U. S. DEPARTMENT OF AGRICULTURE.

The City Libraries were utilized in the effort to place before the public the object and necessity of the campgaing. These displays usually consisted of a placarded bush or possibly two, one of each variety with plenty of descriptive literature near by for free distribution.

The following warning was also placed in the street cars of Denver.

> "Have you destroyed your Common Barberry Bushes, Government Inspectors here again."

Complete and striking demonstrations were maintained at all the leading fairs over the state and at the National Stock Show, hold in Denver. Special effort was made to make this last exhibit complete in every detail, because of the great number of people who would be attracted to it.

Publicity Thru the Theater.

The motion picture houses over the state provided an effective means of advertising the campaign and getting the facts before the people. All the important play houses inDenver and the other cities of the state ran an educational slide for as much as a week at a time. The return of the scouts was also often heralded in this manner and at the same time the people's minds freshened concerning the campaign.

Illustrated lectures were given in the schools and at

farmers meetings over the state. In order to cover the field, several sets were put in use at the same time. In this connection the film "Barbarous Barberry" was used to advantage and was enthusiastically received wherever shown.

The following slides were used:

"Do you know that a fungus parasite, stem rust, destroyed more American wheat in 1916 than 200 Coloradoans could eat in a year, that common barberry, an ornamental shrub spreads this disease?"

Pictures of common barberry with the words: "the common barberry. Triple spines, sawtoothed leaf edges, berberis in clusters. Spreads wheat rust, destroy this bush."

Picture of Japanese barberry and these words: "the Japanese barberry. Single spines, single berries, smooth leaf edges. Does not spread rust, save this bush."

Picture of red rust of wheat and the words: "Stem rust of wheat. Red rust, summer stage. The barberry spreads this stage to the wheat in the spring."

Picture of black stem rust of wheat and the words: "Stem rust of wheat. Black rust, autumn stage. This stage can only infect the barberry. It can not infect wheat."

Life cycle of stem rust. Picture of red rust with label. Picture of black rust with label. Picture of barberry rust with label. Wording "Life cycle of stem rust. Remove the Barberry bush and destroy this cycle."

Colored slide made from Barberry poster.

Slide made from back of stationary.

Picture of girls with skirts and hats blowing and words: "Colorado winds blow dust across the state. Rust spores are lighter than dust particles. They travel hundreds of miles."

Picture of common barberry leaves, stems and spines and words: "Common barberry. Destroy this bush. Spines mostly 3 in a group. At tip of stem sometimes single. At base of stem sometimes in fours.

Picture of Japanese barberry leaves, stems and spines and words: "Japanese Barberry, save this bush. Spines mostly single. Seldom in two's or three's. Leaves smooth.

Picture of Japanese barberry berries and words: "Japanese barberry, save this bush. Berries born singly or in groups of Two's or three's."

Pictures of common barberries and the words: "The common barberry, destroy this bush. Berries in clusters dull red, shriveled.

"Have you destroyed your common barberry bush?" Government Inspectors are here again to save the wheat from rust."

George's cartoon: "The Hun of the Grain World."

Cities and Towns Completed in Survey
From Beginning of Campaign to December 31, 1921
(Very small places omitted.)

Adams County
Adams City, Brighton, Bennett, Darlow, Derby, Eastlake, Hazeltine, Henderson, Sand Creek, Junction, Scranton, Strasburg, Westminister.

Alamaso County
Alamosa, Estrella, Hays, Hooper, Henry, McGinty, Mosca, Willis.

Arapahoe County
Deertrail, Englewood, Littleton, Petersburg, Sullivan

Archuleta County
Arboles, Blanco, Chromo , Pagosa Junction, Pagosa Spgs.

Bacca County
Springfield, Stonington, Two Buttes.

Boulder County
Boulder , Broomfield, Erie, Eversman, Hygiene, La-Gayette, Longmont, Louisville, Lyons, Niwot.

Chaffee County
Buena Vista, Granite, Poncha, Salida.

Cheyenne County.
Cheyenne Wells, Kit Carson, Wild Horse.

Clear Creek County
Dumont, Georgetown, Idaho Springs, Silver Plume

Conejos County
Antonito, Conejos, La Jara, Manassa, Ortiz, Romeo, Sanford,

Costillo County
Blanca, Costillo, San Luis, San Pablo.

Crowley County,
Crowley, King Center, Numa, Olney Springs, Ordway, Sugar City.

Custer County,
None

Delta County
Austin, Decaredge, Delta, Eckert, Hotchkiss, La Zear, Paonia.

Denver County
Denver

Dolores County
Rico

Douglas County
Castle Rock, Larkspur, Sedalia.

Eagle County
Eagle, Gypsum, Red Cliff

Elbert County
Elbert, Elizabeth, Kiowa.

El Paso County
Colorado Springs, Fountain, Manitou, Monument, Palmer Lake

Fremont County
Brewester, Canon City, Concrete, Florence, Howard, Penrose, Portland.

Garfield County
Carbondale, Glenwood Springs, Grand Valley, New Castle, Rifle, Silt.

Gilpin County
Blackhawk, Central City, Gilpin.

Grand County
Granby, Kremmling, Sulphur Springs.

Gunnison County
Crested Butte, Gunnison, Irwin.

Hinsdale County
None

Huerfano County
La Veta, Ravenwood, Rouse, Strong, Walsenburg

Jackson County
None

Jefferson County
Arvada, Edgewater, Colden, Morrison, Wheatridge, Willow Springs.

Kiowa County
Aroington, Brandon, Chivington, Eads, Galatea, Haswell, Sheridan Lake, Towner.

Kit Carson County
Burlington, Flagler, Seibert, Stratton.

Lake County
Leadville, Malta, Birdseye

La Plata County
Durango

Larimer County
Berthoud, Ft. Collins, Loveland, Timnath, Wellington.

Las Animas County
Borwind, Earl, El Moro, Forbes, Hastings, Hoene, Ludlow.

Lincol n County
Arriba, Bovina, Boyero, Genoa, Hugo, Limon.

Logan County
Atwood, Crook, Flemming, Padroni, Peetz, Rrocter, Palisades, Whitewater.

Mineral County
Creede, Wagonwheele Gap.

Moffat County
Craig, Juniper, Great Divide.

Montezuma County
Cortez, Dolores, Mancos

Montrose County
Cimmaron, Montrose, Olathe

Morgan County
Brush, Fort Morgan, Orchard, Snyder, Wiggens.

Otero County
Fowler, La Junta, Manzanola, Rocky Ford, Swink.

Ouray County
Colona, Ouray, Ridgeway.

Park County
None

Philips County
Amherst, Haxtun, Holyoke, Paoli

Pitkin County
Aspen, Norris.

Prowers, County
Briston, Granada, Hartman, Holly, Lamar, Wiley

Pueblo, County
Avondale, Baxter, Boone, Lima, Pueblo, Rye, Siloam.

Rio Blanco County
None

Rio Grand County
Del Norte, Monte Vista, South Fork.

Routt County
Hayden, Phippsburg, Steamboat Springs, Yampa.

Saguache, County
Grestone, La Garita, Mirage, Saguache, Villa Grove.

San Juan County
Howardsville, Silverton

San Miguel County
Placerville, Telluride

Sedgewick County
Julesburg, Ovid, Sedgwick.

Summitt, County
None

Teller County
Cripple Creek, Divide, Florissant, Goldfield,
Independence, Woodland Park, Victor.

Washington County
Arkon, Otis

Weld County

Ault, Briggsdale, Eaton, Erie, Evans, Fort Lupton, Greeley, Hudson, Johnston, Kersey, Lucern, Mead, Miliken, Nunn, Platteville, Pierce, Severence.

Yuma County

Eckley, Laird, Wray, Yuma

Counties Covered in Farm-to-Farm Survey
From Beginning of Campaign to December 31, 1921

Name of County	Area of County	% Survey-ed	No. sq. miles Surveyed	No. mi. travel-ed	No. of Plant-ings	No. Bushes.
Adams	1410	56	789	710	10	31
Alamosa	700	80	560	616	2	7
Arapahoe	890	77	685	612	34	549
Archuleta	1415	30	437	488	---	---
Baca	2530	15	380	364	---	---
Bent	1345	30	469	605	---	---
Boulder	785	58	455	730	163	1911
Chaffee	975	10	97	110	4	5
Cheyenne	1850	66	1235	1164	---	---
Clear Creek	410	50	205	194	4	42
Conejos	1215	15	183	200	6	29
Costillo	1260	16	198	210	---	---
Crowley	800	65	524	351	2	10
Custer	750	---	---	---	---	---
Delta	1215	25	303	366	8	27
Denver	65	100	65	1400	669	9261
Dolores	1095	20	219	195	---	---
Douglas	660	20	602	410	---	---
Eagle	1725	15	258	214	2	2
Elbert	1625	40	730	700	---	---
El Paso	2140	69	1486	1648	230	3912
Fremont	1600	25	400	523	67	2150
Garfield	2700	20	540	481	3	6
Gilpin	175	25	44	76	---	---
Grand	1925	20	385	295	---	---
Gunnison	3275	10	328	368	---	---
Hinsdale	1075	---	---	---	---	---
Huerfano	1530	15	225	240	3	3
Jackson	1660	---	---	---	---	---
Jefferson	770	55	423	900	13	115
Kiowa	1690	40	676	586	---	---
Kit Carson	2210	40	884	751	---	---
Lake	400	60	240	312	---	---
La Plata	1680	25	586	625	5	43
Larimer	2675	55	1471	1974	11 6	1195
Las Animas	4790	12	572	673	4	6
Lincoln	2640	45	1188	972	1	3
Logan	1865	90	1678	1782	4	12
Mesa	3420	30	1026	1263	10	169
Mineral	900	25	225	200	---	---
Moffat	4810	3	144	112	---	---
Montezuma	2215	25	534	594	2	3

Montrose	2310	20.	462	511	7	50
Morgan	1335	100	1335	1721	12	151
Otero	1260	35	441	594	11	99
Ouray	565	27	153	195	---	---
Park	2220	----	---	---	---	---
Philips	690	100	690	570	6	10
Pitkin	980	18	176	195	1	1
Prowers	1360	37	422	555	3	9
Pueblo	2435	60	1455	1895	63	1433
Rio Blanco	3200	---	---	---	---	---
Rio Grand	865	50	432	304	9	24
Routt	2415	5	121	211	---	---
Saguache	3255	13	423	485	---	---
San Juan	435	35	152	203	---	---
San Miguel	1350	20	270	285	---	---
Sedgwick	549	100	549	470	1	2
Summit	650	---	---	---	---	---
Teller	590	5	29	55	---	---
Washington	2600	60	1560	1368	1	7
Weld	4185	80	3347	3990	115	1261
Yuma	2420	30	726	686	6	10
Totals	104834 sq. mi		34194 sq. mi	38307 miles	1596 Props	22548 bushes

(No data on cost per county. Therefore could not give cost per mile per county).

LEGEND

Areas Covered in Farm-to-Farm Survey.

