3-1926

Circular No. 60 - Seed-Potato Treatment: For the Control of Four Common Diseases Rhizoctonia, Scab, Blackleg, Dry-Rot

B. L. Richards

Follow this and additional works at: http://digitalcommons.usu.edu/uaes_circulars

Part of the Agricultural Science Commons

Recommended Citation
Richards, B. L., "Circular No. 60 - Seed-Potato Treatment: For the Control of Four Common Diseases Rhizoctonia, Scab, Blackleg, Dry-Rot" (1926). UAES Circulars. Paper 44.
http://digitalcommons.usu.edu/uaes_circulars/44
SEED-POTATO TREATMENT

For the Control of Four Common Diseases
Rhizoctonia, Scab, Blackleg, Dry-Rot

By B. L. RICHARDS

UTAH AGRICULTURAL EXPERIMENT STATION

LOGAN, UTAH
BOARD OF TRUSTEES

A. W. IVINS, President................................................................. Salt Lake City
C. G. ADNEY, Vice-President.......................................................... Corinne
LORENZO N. STOHL.......................................................................... Salt Lake City
FRANK B. STEPHENS........................................................................ Salt Lake City
ROY BULLEN..................................................................................... Salt Lake City
MRS. LEE CHARLES MILLER.............................................................. Salt Lake City
MRS. BURTON W. MUSSER................................................................. Salt Lake City
J. R. BEUS......................................................................................... Hooper
JOHN E. GRIFFIN.............................................................................. Newton
WESTON VERNON, Sr............................................................... Logan
FREDERICK P. CHAMP..................................................................... Logan
WILFORD DAY................................................................................... Parowan
H. E. CROCKETT, Secretary of State (ex-officio)............................... Salt Lake City
R. E. BERNTSON, Secretary............................................................... Logan

EXPERIMENT STATION STAFF

E. G. PETERSON, Ph. D., President of the College
WILLIAM PETERSON, B. S., Director and Geologist

H. J. FREDERICK, D. V. M............................................................... Veterinarian
J. E. GREAVES, Ph. D................................................................. Chemist and Bacteriologist
*W. E. CARROLL, Ph.D................................................................. Animal Nutrition
GEORGE STEWART, M. S............................................................... Agronomist
BYRON ALDER, B. S................................................................. Poultr yman
O. W. ISRAELSEN, Ph.D................................................................. Irrigation and Drainage
D. S. JENNINGS, Ph.D................................................................. Soils
R. L. HILL, Ph. D................................................................. Human Nutrition
I. M. HAWLEY, Ph. D................................................................. Entomologist
GEORGE B. CAINE, M. A............................................................... Dairy Husbandry
WILLARD GARDNER, Ph. D.......................................................... Physicist
B. L. RICHARDS, Ph.D................................................................. Botanist and Plant Pathologist
R. J. BECRAFT, M. S................................................................. Range Management
P. V. CARDON, B. S................................................................. Farm Economy
KENNETH C. IKELER, M. S............................................................ Animal Husbandman
CARRIE C. DOZIER, Ph.D............................................................. Home Economics
C. T. HIRST, M. S................................................................. Associate Chemist
E. G. CARTER, Dr. P.H............................................................... Associate Bacteriologist
D. W. PITTMAN, M. S............................................................... Associate Agronomist
M. D. THOMAS, A. B., B. S.......................................................... Associate Agronomist
H. J. PACK, Ph. D................................................................. Associate Entomologist
L. M. WINSOR, B. S................................................................. Associate in Irrigation and Drainage
A. F. BRACKEN, M. A............................................................... Assistant Agronomist
T. H. ABELL, M. S................................................................. Assistant Horticulturist
A. L. WILSON, B. S................................................................. Superintendent, Davis County Farm
L. F. NUFFER, M. S................................................................. Assistant Botanist
CHARLES J. SORENSON, B. S........................................................ Assistant Entomologist
GEORGE D. CLYDE, M. S........................................................... Assistant in Irrigation and Drainage
D. C. TINGEY, M. A................................................................. Assistant in Agronomy
ALMA ESPLIN, B. S................................................................. Assistant in Animal Husbandry
ALMEDA P. BROWN, B. S.......................................................... Assistant in Home Economics
PETE R NELSON, M. A................................................................. Farm Superintendent
J. R. BATEMAN, B. S................................................................. Superintendent, Panguitch Livestock Farm
GEORGE Q. BATEMAN, B. S........................................................ Superintendent, Dairy Farm
JOHN W. CARLSON, B. S............................................................ Superintendent, Alfa lfa-seed Experiment Farm, Uintah Basin