Beginning of campaign to June 30, 1919

July 1 to December 31, 1919

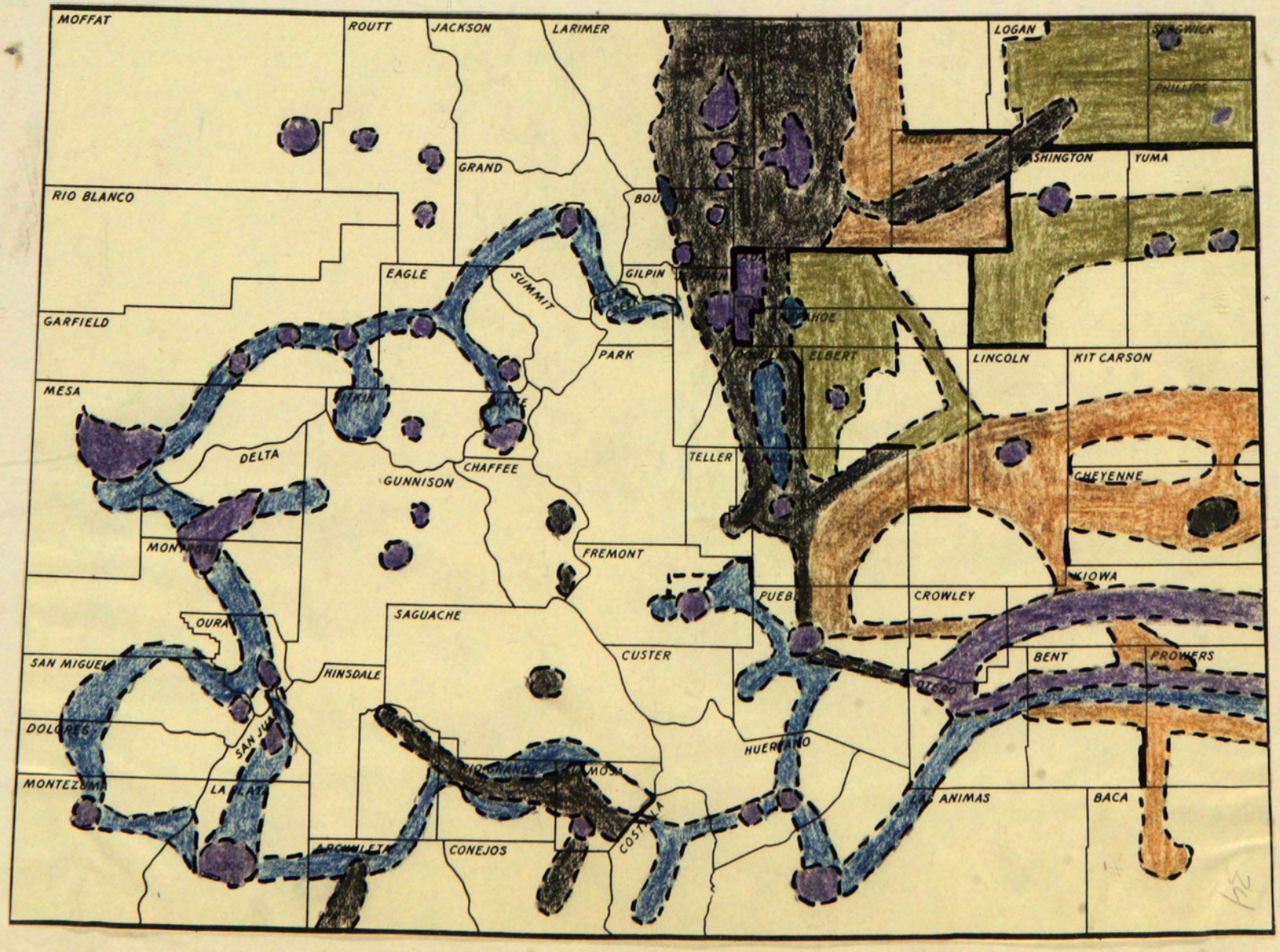
January 1 to June 30, 1920

July 1 to December 31, 1920

January 1 to June 30, 1921

July 1 to December 31, 1921

All work done of Federal Funds.


MOFFAT
ROUTT
JACKSON
LARIMER
LOGAN
SEDGWICK
PHILLIPS
MORGAN
WASHINGTON
YUMA
GRAND
RIO BLANCO
EAGLE
SUMMIT
GILPIN
GARFIELD
PARK
ELBERT
LINCOLN
KIT CARSON
MESA
DELTA
GUNNISON
CHAFFEE
TELLER
CHEYENNE
FREMONT
KIOWA
CROWLEY
SAGUACHE
CUSTER
SAN MIGUEL
HINSDALE
BENT
PROWERS
DOLORES
SAN JUAN
HUERFANO
MONTEZUMA
LA PLATA
LAS ANIMAS
BACA
CONEJOS

LEGEND

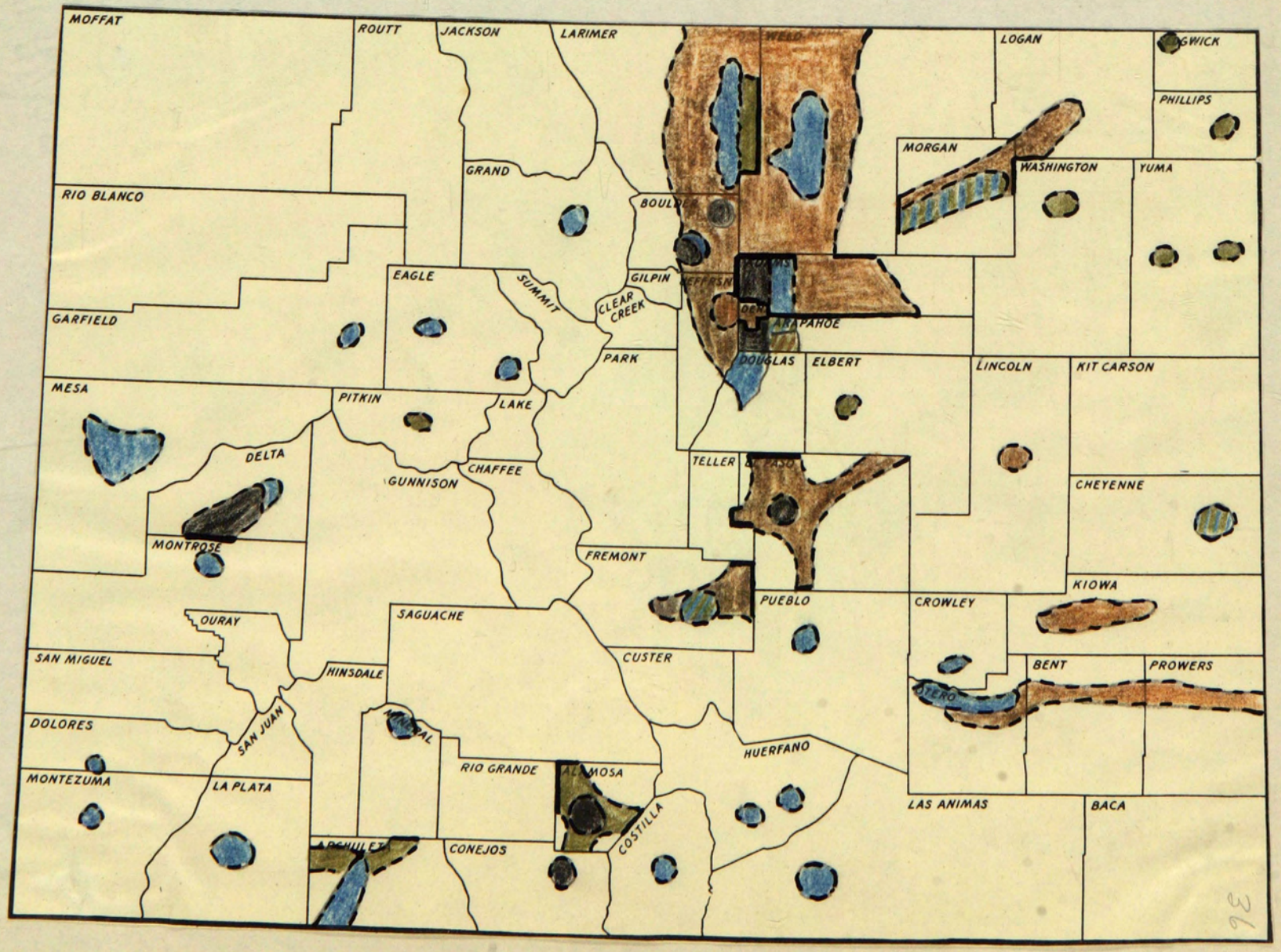
Areas Resurveyed

July 1 to December 31, 1919

January 1 to June 30, 1920

July 1 to December 31, 1920

January 1 to June 30, 1921
July 1 to December 31, 1921


MOFFAT
ROUTT
JACKSON
LARIMER
WELD
LOGAN
SEDGWICK
PHILLIPS
MORGAN
WASHINGTON
YUMA
GRAND
RIO BLANCO
BOULDER
EAGLE
SUMMIT
GILPIN
CLEAR CREEK
GARFIELD
ARAPAHOE
PARK
DOUGLAS
ELBERT
LINCOLN
KIT CARSON
MESA
PITKIN
LAKE
DELTA
GUNNISON
CHAFFEE
TELLER
CHEYENNE
MONTROSE
FREMONT
KIOWA
PUEBLO
CROWLEY
OURAY
SAGUACHE
SAN MIGUEL
HINSDALE
CUSTER
BENT
PROWERS
OTERO
DOLORES
SAN JUAN
HUERFANO
RIO GRANDE
MONTEZUMA
LA PLATA
LAS ANIMAS
BACA
CONEJOS
COSTILLA

Period	Survey	No. of Counties Surveyed	No. of man days	Number of Properties in: Cities and Towns	Country: Having Escapes	Country: Total	Both, on which bushes were Found	Both, on which bushes were Removed	Number of Bushes in: Cities and Towns	Country: Escaped	Country: Total	Both Cities and Country: Found	Both Cities and Country: Removed	Sprouts Found on Re-Survey
This Month	Original	State totals, Beginning of Campaign to Dec. 31, 1921												
	Resurvey Removals													
	Total													
Since Jan. 1	Original	27	362	31	9	52	83	69	607	14	299	906	629	
	Resurvey Removals		73					16					583	630
	Total	27	435	31	9	52	83	85	607	14	299	906	1212	630
Since Jul. 1	Original	16	186	7	1	24	31	26	37	1	213	250	124	
	Resurvey Removals		32					2					35	289
	Total	16	218	7	1	24	31	28	37	1	213	250	159	289
Entire Campaign	Original	59		1499	19	97	1596	1524	19172	1411	3376	22548	20568	
	Resurvey Removals							69					1889	3226
	Total	59		1499	19	97	1596	1593	19172	1411	3376	22548	22457	3226

Period	No. of Counties Surveyed	No. of Man days	Number of Properties in: Cities and Towns	Country: Having Escapes	Country: Total	Both, on which bushes were: Found	Both, on which bushes were: Removed	Number of Bushes in: Cities and Towns	Country: Escaped	Country: Total	Both cities and country: Found	Both cities and country: Removed
This Month												
Since Jan. 1	27	362	31	9	52	83	69	607	14	299	906	629
Since Jul. 1	16	186	7	1	24	31	26	37	1	213	250	124
Entire Camp'gn	59		1499	19	97	1596	1524	19172	1411	3376	22548	20568

Original Survey From Beginning of Campaign to Dec. 31, 1921

MONTHLY REPORT BY COUNTIES

Counties Alphabetically	Am't of county surveyed	Number of properties in: Cities and Towns	Country: Having Escapes	Country: Total	Both, on which bushes were: Found	Both, on which bushes were: Removed	Number of bushes in: Cities and Towns	Country: Escaped	Country: Total	Both cities and country: Found	Both cities and country: Removed
Adams	56	9		1	10	6	27		4	31	25
Alamosa	80	2			2	2	7			7	7
Arapahoe	77	32	2	2	34	33	437	2	112	549	539
Archuleta	30										
Baca	15										
Bent	30										
Boulder	58	150		13	163	136	1808		103	1911	1496
Chaffee	10	4			4	4	5			5	5
Cheyenne	66										
Clear Creek	50	4			4	4	42			42	42
Conejos	15	6			6	6	29			29	29
Costille	16										
Crowley	65	2			2	2					
Custer	-										
Delta	25	7			7	7	27			27	27
Denver	100	669			669	658	9261			9261	8711
Dolores	20										
Douglas	70										
Eagle	15	2			2	2	2			2	2
Elbert	40										
El Paso	69	230			230	229	3912			3912	3872
Fremont	25	43	7	24	67	66	117	1351	1983	3100	1841
Garfield	20	3			3	3	6			6	6
Gilpin	25										
Grand	20										
Gunnison	10										
Hinsdale	-										
Huerfano	15	3			3	3	3			3	3
Jackson	-										
Jafferson	55	11	1	2	13	12	113	1	52	165	162
Kiowa	40										
Kit Carson	40										
Lake	60										
La Plata	25	5			5	5	43			43	43
Larimer	55	88	7	28	116	109	419	12	776	1195	838
Las Animas	12	4			4	4	6			6	6
Lincoln	45	1			1	1	3			3	3
Logan	90	4			4	4	12			12	12
Mesa	30	10			10	10	169			169	169
Mineral	25										
Moffat	3										
Montezuma	25	2			2	2	3			3	3
Montrose	20	7			7	7	50			50	50
Morgan	100	12			12	12	151			151	151
Otero	35	10		1	11	7	98		1	99	72
Ouray	27										
Park	-										
Phillips	100	6			6	6	10			10	10
Petkin	18	1			1	1	1			1	1
Prowers	37	3			3	3	9			9	9
Pueblo	60	63			63	63	1433			1433	1433
Rio Grande	50	9			9	9	24			24	24
Rio Blanco	-										
Routt	5										
Saguache	13										
San Juan	35										
San Miguel	20										
Sedgwick	100	1			1	1	2			2	2
Summit	-										
Teller	5										
Washington	60	1			1	1	7			7	7
Weld	80	89	2	26	115	100	916	45	345	1261	948
Yuma	30	6			6	6	10			10	10

Period	No. of Counties Surveyed	No. of man days	Number of Properties in: Cities and Towns	Country: Having Escapes	Country: Total	Both, on which bushes were Found	Both, on which bushes were Removed	Number of Bushes in: Cities and Towns	Country: Escaped	Country: Total	Both cities and country: Found	Both cities and country: Removed	Sprouts Found on Re-Survey
This Month													
Since Jan. 1		73					31					583	630
Since Jul. 1							2					35	289
Entire Camp'gn							69					1889	3226

Resurvey From Beginning of Campaign To Dec 31, 1921

MONTHLY REPORT BY COUNTIES

Counties Alphabetically	Am't of county surveyed	Number of Properties in: Cities and Towns	Country: Having Escapes	Country: Total	Both, on which bushes were Found	Both, on which bushes were Removed	Number of Bushes in: Cities and Towns	Country: Escaped	Country: Total	Both cities and country: Found	Both cities and country: Removed	Sprouts Found on Re-survey
Adams	55					4					6	
Alamosa	70											
Arapahoe	40					1					10	411
Archuleta	30											
Baca	-											
Bent	10											
Boulder	68					26					388	450
Chaffee												
Cheyenne	19											
Clear Creek	-											
Conejos	10											
Costillo	5											
Crowley	5											6
Custer	-											
Delta	20											5
Denver	100					10					509	889
Dolores	2											
Douglas	10											
Eagle	5											
El Paso	35					1					40	289
Elbert	5											
Fremont	25					1					259	288
Garfield	5											2
Gilpin	-											
Grand	5											
Gunnison	-											
Hinsdale	-											
Huerfano	8											
Jackson	-											
Jefferson	65											1
Kiowa	10											
Kit Carson	-											
Lake	-											
La Plata	8											18
Larimer	63					7					357	202
Las Animas	3											
Lincoln	5											
Logan	10											
Mesa	12											5
Mineral	4											
Moffat	-											
Montezuma	5											
Montrose	5											17
Morgan	50											28
Otero	17					4					27	1
Ouray	-											
Park	-											
Philips	4											2
Powers	10											
Pitkin	4											
Pueblo	5											194
Rio Blanco	-											
Rio Grand	10											
Routt	-											
Saguache	-											
San Juan	10											
San Miguel	5											
Sedgwick	5											
Summit	-											
Teller	-											
Washington	5											
Weld	85					15					313	418
Yuma	5											

LEGENDS

Area of escaped bushes found Jan. 1 to June 30, 1919.

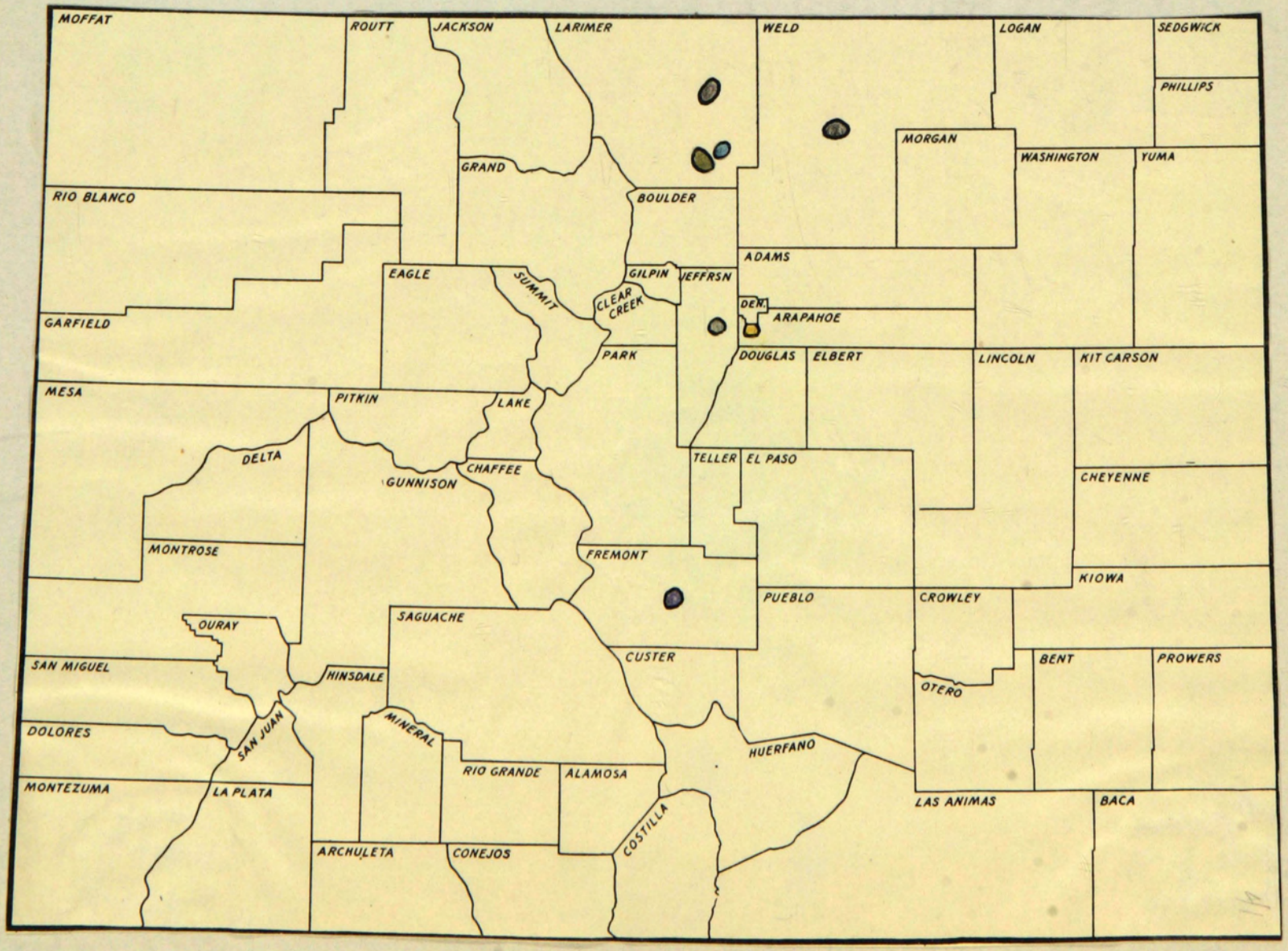
Area of escaped bushes found July 1, to December 31, 1919.

Area of escaped bushes found Januarl 1 to June 30, 1920

Area of escaped bushes found July 1 to December 31, 1920

Area of escaped bushes found Jan. 1, to June 30, 1921

Area of escaped bushes found July 1 to Decemmber 31, 1921


MOFFAT
ROUTT
JACKSON
LARIMER
WELD
LOGAN
SEDGWICK
PHILLIPS
MORGAN
WASHINGTON
YUMA
GRAND
RIO BLANCO
BOULDER
ADAMS
EAGLE
SUMMIT
GILPIN
JEFFRSN
CLEAR CREEK
DEN.
ARAPAHOE
GARFIELD
PARK
DOUGLAS
ELBERT
LINCOLN
KIT CARSON
MESA
PITKIN
LAKE
DELTA
GUNNISON
CHAFFEE
TELLER
EL PASO
CHEYENNE
MONTROSE
FREMONT
KIOWA
PUEBLO
CROWLEY
OURAY
SAGUACHE
CUSTER
SAN MIGUEL
HINSDALE
BENT
PROWERS
OTERO
MINERAL
SAN JUAN
DOLORES
HUERFANO
RIO GRANDE
ALAMOSA
MONTEZUMA
LA PLATA
LAS ANIMAS
BACA
COSTILLA
ARCHULETA
CONEJOS

LIST OF PROPERTIES
WHERE
ESCAPED BUSHES WERE FOUND

Name	Town	County	Bushes
United Oil Co.	Canon City	Fremont	1
----------	Arvada	Jefferson	1
Greeley-Loveland Irrigation Co.	Loveland	Larimer	2
Big Thompson River	Loveland	Larimer	1
Home Supply Ditch Company	Loveland	Larimer	5
Home Supply Ditch Company	Loveland	Larimer	31
Home Supply Ditch Company	Loveland	Larimer	39
School house (rural)	Loveland	Larimer	40
Mrs. M. A. Alps	Loveland	Larimer	15
Glen Kester	Loveland	Larimer	2
Mr. Buckingham	Loveland	Larimer	7
C. C. Richardson	Loveland	Larimer	7
J. C. Ruple	Loveland	Larimer	150
Loyd Jones	Loveland	Larimer	50
Poudre River	Ft.Collins	Larimer	15
Poudre River	Ft.Collins	Larimer	71
Coy Ranch	Ft.Collins	Larimer	1
Poudre River	La Porte	Larimer	1
Vacant Lot	Greeley	Weld	1
Park	Greeley	Weld	4
----------	Littleton	Arapahoe	1
Lyons & Johnson	Englewood	Arapahoe	1

(Bushes located near town named)

Average Cost by years.

Year	Miles Travel-ed	Cost per running mile	Cost per sq. mi.	Cost per Planting	Cost per bush
1918	2702	$.314	$.457	$5.38	$ .486
1919	17603	.375	.495	4.80	.357
1920	11705	.177	.187	83.00	1.05
1921	21556	.226	.210	58.80	5.386
Campaign to Dec. 31, 1921	49076	.289	.269	8.90	.63

General Discussion.

Several methods of scouting have been tried out in Colorado since the beginning of the campaign. Practically all of the work was done on foot the first year, being limited to the towns in the north part of the state. Travel between the towns was by means of the railroads. The cose per square mile amounted to $.457 . The same system was used the following year of 1919, bicycles, however, being used to advantage and during the latter part of the season a car was pressed into service for a short time. This season found the scouts spreading out into sections where the towns were smaller and further apart. Also some rural work was onde. The cost per square mile amounted to $.495 1920 witnessed the real advent of the automobile into the field one scout using one car the whole season. In addition another scout was placed in the dities on foot. However, this last scout was used only for a short time. The scout with the car traveled in very favorable sections and proved the value of the automobile in the field the cost per square mmle being $.187. The following year, two cars were placed in the field but with two men to the car. This proved more costly than where one man was used to the car and would have proven so except for the fact that much of the work was

done in sparsely populated districts where very good time could be made. The cost per square mile for the year came to $.210.

The cost per bush was of course lowest the first two years of the campaign, since the work was done in the cities and thickly populated regions where most of the bushes of the state were known to be located. The following year saw a material increase in cost per bush as the scouts spread out into the rural sections and a still greater increase the year after that when most of the work was carried on in the dry land sections.

In this report all cost per year is based on the total amount spent that year in all the branches of the work since the records do not indicate how the money was apportioned to the different phases.

Up to date, 446 escaped bushes have been found in the state, most of them being in Larimer county. The rivers and irrigation systems of the regions located close to the mountains seem to have proven themselves the most dangerous agencies for spreading the barberry. Thru this means the seeds would in a comparatively short time be scattered over all the districts by the irrigation waters, while the rivers could carry them for miles. Many escapes were also found in wooded areas, having been carried

there thru the agency of birds. Cattle, horses, and other live stock have also proved themselves to be a means of spreading the bushes since many escaped have been found in pasture which were free from trees.

In making the farm to farm surveys it has been the practice to drive into the farm yard and thoroly inspect all places where barberries might be found. As a usual thing it is advisable to first make known the purpose of the visit. If no bushes are found a bulletin is left with the farmer and no more of his or the scout's time is taken up. Where bushes are located, it is usually necessary to spend some little time in going thru the matter in order that there may be a clear understanding as to the reason for removing the barberries. As a usual thing very little difficulty is experienced in gaining the farmers' interest and co-operation. In the course of the campaign very few people have been encountered who have absolutely refused to have their bushes removed. As the usual thing such parties are city dwellers who think they can go on existing whether the farmer exists or not. In such cases the pressure of the law is called upon to accomplish the desired end. We are thankful that only a few of this type are found over the state. A few of course are essential to normalcy.

Progress of Eradication Campaign

January 1 to December 31, 1922

Introduction.

This report coveres the activities of the barberry eradication campaign in Colorado for the period January 1, 1922 to December 31, 1922.

A slightly greater appropriation was used than during the preceding year, practically the same amount of ground being covered. However, considerable more money was used in administration than in 1921.

Work was done in 45 counties. Original survey work was carried on in 23 of these 45 counties and resurvey in all but two of them.

1453 Bushes were found on 46 properties and 1365 bushes removed from 46 properties, making a total of 24,001 bushes found during the entire campaign on 1642 properties of which all but 179 have been removed. One hedge of 175 bushes remains in Jefferson county, one planting of three bushes is still in the city of Boulder, and one bush remains on a city property of Denver, these will be out before spring.

In this report in estimating percent of a county surveyed we consider only that part surveyed which has been actually gone over. Areas too rough and mountainous to be surveyed or of a nature not requiring going over, are not considered as surveyed.

Many counties which appear to be only partially

covered are actually one hundred per cent surveyed so far as the territory requiring inspection is concerned. This explanation is offered because of the fact that earlier in the campaign many counties were reported almost entirely covered when the nature of the section would make such practically impossible. Larimer county is a good example of this. Early in the campaign it was reported ninety per cent surveyed, which no doubt it was so far as the ground requiring surveying was concerned. However, over half of the county is of a mountainous nature, not requiring going over and offering great obstacles to any attempt at such. This we report as unsurveyed.

PERSONNEL

Fitzsimmons, J. R. St. Leader Colo. $150.00 mo. June 15 to September 25.

Learn, C. D., Collab. Colo. 125 mo. April 1 to Sept. 23.