B LANCHE C. PITTMAN, A. B........................................................ Publications and Library
DAVID A. BURGOYNE, B. S........................................................ Secretary to the Director

*On leave of absence.
SEED-POTATO TREATMENT
For the Control of Four Common Diseases
Rhizoctonia (Stem Canker), Scab, Blackleg, Dry-Rot

By B. L. RICHARDS

TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction</td>
</tr>
<tr>
<td>Four Surface Tuber-borne Potato Diseases</td>
</tr>
<tr>
<td>Rhizoctonia (Stem Canker)</td>
</tr>
<tr>
<td>Common Scab</td>
</tr>
<tr>
<td>Blackleg</td>
</tr>
<tr>
<td>Dry-Rot</td>
</tr>
<tr>
<td>Control Measures</td>
</tr>
<tr>
<td>Corrosive Sublimate Treatment</td>
</tr>
<tr>
<td>Equipment for Treating with Corrosive Sublimate</td>
</tr>
<tr>
<td>Precautions to be Observed</td>
</tr>
<tr>
<td>Cold Formaldehyde Treatment</td>
</tr>
<tr>
<td>Improved or Hot Formaldehyde Treatment</td>
</tr>
<tr>
<td>Hot Formaldehyde a Practical Method</td>
</tr>
<tr>
<td>Advantages of Hot Formaldehyde Method</td>
</tr>
<tr>
<td>Precautions to be Observed in Use of Hot Formaldehyde</td>
</tr>
<tr>
<td>Other Helps in Disease Control</td>
</tr>
</tbody>
</table>

Potato diseases are a constant menace to the Utah potato crop. During the 4-year period from 1920 to 1924 losses sustained from disease averaged 19.5 per cent, or approximately one-fifth of the entire state crop. This means that every year a large percentage of the seed planted is useless and that one-fifth of every acre planted to potatoes is wasted. Again, labor in the way of planting and in cultivation is used to poor advantage, and finally the grower suffers a direct financial loss which frequently eats up his expected profit.

The potato is subject to more diseases than any other cultivated crop. At present scientists recognize upwards of twenty-three distinct potato diseases, ten of which are considered of serious economic importance. The other diseases are less severe in their attacks on the potato crop; however, under favorable conditions any one of these may definitely interfere with the production of high yields of first-quality potatoes. The greater number of these diseases are now present in Utah and exact their toll annually from the potato grower. Others are still on the outside ready to be introduced. Among these latter are some of the most deadly diseases known to affect plants. It is safe to estimate that fully one-half of the seed tubers planted each
spring carry some form of potato disease which may seriously impair the production power of the crop. Many of these maladies are caused by minute plant parasites, which, when once introduced into the soil, may grow and multiply there indefinitely. Certain of these disease-producing organisms are so persistent that the soil becomes permanently impaired for potato culture.

A number of these tuber-borne diseases (such as fusarium wilt, mosaic, and leafroll) are carried from year to year in the tissues of potato tubers. With others, however, the causal organisms overwinter in a dormant state on the surface of the tuber and are carried back to the soil at planting time. Seed treatment, when properly applied, frees the potato tuber from the organisms producing this latter group of diseases and effectively reduces the losses with relatively small expense to the grower.

Fig. 1.—Potato stem canker caused by Rhizoctonia. Four shoots have been cut off or the growing points completely destroyed by Rhizoctonia. The one large shoot is so injured that it will not push thru the soil. Note that it is practically severed near the base. Plants so injured seldom get thru the soil and are usually counted as "misses".
FOUR SURFACE TUBER-BORNE POTATO DISEASES

Rhizoctonia (stem canker), common scab, blackleg, and dry-rot belong to the surface tuber-borne group of diseases, and it is these with which the farmer is most concerned in seed treatment. All four are widespread and very destructive in Utah.

Fig. 2.—This potato field shows the danger to the crop from Rhizoctonia and also the advantages to be derived from seed treatment. All tubers used in planting the field were selected from the same seed lot and were equally covered with the sclerotia or resting bodies of Rhizoctonia. In the third row from the right the seed tubers were planted without treatment. For all other rows the seed was treated for different periods with mercuric chloride (1-1000). Numbering from the right, treatments were applied as follows: ROW 1, one-half hour; ROW 2, one hour; ROW 3, no treatment; ROW 4, one and one-half hours; ROW 5, two hours. Compared with Rows 1, 2, 4, and 5, Row 3 showed the following: No. of plants diseased, 80%; tubers showing sclerotia, 100%; decrease in stand, 16%; decrease in stems per hill, 26%; average decrease in number of tubers per hill, 20.7%; average decrease in yield per hill, 34%; total decrease in yield in row, 50.2%.

Similar results may be expected any year if tubers equally diseased are planted without treatment.

Rhizoctonia

Rhizoctonia (See Fig. 1) is probably the most common and one of the most destructive of all potato diseases. The fungus responsible for the trouble causes a dry rot of and may even destroy all underground parts of the potato plant—roots, stems, stolons, and young tubers. Under certain soil conditions, the fungus may even kill the plant before it pushes thru the soil.
Rhizoctonia decreases the stand, the number of stems to the hill, size and number of potatoes, and finally the total yield of the crop (See Fig. 2). In a cool soil, favorable to the development of Rhizoctonia this loss may be as high as 50 per cent of the total yield, especially if heavily-infested tubers are planted without treatment. The fungus grows luxuriantly in the soil, and toward autumn forms dirt-like specks (sclerotia) on the mature tubers which render them unsightly and frequently unsalable for seed. (See Cover Cut). It is these resting sclerotia of the fungus which germinate and rein­fest the soil when planted with the tuber the following season.

When once in the soil, Rhizoctonia persists indefi­nitely and not only attacks the potato but is found to cause disease on upwards of approximately 150 other plants, among which are a number of our most im­portant agricultural crops. This latter fact greatly complicates the problem of control and further em­phasizes the danger of in­troducing Rhizoctonia into the soil. Seed-potato treat­ment is the only safe method of preventing this introduction.

Common Scab

Scab (See Fig. 3) is readily recognized by the roughened and corky patches on the tuber. It is not so generally known, however, that this disease is produced by a minute fungus or a group of fungi which flourish on fresh manure and all forms of organic matter present in the soil. Experience has shown de­finitely that warm, dry soil, rich in organic matter, favors both the development of the scab organism and also the production of the disease on the young growing potato tubers.
Scab is rapidly increasing in Utah, especially in the intensive trucking districts where potatoes are grown for the early market. Numerous fields in these areas at present are so filled with the scab organisms that they are practically unfit for potato production. As the scab organisms live more or less indefinitely in the soil, fields so infested can be reclaimed for potato-growing only after years of careful rotation.

A scabby crop means a decreased profit to the grower, as diseased tubers are classed as culls by the dealer and are wholly undesirable for any culinary purpose. The organism which produces scab winters over and is carried from field to field on the tubers. Seed treatment is the only means of freeing the tuber of these organisms.

**Blackleg**

Blackleg (See Fig. 4) rots both the potato set and the young shoot and thereby seriously decreases the stand. In addition, it

---

**Fig. 4.** Young potato plants affected with blackleg. In the plant to the right the disease has progressed upward from the apex of the stem to within a short distance from the soil line. With plants so diseased the leaves seldom spread normally but remain upright, turn yellow, and die early. Complete rotting of the pith is shown in the plant to the left.
may destroy older plants and even rot the tubers either before or after maturing. In the early crops it is not uncommon to find from 2 to 20 per cent of the plants killed by the disease before the crop is matured. Blackleg is carried over winter in the decaying tubers and frequently on the surface of both healthy and diseased potatoes.

Fig. 5.—Tuber dry-rot. Under poor storage conditions heavy losses frequently occur. A. Tuber showing characteristic shrinking and wrinkling of the tuber surface. B. Longitudinal section of the same tuber. Tubers showing the slightest degree of dry-rot should be discarded both for seed and for shipping.