Lungren, E. A., Field Asst. Colo. 125 mo. April 1 to Sept. 23

Thornton, B. J. Field Asst. Colo. 125. mo. July 1 to Nov. 30.

Miss Downs Stenographer.

State Financial Aid.

1. Cash Appropriations.

No cash appropriations made toward campaign by State of Colorado.

2. Financial aid other than cahs appropriations. Office space, light, heat, stenographic, supplies, etc., estimated at $350.00

Publicity.

Bulletin and Circulars Distributed.

Name	Number of copies
Farmers' Bul. No. 1058	1,000
Circular No. 186	1,000
Reprint (Yr. book 1918) No. 796	.500
Life cycle cards	
Circulars	
Posters	

News Articles

News articles were put in the papers of those towns and regions where barberries had been found or were known to be present. Lengthy articles appearing in Denver Post, Pueblo Chieftan, and other of the larger papers of the Stat.

Educational Features:

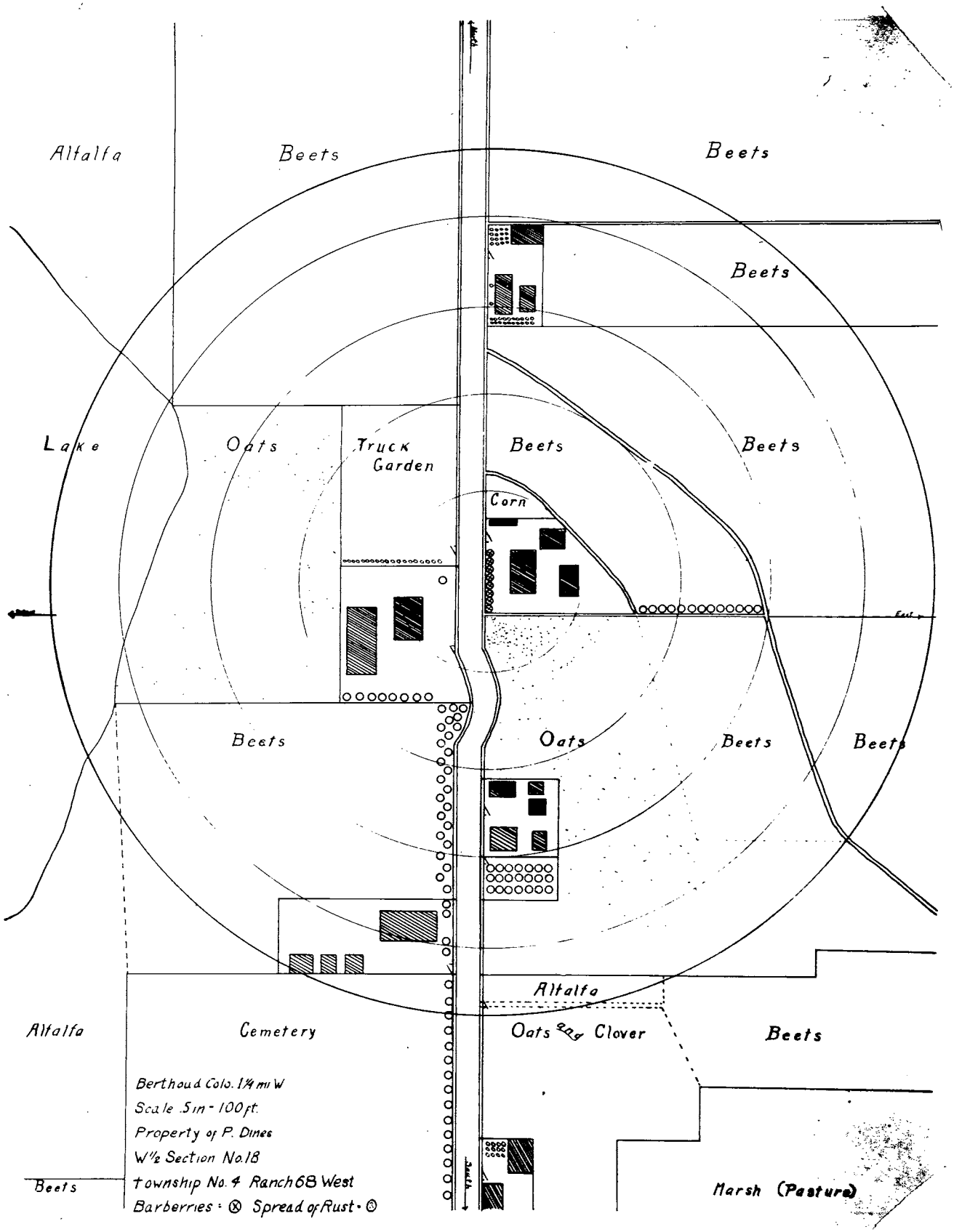
Nothing was done along this line beyond the distribution of posters, circulars, bulletins and life cycle cards.

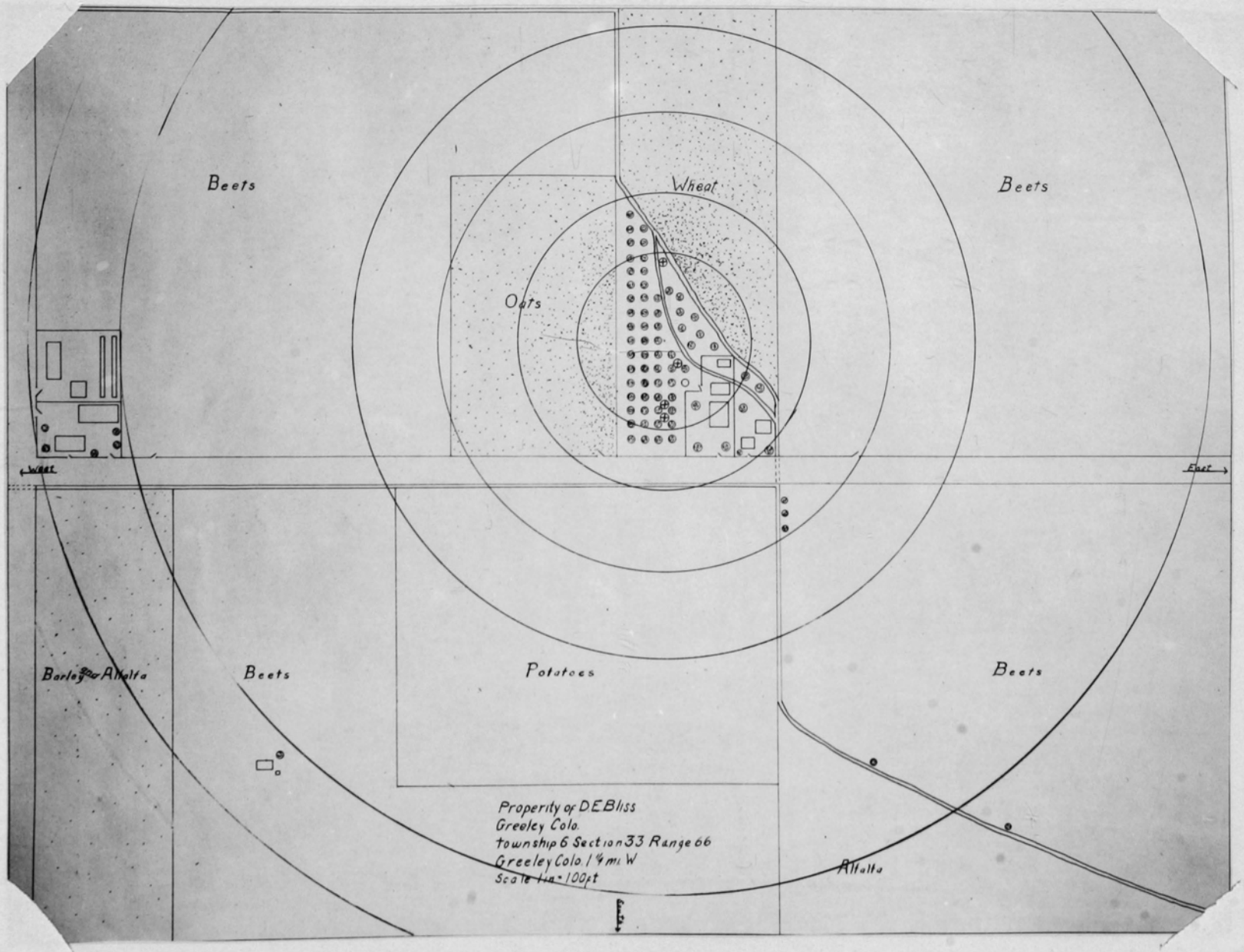
Personal Letters:

Personal letters were sent out to those tenants and land owners where sprouts were expected to give trouble.

Fair demonstrations

No demonstrations of any kind were made during the year.


Altalfa
Beets
Beets
Beets
Lake
Oats
Truck Garden
Beets
Beets
Corn
Beets
Oats
Beets
Beets
Altalfa
Altalfa
Cemetery
Oats and Clover
Beets
Berthoud Colo. 1¼ mi W
Scale .5in - 100ft.
Property of P. Dines
W½ Section No.18
Township No. 4 Ranch 68 West
Barberries = ⊗ Spread of Rust = ⊙
Beets
Marsh (Pasture)


Beets
Wheat
Beets
Oats
West
East
Barley
Alfalfa
Beets
Potatoes
Beets
Property of D.E. Bliss
Greeley Colo.
township 6 Section 33 Range 66
Greeley Colo. 1¼ mi W
Scale 1in = 100ft
Alfalfa
South

Heavily Rusted Grain And Grasses, Burlington Colo. 1922

Finding An Abundant of Rust Caused By Infected Barberries
Burlington Colo. 1922.

Barberry Hedge Before Digging; Bent County 1922

Escaped Barberry Digging By Hand, Wolhurst Colo. 1922

LEGEND

Areas Covered in farm to farm Survey.

Beginning of Campaign to June 30, 1919

July 1 to December 31, 1919

January 1 to June 30, 1920

July 1 to December 31, 1920

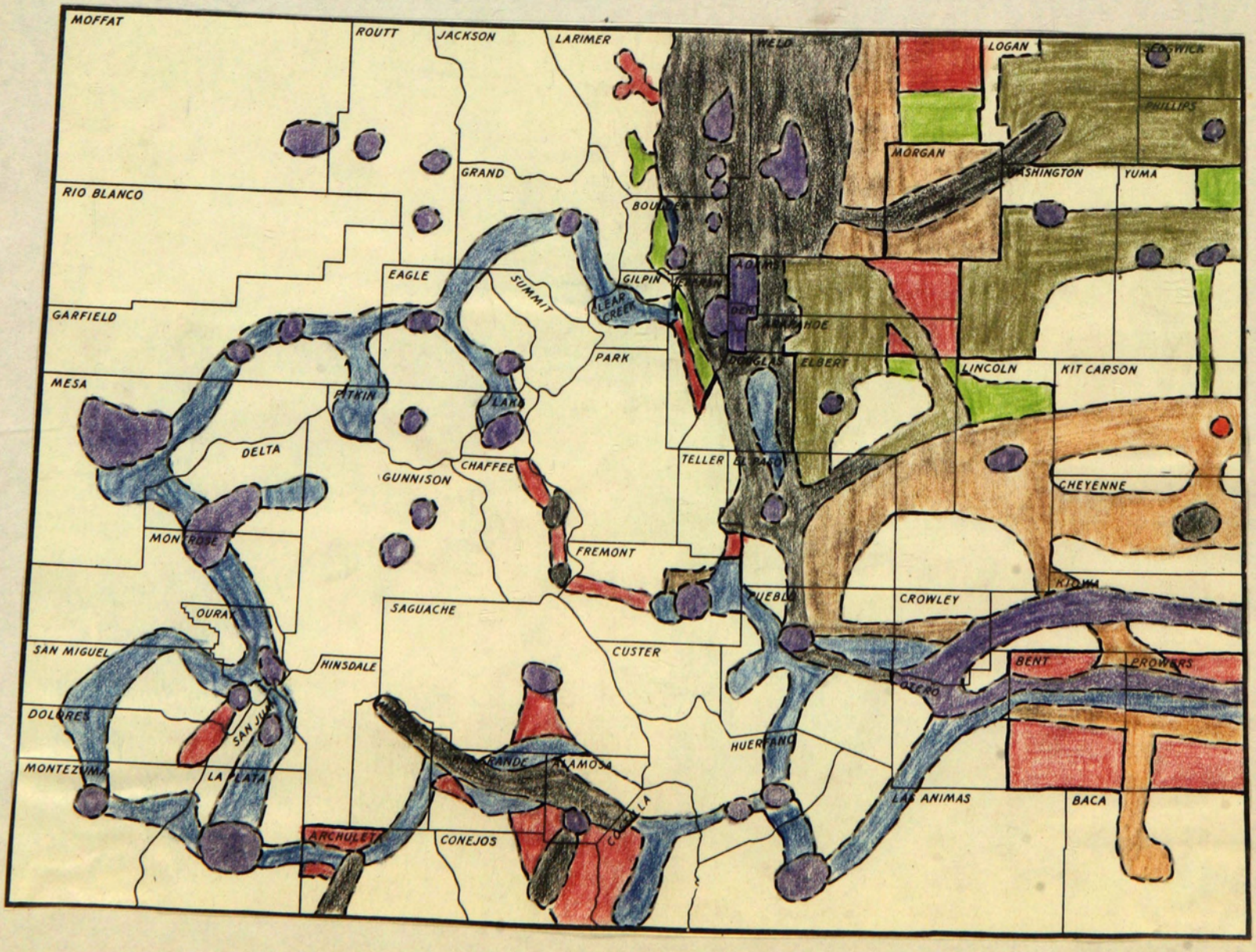
January 1 to June 30, 1921

July 1 to December 31, 1921

January 1 1921 to June 31, 1921

July 1 to December 31, 1922

All work done on Federal Funds.