Dry-Rot

Dry-rot (See Fig. 5) is essentially a storage trouble, and under poor storage conditions a high percentage of the tubers are rotted while in the bin. The organisms producing this disease live in the soil and are carried to the cellar with the tubers and finally back to the soil again at planting time. Seed selection and seed treatment will help to prevent these organisms from being carried in great numbers back to the soil.
CONTROL MEASURES

Two chemicals, corrosive sublimate (at room or air temperature) and formaldehyde (raised to temperatures of from 121 to 125 degrees Fahrenheit) are at present employed with success as tuber disinfectants for the control of Rhizoctonia, scab, blackleg, and dry-rot.

Corrosive Sublimate Treatment

Corrosive sublimate (4 ounces of the chemical to 30 gallons of water) has proved the best disinfectant for the control of Rhizoctonia, under Utah conditions. It is also equally effective in killing scab and blackleg. For best results dormant potatoes are treated in this solution for one and a half hours. However, if the seed has commenced to sprout and is fairly free from Rhizoctonia and scab, the time of treatment may be reduced to one hour or even to one-half an hour. Only sound and uncut tubers should be treated and if possible before the sprouts are started. Experiments have shown that the corrosive sublimate, adhering to potato tuber after removal from the solution, continues to act on the potato tissues and may seriously damage the germinating power of the seed, especially if treated tubers are stored while wet in bulk or in sacks. To avoid this danger, treated tubers should be dried as rapidly as possible after treatment. This rapid drying has the added advantage of permitting the formation of a thin film of corrosive sublimate on the surface of the tuber, which further acts as a protection against disease. This protective film, while helpful, is not sufficient to prevent recontamination of the tuber by Rhizoctonia and scab. Under no conditions, therefore, should treated seed be placed in unsterilized sacks or bins previously used for potatoes.

It has been found helpful in starting the crop after treatment to place the treated tubers before cutting in clean crates or sacks and expose to subdued sunlight for a period of ten days to two weeks. This practice is especially advantageous with the early crops and particularly when some injury has resulted from treatment. Direct sunlight should be avoided as it endangers the vitality of the seed.

Corrosive sublimate solution loses strength with treatment; therefore, the original concentration should be maintained by the addition of one-half ounce of the chemical for every four or five bushels treated. However, if the time for treatment is decreased, the quantity of chemical necessary to keep up the strength must be proportionately reduced. For accurate work,
the original volume of water should be kept constant. Because of the rapid accumulation of dirt with continued treatment, it is well to discard the solution after the eighth or ninth treatment even tho the concentration of the solution is maintained by the suggested additions. Corrosive sublimate is not readily soluble in cold water; therefore, it is important to know that the chemical is thoroly dissolved before using. It is usually best to dissolve the chemical in about a gallon of hot water in a glass or earthen vessel and then add it to the measured quantity of water in the treating container.

![Barrels for treatment with corrosive sublimate. Barrels placed on a platform at a convenient height for transfer of liquid make good containers for treating potatoes. The number of barrels used will depend upon the number of potatoes to be treated and the help available. Five barrels make a good working unit for one man. Various devices may be employed in handling the potatoes. Burlap sacks should not be used. (Photograph, courtesy M. B. McKay. Oregon Agr. Exp. Sta. Cir. 24, Fig. 4)](image)

**Equipment For Treating With Corrosive Sublimate**

The long period of one and a half hours, necessary for effective control of Rhizoctonia with corrosive sublimate, has been offered as the principal objection to the method and in fact has prevented the establishment of seed treatment as a general practice in potato culture. The use of a sufficient number of barrels or of large wooden or cement tanks may overcome this objection. Five to seven barrels properly raised and adjusted for ease in the transfer of the solution has been found generally satisfactory (See Fig. 6). Likewise, wooden tanks of varying
sizes have also become very popular in certain potato-growing districts. Cement tanks (See Fig. 7) are equally valuable when properly reinforced during construction to prevent cracking. The tubers may be treated loose or in crates with either tanks or barrels. If crates are used they should be so constructed as to properly utilize the space of the treating structure.