MOFFAT
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JACKSON
LARIMER
WELD
LOGAN
SEDGWICK
PHILLIPS
MORGAN
WASHINGTON
YUMA
RIO BLANCO
GRAND
BOULDER
EAGLE
SUMMIT
GILPIN
CLEAR CREEK
ADAMS
DENVER
ARAPAHOE
GARFIELD
PARK
DOUGLAS
ELBERT
LINCOLN
KIT CARSON
MESA
PITKIN
LAKE
DELTA
GUNNISON
CHAFFEE
TELLER
EL PASO
CHEYENNE
MONTROSE
FREMONT
KIOWA
PUEBLO
CROWLEY
OURAY
SAGUACHE
SAN MIGUEL
HINSDALE
CUSTER
BENT
PROWERS
OTERO
DOLORES
SAN JUAN
HUERFANO
MONTEZUMA
LA PLATA
RIO GRANDE
ALAMOSA
LAS ANIMAS
BACA
ARCHULETA
CONEJOS
COSTILLA

LEGEND

July 1 to December 31, 1919.

January 1 to June 30, 1920

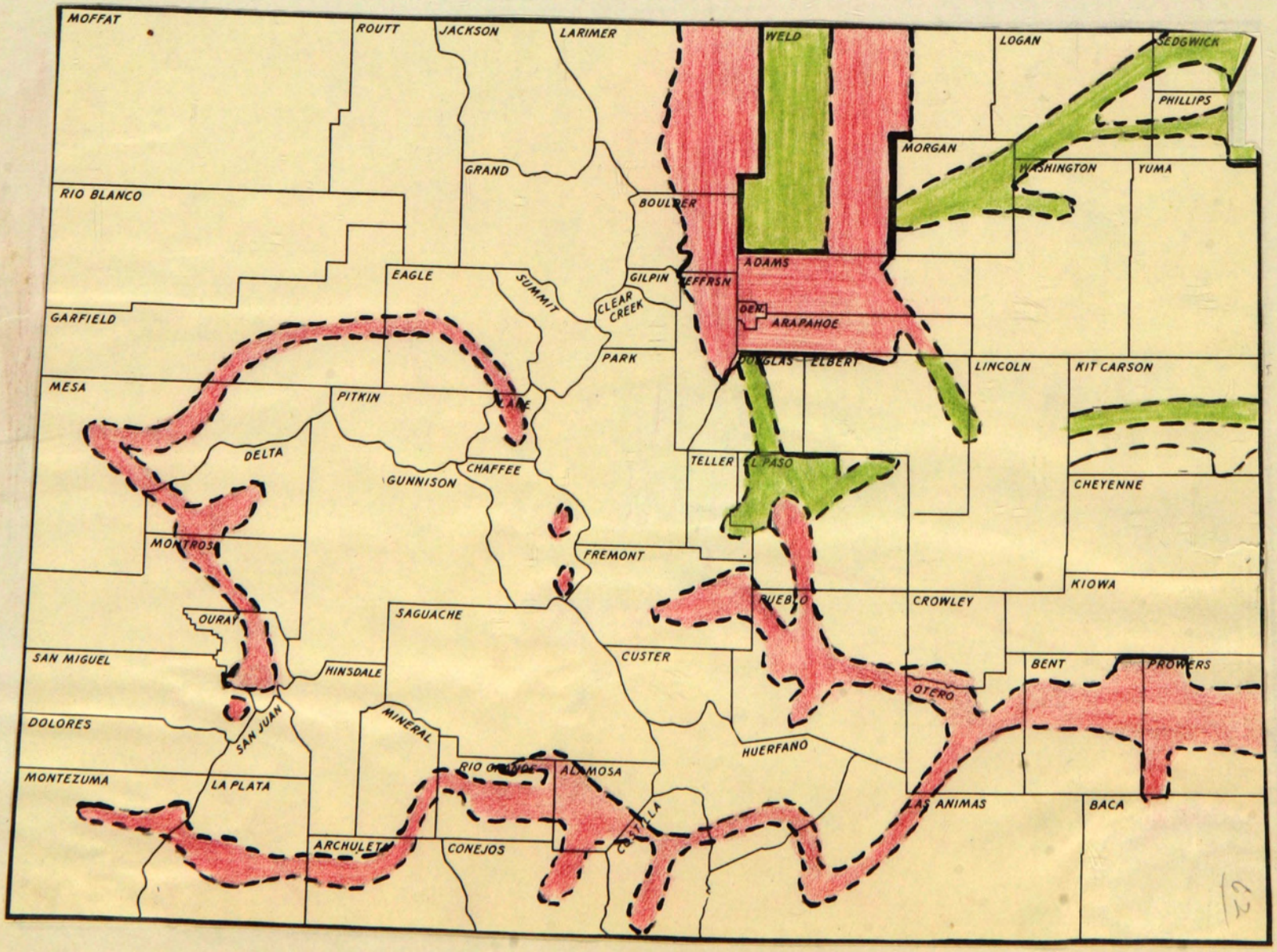
July 1 to December 31, 1920

January 1 to June 30, 1921

July 1 to December 31, 1921

January 1 to June 30, 1922

July 1 to December 31, 1922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CONEJOS
COSTILLA

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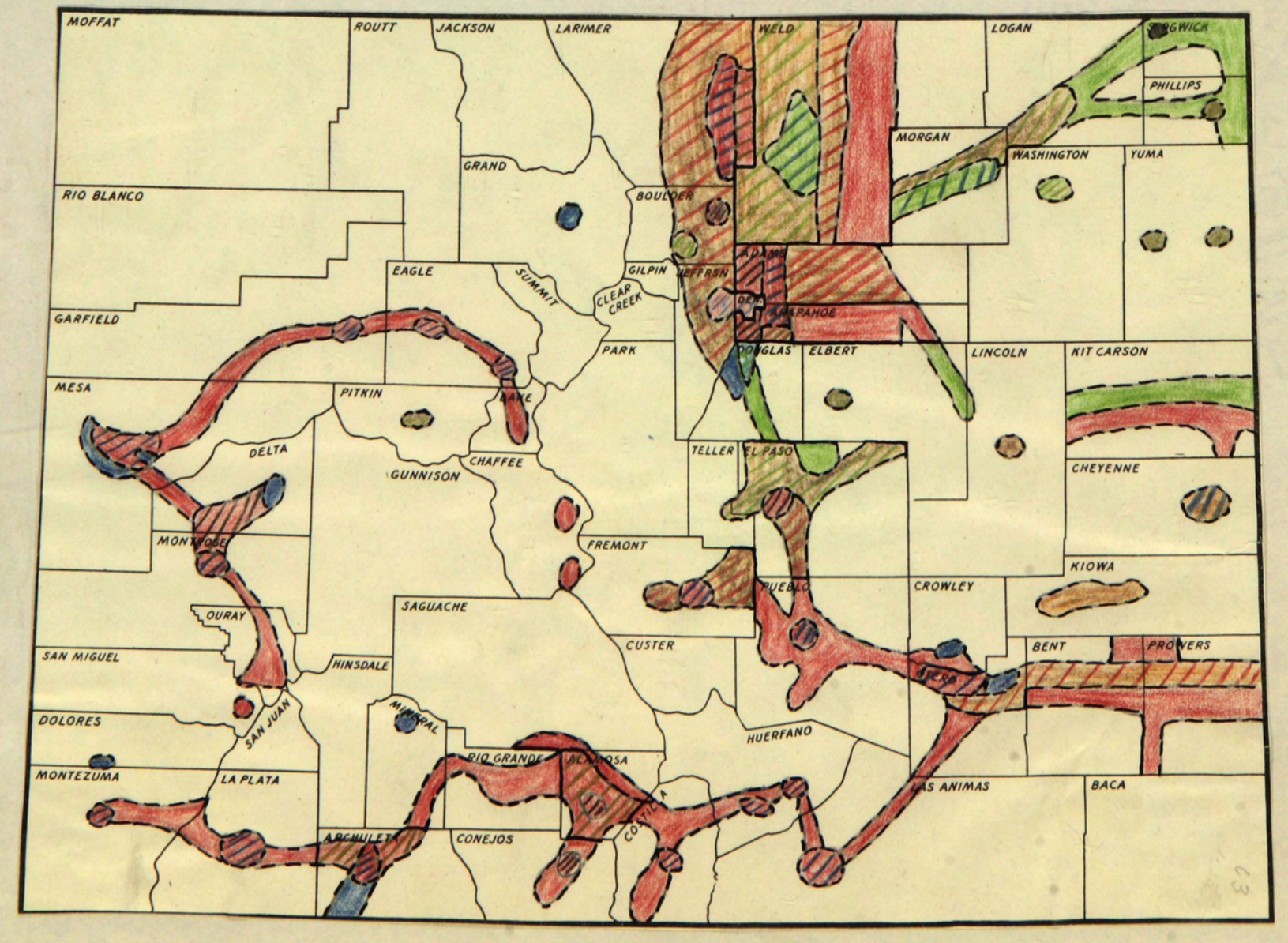
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PHILLIPS
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WASHINGTON
YUMA
GRAND
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SUMMIT
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JEFFERSON
ADAMS
DENVER
ARAPAHOE
GARFIELD
PARK
DOUGLAS
ELBERT
LINCOLN
KIT CARSON
MESA
PITKIN
LAKE
DELTA
GUNNISON
CHAFFEE
TELLER
EL PASO
CHEYENNE
MONTROSE
FREMONT
KIOWA
PUEBLO
CROWLEY
OURAY
SAGUACHE
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MINERAL
DOLORES
HUERFANO
RIO GRANDE
ALAMOSA
MONTEZUMA
LA PLATA
LAS ANIMAS
BACA
COSTILLA
ARCHULETA
CONEJOS

Period	Survey	No. of Counties Surveyed	No. of man days	Number of Properties in: Cities and Towns	Country: Having Escapes	Country: Total	Both, on which bushes were: Found	Both, on which bushes were: Removed	Number of Bushes in: Cities and Towns	Country: Escaped	Country: Total	Both Cities and Country: Found	Both Cities and Country: Removed	Sprouts Found on Re-Survey
This Month	Original													
	Resurvey													
	Removals													
	Total													
Since Jan. 1	Original	23	61	27	11	19	46	37	360	1004	1093	1453	1260	
	Resurvey													
	Removals	45	288					9					105	2458
	Total	68	349	27	11	19	46	46	360	1004	1093	1453	1365	2458
Since Jul. 1	Original	14	38	18	7	11	29	24	335	960	1044	1379	1198	
	Resurvey													
	Removals	37	222					8					90	2167
	Total	51	260	18	7	11	29	32	335	960	1044	1379	1288	2167
Entire Campaign	Original			1526	30	116	1642	1561	19532	2415	4469	24001	21828	
	Resurvey													
	Removals							78					1994	5684
	Total			1526	30	116	1642	1639	19532	2415	4469	24001	23822	5684

State Totals, Beginning of Campaign To Dec. 31, 1922

Period	No. of Counties Surveyed	No. of Man days	Number of Properties in: Cities and Towns	Country: Having Escapes	Country: Total	Both, on which bushes were: Found	Both, on which bushes were: Removed	Number of Bushes in: Cities and Towns	Country: Escaped	Country: Total	Both cities and country: Found	Both cities and country: Removed
This Month		Original survey from Beginning of Campaign To Dec. 31, 1922										
Since Jan. 1	23	117	27	11	19	43	37	360	1004	1093	1453	1260
Since Jul. 1	14	45	18	7	11	29	24	335	960	1044	1379	1198
Entire Camp'gn			1526	30	116	1642	1561	19532	2412	4469	34001	31828

MONTHLY REPORT BY COUNTIES

Counties Alphabetically	Am't of county surveyed	Number of properties in: Cities and Towns	Country: Having Escapes	Country: Total	Both, on which bushes were: Found	Both, on which bushes were: Removed	Number of bushes in: Cities and Towns	Country: Escaped	Country: Total	Both cities and country: Found	Both cities and country: Removed
Adams	100	9		1	10	6	27		4	31	25
Alamosa	80	2			2	2	7			7	7
Arapahoe	100	33	5	6	39	38	438	105	290	728	718
Archuleta	30										
Baca	15										
Bent	100										
Boulder	74	153	1	15	168	140	1813	1	106	1919	1547
Chaffee	10	4			4	4	5			5	5
Cheyenne	66										
Clear Creek	50	4			4	4	42			42	42
Conejos	15	6			6	6	39			39	39
Costillo	16										
Crowley	65	2			2	2	10			10	10
Custer	-										
Delta	35	7			7	7	27			27	27
Denver	100	671			671	660	9264			9264	8754
Dolores	40										
Douglas	70										
Eagle	15	2			2	2	2			2	2
Elbert	45										
El Paso	69	236			236	234	3925			3925	3850
Fremont	27	43	9	28	71	70	117	2837	2876	2993	2734
Garfield	20	3			3	3	6			6	6
Gilpin	25										
Grand	20										
Gunnison	10										
Hinsdale	-										
Huerfano	15	3			3	3	3			3	3
Jackson	-										
Jefferson	75	14	1	2	16	15	377	1	52	429	254
Kiowa	40										
Kit Carson	41	3			3	3	12			12	4
Lake	60										
La Plata	35	5			5	5	43			43	43
Larimer	66	88	12	37	126	119	425	36	795	1220	863
Las Animas	12	4			4	4	6			6	6
Lincoln	55	1			1	1	3			3	3
Logan	90	4			4	4	12			12	12
Mesa	30	10			10	10	169			169	169
Mineral	25										
Moffat	3										
Montezuma	35	2			2	2	3			3	3
Montrose	20	7			7	7	50			50	50
Morgan	100	12			12	12	151			151	151
Otero	35	10		1	11	7	98		1	99	72
Ouray	27										
Park	-										
Philips	100	6			6	6	10			10	10
Pitkin	18	1			1	1	1			1	1
Prowers	100	4			4	4	29			29	29
Pueblo	60	63			63	63	1433			1433	1433
Rio Blanco	-										
Rio Grand	60	9			9	9	24			24	24
Routt	5										
Saguache	23										
San Juan	35										
San Miguel	30										
Sedgwick	100	1			1	1	2			2	2
Summit	-										
Teller	15										
Washington	60	1			1	1	7			7	7
Weld	100	96	2	28	122	101	952	45	345	1297	923
Yuma	40	6			6	6	10			10	10

Period	No. of Counties Surveyed	No. of man days	Number of Properties in: Cities and Towns	Country: Having Escapes	Country: Total	Both, on which bushes were Found	Both, on which bushes were Removed	Number of Bushes in: Cities and Towns	Country: Escaped	Country: Total	Both cities and country: Found	Both cities and country: Removed	Sprouts Found on Re-Survey
This Month													
Since Jan. 1	48	256					9					105	3458
Since Jul. 1	40	215					8					90	2187
Entire Camp'gn							78					1994	5684

Resurvey from Beginning of Campaign to Dec. 31, 1922

MONTHLY REPORT BY COUNTIES

Counties Alphabetically	Am't of county surveyed	Number of Properties in: Cities and Towns	Country: Having Escapes	Country: Total	Both, on which bushes were Found	Both, on which bushes were Removed	Number of Bushes in: Cities and Towns	Country: Escaped	Country: Total	Both cities and country: Found	Both cities and country: Removed	Sprouts Found on Re-survey
Adams	100					4					6	
Alamosa	90											
Arapahoe	100					1					10	528
Archuleta	40											
Baca	-											
Bent	40											
Boulder	68					27					369	710
Chaffee	10											
Cheyenne	19											
Clear Creek	-											
Conejos	10											
Costillo	16											
Crowley	10											7
Custer	-											
Delta	30											5
Denver	100					10					509	1207
Dolores	2											
Douglas	25											
Eagle	15											
Elbert	15											
El Paso	65					2					75	589
Fremont	25					1					259	986
Garfield	15											2
Gilpin	-											
Grand	5											
Gunnison	-											
Hinsdale	-											
Huerfano	13											
Jackson	-											
Jefferson	75											121
Kiowa	10											
Kit Carson	40					1					8	
Lake	-											
La Plata	28											22
Larimer	66					7					357	507
Las Animas	15											
Linclon	5											
Logan	30											1
Mesa	17											14
Mineral	9											
Moffat	-											
Montezuma	20											
Montrose	10											25
Morgan	90											28
Otero	39					4					27	5
Ouray	15											
Park	-											
Philips	44											2
Pitkin	4											
Prowers	45											
Pueblo	40											221
Rio Blanco	-											
Rio Grand	45											1
Routt	-											
Saguache	-											
San Juan	10											
San Miguel	10											
Sedgwick	65											
Summit	-											
Teller	5											
Washington	13											
Weld	90					21					374	703
Yuma	5											

Period	No. of Counties Surveyed	No. of man days	Number of Properties in: Cities and Towns	Country: Having Escapes	Country: Total	Both, on which bushes were: Found	Both, on which bushes were: Removed	Number of Bushes in: Cities and Towns	Country: Escaped	Country: Total	Both cities and country: Found	Both cities and country: Removed	Sprouts Found on Re-Survey
This Month	Results of Barberry Eradication, Colorado, 1918 to Dec. 31, 1922												
Since Jan. 1	County Totals 1918 to Dec. 31, 1922												
Since Jul. 1													
Entire Camp'gn	57		1526	30	116	1642	1639	19532	2415	4469	24001	23822	

MONTHLY REPORT BY COUNTIES

Counties Alphabetically	Am't of county surveyed	Number of Properties in: Cities and Towns	Country: Having Escapes	Country: Total	Both, on which bushes were: Found	Both, on which bushes were: Removed	Number of Bushes in: Cities and Towns	Country: Escaped	Country: Total	Both cities and country: Found	Both cities and country: Removed	Sprouts Found on Re-survey
Adams	100	9		1	10	10	27		4	31	31	
Alamosa	90	2			2	2	7			7	7	
Arapahoe	100	33	5	6	39	39	438	105	290	728	728	528
Archuleta	40											
Baca	15											
Bent	100											
Boulder	68	153	1	15	168	167	1813	1	106	1919	1916	710
Chaffee	15	4			4	4	5			5	5	
Cheyenne	66											
Clear Creek	50	4			4	4	42			42	42	
Conejos	40	6			6	6	29			29	29	
Costillo	31											
Crowley	65	2			2	2	10			10	10	7
Custer	-											
Delta	25	7			7	7	27			27	27	5
Denver	100	671			671	670	9264			9264	9263	1207
Dolores	40											
Douglas	70											
Eagle	15	2			2	2	2			2	2	
Elbert	45											
El Paso	69	236			236	236	3925			3925	3925	589
Fremont	27	43	9	28	71	71	117	2237	2876	2993	2993	986
Garfield	20						6			6	6	2
Gilpin	25											
Grand	20											
Gunnison	10											
Hinsdale	-											
Huerfano	15	3			3	3	3			3	3	
Jackson	-											
Jefferson	75	14	1	2	16	15	377	1	52	429	254	121
Kiowa	40											
Kit Carson	41	3			3	3	12			12	12	
Lake	60											
La Plata	35	5			5	5	43			43	43	22
Larimer	66	89	12	37	128	126	425	26	795	1220	1220	507
Las Animas	12	4			4	4	6			6	6	
Lincoln	55	1			1	1	3			3	3	
Logan	90	4			4	4	12			12	12	
Mesa	30	10			10	10	169			169	169	14
Mineral	25											
Moffat	3											
Montezuma	25	2			2	2	3			3	3	
Montrose	20	7			7	7	50			50	50	25
Morgan	100	12			12	12	151			151	151	28
Otero	35	10		1	11	11	98		1	99	99	5
Ouray	27											
Park	-											
Philips	100	6			6	6	10			10	10	2
Pitkin	18	1			1	1	1			1	1	
Prowers	100	4			4	4	29			29	29	
Pueblo	60	63			63	63	1433			1433	1433	221
Rio Blanco	-											
Rio Grand	60	9			9	9	24			24	24	1
Routt	5											
Saguache	23											
San Juan	35											
San Miguel	30											
Sedgwick	100	1			1	1	2			2	2	
Summit	-											
Teller	15											
Washington	60	1			1	1	7			7	7	
Weld	100	96	2	26	122	122	952	45	345	1297	1297	703
Yuma	40	6			6	6	10			10	10	

Cities and Towns covered 1922 - Original Survey.

No original survey workdone in towns of Colorado during the year 1922.

LEGEND

Area of escaped bushes found Jan. 1 to June 30, 1919.

Area of escaped bushes found July 1, to Dec. 31, 1919.

Area of escaped bushes found Jan. 1, to June 30, 1920.

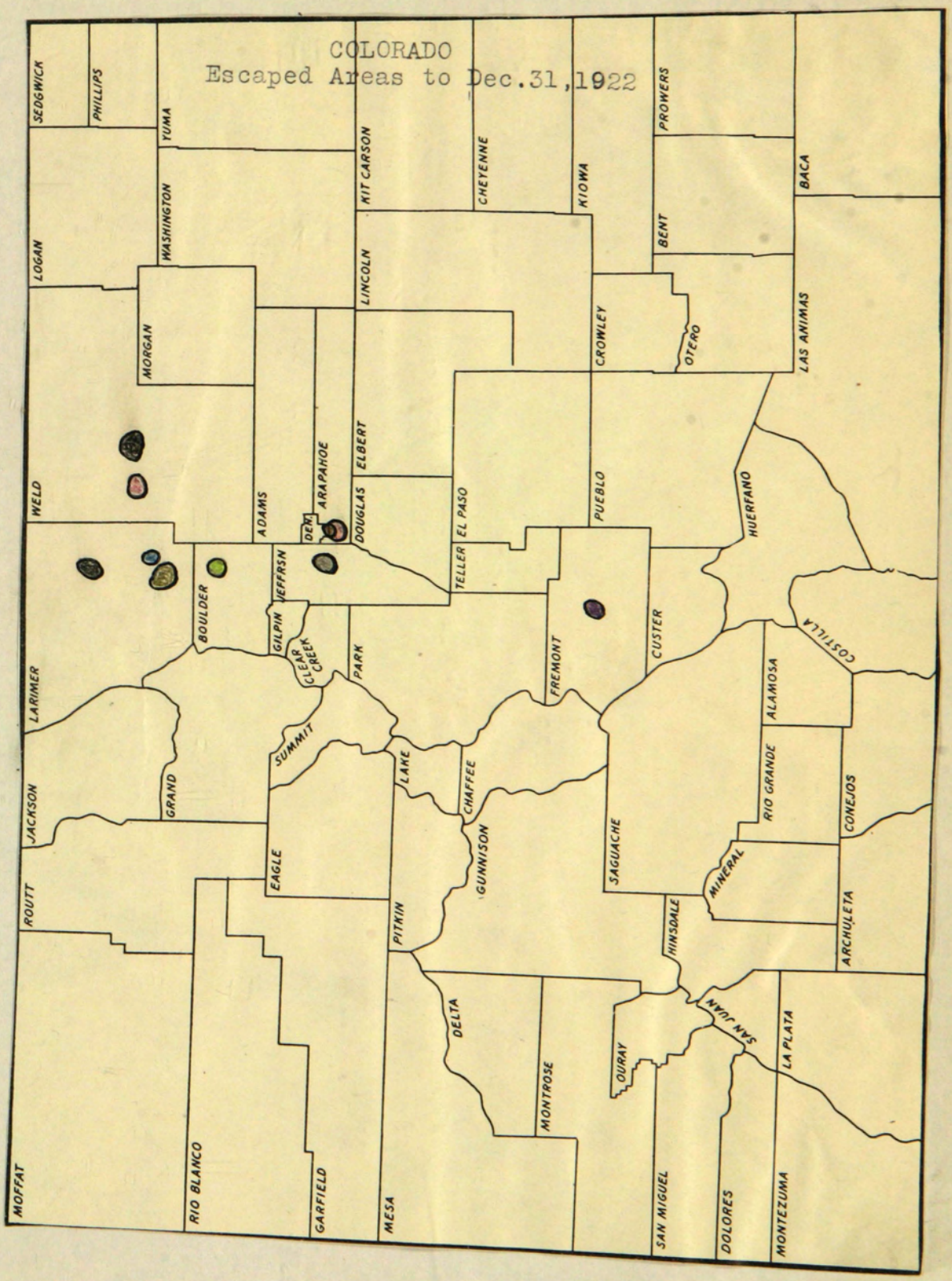
Area of escaped bushes found July 1 to Dec. 31, 1920.

Area of escaped bushes found Jan. 1 to June 30, 1921

Area of escaped bushes found July 1 to Dec. 31, 1921

Area of escaped bushes found January 1 to June 30, 1922

Area of escaped bushes found July 1 to Dec. 31, 1922


COLORADO
Escaped Areas to Dec.31,1922
SEDGWICK
PHILLIPS
YUMA
PROWERS
KIT CARSON
CHEYENNE
KIOWA
BACA
LOGAN
WASHINGTON
LINCOLN
BENT
MORGAN
CROWLEY
OTERO
LAS ANIMAS
WELD
ADAMS
ARAPAHOE
DEN
ELBERT
DOUGLAS
EL PASO
PUEBLO
HUERFANO
LARIMER
BOULDER
JEFFRSN
GILPIN
CLEAR CREEK
TELLER
PARK
FREMONT
CUSTER
COSTILLA
JACKSON
GRAND
SUMMIT
LAKE
CHAFFEE
ALAMOSA
RIO GRANDE
CONEJOS
ROUTT
EAGLE
GUNNISON
SAGUACHE
MINERAL
ARCHULETA
PITKIN
HINSDALE
DELTA
MONTROSE
OURAY
SAN JUAN
LA PLATA
MOFFAT
RIO BLANCO
GARFIELD
MESA
SAN MIGUEL
DOLORES
MONTEZUMA

List of Properties where
Escaped bushes were found.

Name	Town	County	Bushes
United Oil Co.	Canon City	Fremont	1
----------	Arvada	Jefferson	1
Greele-Loveland IrrigationCo.	Loveland	Larimer	2
Big Thompson River	"	"	1
Home Supply Ditch Co.	"	"	5
Home Supply Ditch Co.	"	"	31
Home Supply Ditch Co.	"	"	39
School house (rural)	"	"	40
Mrs. M.A.Alps	"	"	15
Glen Kester	"	"	2
Mr. Buckingham	"	"	7
G. C. Richard-son	"	"	7
J. C. Ruple	"	"	150
Loyd Jones	"	"	50
Poudre River	Ft.Collins	"	15
Poudre River	"	"	71
Coy Ranch	"	"	1
Poudre River	La Porte	"	1
Vacant lot (rural)	Greeley	Weld	4
Park (rural)	"	"	4
----------	Littleton	Arapahoe	1
Lyosn and Johnson	Englewood	Arapahoe	1
Wolhurst Farm	Wolhurst	"	70
---------	W.Littleton	"	1
M. F. Allen	Longmont	Boulder	37
G. Osterhout	Windsor	Weld	11
Park (rural)	Greeley	Weld	2
McCormack	Greeley	"	2

(Bushes located near towns named)

Resurvey Results
1922

County	CITY Props visited	No. Sprouts	% of bushes sprouting	% of properties having sprouts
Adams	9	---	---	---
Alamosa	2	---	---	---
Arapahoe	32	106	148	44
Boulder	150	148	8	19
Chaffee	4	---	---	---
Conejos	6	---	---	---
Crowley	2	1	10	50
Delta	7	---	---	---
Denver	669	318	3	8
Eagle	2	---	---	---
El Paso	230	300	8	6
Fremont	43	18	16	9
Garfield	3	2	33	33
Huerfano	3	---	---	---
Jefferson	11	86	57	54
La Plata	5	4	10	40
Larimer	88	21	18	25
Las Animas	4	---	---	---
Logan	4	1	8	25
Mesa	10	9	6	30
Montezuma	2	--	--	--
Montrose	7	8	16	14
Morgan	12	--	--	--
Otero	10	4	4	10
Philips	6	--	---	---
Prowers	3	---	---	---
Pueblo	63	27	2	14
Rio Grand	9	1	4	11
Sedgwick	1	---	---	---
Washington	1	---	---	---
Weld	89	259	21	18
				410

Resurvey Results
1922

R U R AL

County	Props visited	No. Sprouts	% of bushes sprouting	% of properties having sprouts
Adams	1	---	---	---
Alamosa	---	---	---	---
Arapahoe	2	11	10	100
Boulder	13	65	12	54
Chaffee	----	---	---	---
Conejos	---	---	---	---
Crowley	---	---	---	--
Delta	---	---	---	---
Denver	----	---	---	---
Eagle	---	---	---	---
El Paso	---	---	---	---
Fremont	24	680	33	26
Garfield	---	---	---	---
Huerfano	---	---	---	---
Jefferson	2	34	65	100
La Plata	---	---	---	---
Larimer	28	284	24	85
Las Animas	---	---	---	---
Logan	---	---	---	---
Mesa	---	---	---	---
Montezuma	---	---	---	--
Montrose	---	---	---	---
Morgan	---	---	---	--
Otero	1	---	---	--
Philips	---	---	---	---
Prowers	----	---	---	---
Pueblo	---	---	---	---
Rio Grand	---	---	---	---
Sedgwick	---	---	---	---
Washington	---	---	---	---
Weld	26	26	58	50

Summary of Barberry Survey
By Federal Department, 1922

County	Sq. mi.	Miles run	Mi. per sq. mi.	Total Cost	Cost sq. mi.	Cost Mile	Man Days.
Adams	1410	900	.638	$157.85	$ .112	$.175	14
Alamosa	490	340	.694	62.95	.128	.185	5
Arapahoe	890	1215	1.366	216.15	.243	.178	18
Archuleta	424	325	.766	54.85	.129	.169	5
Bent	1345	1197	.890	168.20	.125	.141	14
Boulder	534	1048	1.963	324.25	.607	.309	27
Chaffee	146	105	.719	18.15	.127	.76	1
Conejos	486	419	.866	79.79	.164	.190	6
Costillo	391	318	.813	60.10	.154	.189	5
Crowley	80	53	.662	8.50	.106	.160	.5
Delta	182	130	.714	21.00	.115	.161	2
Denver	65	1076	16.554	360.75	5.550	.335	30
Dolores	219	183	.836	42.25	.189	.231	4
Douglas	129	183	1.419	19.70	.152	.164	2
Eagle	172	141	.218	24.40	.142	.173	2
El Paso	774	821	1.061	143.25	.185	.174	12
Fremont	352	292	.829	51.90	.147	.178	5
Garfield	270	214	.793	32.10	.119	.150	2
Huerfano	77	65	.844	9.90	.128	.152	1
Jefferson	577	1573	2.726	228.00	.395	.145	19
Kit Carson	906	758	.837	123.20	.136	.162	11
Lake	100	74	.740	12.95	.129	.175	1
La Plata	336	267	.795	38.60	.115	.152	3
Las Animas	575	489	.805	60.10	.105	.123	5
Larimer	1964	3251	1.644	445.40	.226	.137	43
Lincoln	264	212	.821	30.15	.115	.142	3
Logan	373	315	.845	42.30	.113	.134	4
Mesa	171	186	1.088	23.05	.135	.124	4
Mineral	45	38	.844	7.05	.156	.201	1
Montezuma	317	308	.971	40.65	.128	.132	4
Montrose	115	98	.852	15.50	.135	.158	1.5
Morgan	534	470	.880	58.45	.106	.125	5
Otero	315	344	1.092	47.35	.150	.138	4
Ouray	85	67	.788	11.35	.133	.169	1
Philips	276	240	.870	33.20	.120	.138	3
Prowers	1360	1295	.952	150.30	.110	.115	15
Pueblo	365	397	1.088	57.45	.158	.145	5
Rio Grand	390	386	.990	46.15	.119	.120	3
Saguache	488	408	.836	46.30	.095	.113	4
San Miguel	203	168	.828	24.10	.118	.144	2
Sedgwick	329	290	.881	34.60	.105	.119	3
Teller	89	70	.787	19.40	.117	.148	1
Washington	182	156	.857	20.30	.111	.130	2
Weld	4185	3915	.912	549.25	.131	.140	46
Yuma	242	190	.785	25.25	.105	.134	2
TOTALS	23222	24990	1.076	4037.25	.174	.162	349

Summary of Costs - Original Survey

	Man Days	Total Cost	Miles	Cost per Mile	Cost per Sq. mile	Plant-ings	Cost per plant	Bushes	Cost per bush
Adams	5	$70.10	520	$.133	$.113				
Alamosa	1	12.50	65	.192	.179				
Arapahoe	2	25.15	200	.122	.123	5	5.03	179	$.15
Bent	8	95.80	742	.129	.109	5	4.25	8	2.65
Chaffee	.3	6.40	40	.160	.128				
Conejos	.5	33.10	267	.124	.109				
Costillo	1.7	21.55	172	.124	.113				
Denver	.5	6.00	40	.150	.400	2	3.00	3	2.00
Dolores	4	42.25	183	.231	.189				
El Paso	.3	3.50	23	.152	.140	6	.56	13	.27
Fremont	1.2	14.95	80	.187	.87	5	2.99	893	.02
Jefferson	3	36.50	212	.172	.238	3	12.17	264	.14
Larimer	3.3	46.10	310	.149	.157	9	5.12	25	1.84
Kit Carson	.5	5.25	43	.122	.240	3	1.75	12	.44
Lincoln	3	30.15	2.2	.142	.115				
Prowers	9	105.00	820	.128	.112	1	105.00	20	5.25
Rio Grand	1	11.50	80	.147	.133				
Saguache	2.5	38.45	269	.149	.119				
San Miguel	1.2	16.10	121	.133	.119				
Teller	.7	7.65	50	.153	.130				
Weld	6.8	94.15	683	.138	.112	7	13.45	36	2.62
Yuma	2	25.25	190	.134	.105				
State Totals	61	768.45	5463	.140	.122	46	16.70	1453	.53

Summary of Costs Per Acre
1922

Total Costs
(Including Administration and Overhead)

Cost per Acre	Cost per A.wheat	Cost per A.small grains	Cost per bushel wheat	Cost per bushel small grains
$.000361	$.00333	$.000258	$.000248	$.000149

Field Costs
(Including only expenses incurred in field)

Cost per Acre	Cost per A.wheat	Cost per A. small grains	Cost per bu. wheat	Cost per bu. small grains
$.000272	$.00249	$.00193	$.000185	$.000112

Note: Production statistics per county not yet available

Resurvey Costs.
1922

County	Man Days	Total Props.	Total Sp'ts	Total Cost	Cost per Prop.	Cost per Sprout
Adams	9	10		$ 87.75	$ 8.78	$
Alamosa	4	2		50.45	25.22	
Arapahoe	16	34	117	191.00	5.62	1.63
Archuleta	5			54.85		
Bent	6			72.40		
Boulder	25.5	163	260	303.00	1.86	1.17
Chaffee	..7	4		11.75	2.94	
Conejos	3.5	6		46.60	7.77	
Crowley	.5	2	1	8.50	4.25	8.50
Delta	2	7		21.00	3.00	
Denver	29.5	669	318	354.75	.53	1.12
Douglas	2			19.70		
Eagle	2	2		24.40	12.20	
El Paso	11.7	230	300	139.75	.61	.45
Fremont	3.8	67	698	36.95	.55	.05
Garfield	2	3		32.10	10.70	
Huerfano	1	3		9.90	3.30	
Jefferson	16	13	120	192.50	14.81	1.60
Kit Carson	10.5			117.95		
La Plata	3	5	4	38.60	7.72	9.65
Larimer	39.7	116	305	399.30	3.44	1.31
Las Animas	5	4		60.10	15.02	
Logan	4	4	1	42.30	10.57	42.30
Mesa	2	10	9	23.04	2.30	2.72
Mineral	1			7.05		
Montezuma	4	2		40.65	20.33	
Montrose	1.5	7	8	15.50	2.21	1.94
Morgan	5	12		58.45	4.87	
Otero	4	11	4	47.35	4.30	11.84
Ouray	1			11.35		
Philips	3	6		33.20	5.53	
Prowers	6	3		45.30	15.10	
Pueblo	5	63	27	57.45	.91	2.13
Rio Grand	2	9	1	34.65	3.85	34.65
Saguache	1.5			7.75		
San Miguel	.8			8.00		
Sedgwick	3	1		34.60	34.60	
Teller	.3			2.75		
Washington	2	1		20.30	20.30	
Weld	39.2	115	285	455.10	3.96	1.60
STATE TOTALS	288	1584	2458	3269.80	2.06	1.33

Discussion of Resurvey.

Two methods of resurvey were employed during the year. The one used depending upon the county being gone over. In very important sections and where numerous barberries had previously been found the resurvey was made with as much care and diligence as was the original inspections every precaution being tak n to make sure that no bushes remained. In less important sections and where the plantings were few and well scattered the resurvey was made very thoro in the neighborhood of these plantings and also in such sections as gave the appearance of furnishing favorable conditions for the propagation of the rust harboring bushes. The remainder of such country was of course gone over more less rapidly, depending upon its general characteristics.

As in the original survey the percent of resurvey in a count refers to that part of the total area of the county. It is evident that earlier reports indicated the percentage of the original survey which has been given resurvey since in many instances the first resurvey was greater than the original. For example counties only partially covered in the original survey were reported as one hundred per cent resurveyed. The short time consumes in making these resurveys as compared to the area of the county in which the survey was made lends further support to the theory

that the original survey was taken as the percentage basis for the resurvey.

In going over the ground a second time it was noted that in the majority of cases where the removal of the bushes was left to the tenant or land owner, due to lack of thoroness in digging out the roots, it being difficult to impress people with the necessity of so doing. In those few instances where the person living on the ground really took the interest and saw to the complete removal of the roots and watched afterwards for sprouts, eradication proved very effective. Their attitude, if it could be instilled into everyone, would prove the greatest means of forever ridding the country of this pest.

It is noticeable that, where bushes are poorly dug in the first place, their complete eradication becomes more difficult. Not only are the remaining roots more difficult to remove, but those remaining in the ground seem to have greater powers for sending up shoots, large bushes springing up from small roots in a very short time.

To the most effective means of completely destroying the common barberry bush and preventing the growth of sprouts is to treat the bush with a chemical such as NaCl.

Continued digging of roots whenever sprouts indicate their presence will, after a time, bring about the total destruction of the bush, but in out of the way placed this is a difficult process to carry out. Also, in many instances, we find the barberries growing in wooded and rocky regions where it is impossible toremove all the roots. In such cases and in other instances where digging is impractical chemicals furnish the only means of complete eradication.

In the south western part of the state numerous bushes of Berberis fendleri were found scattered over the hill sides. Cluster cups were present in abundance on the leaves of these bushes but this particular strain or rust did not carry over to the wheat or other grains in the adjacent fields.

There proved to be a great variation in the percentages of bushes having sprouts and in the percentages of properties having sprouting bushes, even in the same and adjacent localities. However, the pe centage estimated for the territory resurveyed indicates 16 per cent of the bushes to have sprouted on 20.2 per cent of the properties having bushes.

A great variation was also observed in the ability of the bushes with regard to their abi ity to propagate their kind. Many large hedges were found bearing seeds in great quantities, and yet no seedlings were in evidence in the vicinity. In other instances a single

bush was known to produce a great many seedlings, some times reaching a considerable distance with their offspring.

In the State of Colorado we are strong believers in the possibilities of chemical eradication and think it should be employed wherever possible. We are planning a great deal on its use in handling the sprout situation the coming season. Where chemical can not be used complete removal thru digging is the only recourse. In this connection we recommend digging until sure all roots are removed followed by considerable more digging in all directions. If the co-operation of the person living on the property can be secured to the extent that he will conscientiously watch for and remove all sprouts certain death for the plant is assured. Otherwise it is necessary to make frequent visits to the place until sprouting ceases and even after that another visit should be made after a long period to make sure no sprouts have managed to obtain life from dormant root ends.

Epidemiology Studies.

In the fall of 1921 various plots of rusted grasses were selected near the College campus with a view to making frequent germination tests of the urediniospores. The purpose of this experiment was to determine the longevity or viability of the red summer spores.

The stations or plots were as follows:

No.	Location	Host	Date Located
1	3 mi.S. of Ft.Collins	Oats	Sept. 15, 1921
2	South of City Park	"	Oct. 1, 1921
2'	" " "	Barley	" " "
3	Experiment Station	Wheat	Sept. 15, 1921
4	Greeley	Wheat	Oct. 3, 1921
4'	"	Oats	" " "
5	3 Mi. north of Loveland	Timothy	Oct. 8, 1921
5'	" " " "	W. Barley	" " "
6	1 Mi. east of Berthoud	Oats	" " "
7	2 Mi. south of Ft. Collins	W. wheat	Oct. 20, 1921

Germination tests were taken from the various plots at approximately two week intervals.

Two methods were used in making these germination tests. The first practice was to sow the spore s on a cover glass holding distilled water. The class was

inverted ovar a ring placed on a slide so as to hold the distilled water. The second method and the one generally used in this experiment consisted of placing a drop of distilled water within a ring of vaseline on a glass slide. The spores were then sown in the water and the whole placed on a petri dish containing a moist blotter. The spores were incubated at a constant temperature of 20 degrees C.

Germination tests were made from each plot at the intervals stated from the date of the first test until zero or no germination was shown. The following data was obtained.

No.	Host	First Test Made	% spores viable	Final test made	% spores viable
1	Oats	Sept. 15, 1921	94	Dec. 12, 1921	0
2	"	Oct. 1, 1921	84	Jan. 13, 1921	0
2'	Barley	" " "	75	" " "	0
3	Wheat	Sept. 15, 1921	89	Jan. 16, 1921	0
4	"	Oct. 3, 1921	40	lost	
4'	Oats	Oct. 3, 1921	85	Nov. 2, 1921	0
5	Timothy	Oct. 8, 1921	20	Dec. 2, 1921	0
5'	Wild Barley	" " "	40	Mch. 12, 1922	0
6	Oats	" " "	50	Jan. 16, 1922	0

Each germination test, from the starting date to the time of zero germination, showed a slight decrease over the preceding test with regard to per cent of viable spores.

The spores remaining viable for the greatest length of time were found on Hordeum jubatum (wild barley) at Station No. 5', the strain on this grass being identified as Puccinia graminis tritici by Dr. E. C. Stakman.

Temperature and precipitation observations were made during the experiment and the temperatures at the Stations were observed when the spores were collected for the germination tests.

Stubble well supplied with red spores was placed out in the open in a pasture, being exposed to full weather conditions. The material was protected by having a small wire fence built around it. Several bundles of the stubble were used in the experiment and each was numbered, the spores being tested for germination at frequent intervals.

The first test was made on September 27, 1921 all proving viable, the highest running 75 per cent. On December 20, 1921, all tests have zero germination both with 48 and 7r hour incubation periods. Another test was made later and with the same results. It was concluded that the red spores could not remain viable over winter when exposed to the elements on stubble.

Asimilar experiment was tried in which the spore laden stubble was placed in a hole in the ground which

was about four feet deep. The results obtained were practically the same as where the spores were exposed idrectly to the elements.

The same results were also obtained when the stubble and spores were placed under several inches of of leaves. In fact the spores remained viable for a shorter length of time in this test than in the one where they were placed out in the open.

IV. Inoculated wheat in pots Decemver 28, with Puccinia graminis , form 3, from St. Paul.
Set in incubator 48 hours and set out on bench.

Jan. 3, 1923, flecks appearing and rust starting to develop on the Marquis.
Placed out of doors to harden.

Jan. 12, 1923, pots exposed to out of door conditions.

Jan. 19, 1921 germination tests taken at 20 degrees C.

Jan. 20, 1921 Marquis wheat placed in greenhouse for further inoculation.

January 22, 1923, spores germinated 85 %.
Note: Inoculation at this time successful on the Marquis. Kanred showing resistance.

Jan. 26, 1923, Spores collected from wheat exposed and germinated at 20 degrees C. Covered with ½ in snow.

Jan. 29, 1923 30% germination

Jan. 30, 1921 40% "

V. Future work when plenty of rust material is available.

Pots kept in dark chamber. Pots exposed to open weather.
Pots covered with debris. Pots kept for furture inoculation work.
Germination tests to be made in the usual manner each week.

Inoculations by putting spores in distilled water sprayed on plants, also by thumb and finger method.

VI. Weather reports

VII. Early spring observations.
First indication of rust in field.
First infection of barberry bushes or sprouts.

Overwintering of Urediniospores.

No field plots could be located in this section for the carrying on of overwintering tests because of the absence of rust in the fields. Observations were made by Professor C. D. Learn and E. A. Lungren.

Following are some of the results obtained from the carried on:

I. Rust on leaves, Puccinia graminis tritici, collected summer of 1922.

Set in germinator Dec. 8, 1922.

Test	Dec.	10,	1922	no	germination.	Temp.	20 C.
"	"	11	"	"	"	"	"
"	"	15	"	"	"	"	"

Three petri dishes containing moist blotters with slides holding distilled water within a ring of vaseline were used. The spores were placed in the distilled water.

II . Red rust from stubble, collected in 1922. Eight petri dishes, each containing red spores in distilled water on glass slide. 20 degree C. and 30 C.

Set in germinator December 15, 1922

No.	% germination Dec. 18, 1922	% germination Dec. 20, 1922	Temp. K
1	0	0	20 C.
2	"	"	20 C.
3	"	"	"
4	"	"	"
5	"	"	30 C.
6	"	"	"
7	"	"	"
8	"	"	"

III. Wheat planted in 6 in. pots in greenhouse Nov. 2, 1922.

2 Plots	13274	Certified	Marquis
" "	13408	"	"
" "	13407	"	Kanred
" "	13409	"	"
" "	1310	"	"

LEGEND

Location of chemically treated bushes July 1 to December 31, 1922

CHEMICAL ERADICATION

Chemical eradication was first practiced in the state of Colorado during the latter part of the season of 1923. The scouts in the field supplied the NaCl, which was the chemical used, at their own expense, there being no cost to the Government. Bushes were treated in the counties of Adams, Arapahoe, Boulder, Jefferson, Larimer and Weld. Varying amounts of chemical were used, but no case did the quantity applied equal that advised by the Departmental circulars which were received later in the year. However, the treatment with these lesser quantities seems to have been effective so far as the bushes in the vicinity of Fort Collins were concerned. None of the others have been revisited and therefore we do not deem it advisable to draw conclusions as to the results of treating the bushes with chemicals. Next year definite data on the subject will be obtainable

HISTORY OF PLANTINGS.

One of the most important barberry hedges in Colorado was located on the far m of J. C. Ruple, three miles west and three miles south of Loveland. The hedge was very old and the bushes very large, dynamite and teams with block and tackle being utilized in removing them. These barberries proved to be prolific bearers of fertile seeds and seedlings and bushes were well scattered over the surrounding country. Thru the farm runs the Home Supply Ditch one of the larger irrigation ditches of the community, and this proved an effective means of carrying seeds thruout the rich agricultural region which it waters. Sprouts and escapes still offer a problem in this district. They have, however, for the most part, been removed with the result that for the past two years very little rust has been experienced in the community where formerly the loss from this disease was so high as to almost prohibit grain growing.

The Handy ditch furnishes a similar example of the spread of the barberry over the country. This ditch received its waters from the same stream as does the Home Supply. Near its head was located the farm of Mrs. M. A. Alps whereon grew some highly prized common

barberries. Birds deposited the seeds under the trees along the banks of the ditch and from there the bushes were being spread over the section served by this irrigation system.

One large bush, located on the Poudre River, north west of Ft. Collins, and near the foot hills, proved to be the source of a great many rust spreading barberries scattered along the banks of this stream and in adjacent field.

Mr. Alfred Bosbec, living north of Loveland volunteers the information that since the removal of his barberry hedge he has been able to grow wheat in a field that formerly proved almost a total loss when put into grain because of the rust attack.

The Wolhurst farm, south of Denver, had a flourishing barberry hedge located near the farmhouse on the bench above the river. From here the bushes has spread down to the river and had commenced their marck along its banks. Since the removal of this hedge and the escapes from the surrounding territory very little rust has been experienced in the section where formerly it gave a great deal of trouble.

A great many instances, similar to the above could be cited over various parts of the state, and it is with great satisfaction that we note the decreasing losses thru rust.

DISCUSSION OF THE YEAR'S WORK.

Considerable has been accomplished during the past year in theway of eradicating the common barberry from the state of Colorado. We feel quite safe in saying that practically all the bushes of the state have been discovered, although of course there may be a few in hiding in certain parts of the state which have not been thoroly gone into, if worked at all. The main problem at present is to completely do away with those bushes found and prevent the shooting up of sprouts every year, This we hope to be able to accomplish in most instances by means of chemical eradication. The comparative few that can not be dealt with in this way will be killed off by thoro and persistant digging of roots wherever their location is indicated by the presence of sprouts.

During the year three scouts were employed in the field and for various lengths of time, one of them being the State Leader. Each one was equipeed with a car and assighed certain territory to cover, this proved the most economical system of survey so far practiced in view of the fact th t considerable more money was spent in Administration and Overhead than in previous years. The actual field expenses averaged $.161 per running mile and $.174 sq. mile surveyed. This same method was employed during the season of 1920 and it is possible that

the actual field expenses for that year were slightly under those of 1922. However, the nature of the work that season differed somewhat from that performed the past year and after everything is taken into consideration the average field expenses for the two years appear practically the same for the two years, i. e., those of 1920 as compared to those of 1922. However, too definite conclusions should not be drawn from such comparisons as the controlling factors are so varying with different years.

Little was done toward publicity during the year for the reason that there was nothing to be gained by it. The work had been carried on practically all over the state and every section was familiar with its nature and purpose.

The chemical treatment of bushes was not carried on to the degree that we would have wished because of the fact that the field men were not in possession of the details necessary to the carrying on of this phase of the work effectively. However, a start was made and future work will be guided by past experience.

One beautiful example of the spread of rust from the barberry was observed near the town of Burlington in Kit Carson County. On recommendation of the county agent this section was not surveyed the previous year because he know that there were no barberry bushes in the community. Last year an outbreak of rust in the

grain fields was called to the attention of the State Leader and an investigation was made. As a result a prosperous barberry was discovered in the center of the epidemic from which the spread of rust could be traced. A few other bushes were located over the state by this same method and it is our plan to watch closely for rust outbreaks next year.