![Cement tank for seed-potato treatment. A tank of the size shown here may be constructed of either wood or cement. Open bushel crates are very convenient for placing the tubers in the solution; however, such tanks are equally usable for treating the potatoes in bulk. When potatoes are treated loose it is best to employ a slanting board so placed in one end to make possible the use of a beet fork for removing the tubers after treatment. (Photograph, courtesy R. E. Vaughan, Wisconsin Agr. Exp. Sta. Bul. 331, Fig. 4)](image)

Precautions to Be Observed in Treating Seed Potatoes With Corrosive Sublimate

1.—Treating solutions must be maintained at full strength by proper addition of corrosive sublimate.

2.—It is absolutely necessary that all corrosive sublimate be dissolved before treatment.

3.—Treatment must continue the necessary length of time, as is indicated by the amount of disease and by degree of germination.

4.—Treated tubers must be dried as soon as possible after treatment. Drying inhibits injury from continued action of the
chemical and leaves a protective coat of corrosive sublimate on the tuber.

5.—Corrosive sublimate is a DEADLY POISON. Therefore, it should be kept away from children and all farm animals. It is dangerous if splashed or rubbed into the eyes.

6.—Unused treated tubers, if eaten, are dangerous to the health and probably to the life of all animals; therefore, they should be burned or buried.

7.—Wooden or cement containers should be used for treating. Corrosive sublimate rapidly corrodes and destroys metals.

8.—Tubers should be treated loose or in crates. Burlap sacks rapidly decrease the strength of the treating solution. If sacks are used, the same sacks should be used continuously so as to prevent the decrease in strength from the use of new sacks with each lot of potatoes.

Cold Formaldehyde Treatment

Formaldehyde at ordinary air or room temperatures (1 pint to 30 gallons of water) has been used widely as a tuber disinfectant. Recent investigations, however, show this method to be ineffective and unreliable for the control of either Rhizoctonia or scab. In fact, in most potato-growing sections the method has been discarded.

Improved or Hot Formaldehyde Treatment

The effectiveness of formaldehyde as a disinfectant increases rapidly with the rise of temperature. This fact has been used by Dr. I. E. Melhus of Iowa as a basis for a new method of seed-potato treatment. The process consists in treating uncut potatoes for three minutes in a solution of formaldehyde (1 pint to 15 gallons of water) held at a temperature between 121 and 125 degrees Fahrenheit (50 to 52 degrees Centigrade). After three minutes' exposure in the hot solution the tubers are removed, piled, and covered while warm for at least an hour. The seed is then dried and at the convenient time cut and planted.

Dr. Melhus suggests that small lots of potatoes can be treated in a common 15-gallon wash boiler or metal tub on an ordinary cook stove or open fire. If such methods are employed, adequate help must be available for immediate transfer of the vessel from or onto the heating device. Larger lots may be effectively treated in one-half of a 60- or 80-gallon hogshead in which is used some type of submerged heating unit, live steam from a tractor or from a nearby creamery. Large wooden or cement
tanks may be employed if heating conveniences are available for maintaining proper temperature.

The limitation of the method lies in lack of the proper heating devices on the farm for maintaining the desired temperatures. This handicap may be so great in certain districts as to render the method less desirable than the longer time-consuming corrosive sublimate treatment. In fact, in many districts of the United States farmers (because of this difficulty) have swung back to corrosive sublimate. A choice between the two methods, therefore, becomes a local problem. However, difficulties for any one district may be overcome by community cooperation, especially where creameries with live steam are available. Seedsmen may aid also in the solution of the problem by equipping for treatment on a large scale. The most serious objection to the hot formaldehyde method, if employed by the individual farmer, lies in the danger from overheating which injures the germinating powers of the tubers. On the other hand, too low a temperature (below 121 degrees Fahrenheit) is of little value, as it will not control the scab and Rhizoctonia.

Hot Formaldehyde a Practical Method

In Iowa and in various other parts of the United States the hot formaldehyde is reported equally effective with corrosive sublimate in controlling Rhizoctonia and scab. This has not been found to be the case, however, in Utah and in Wisconsin. Nevertheless, the method is sufficiently effective as to render it practical where facilities are available for proper application.

Advantages of the Hot Formaldehyde Treatment

1. The treating time is reduced from one and one-half hours to three minutes.

2. The treating solution does not lose strength with use; therefore, no addition of chemical is necessary.

3. Formaldehyde is less poisonous to human beings and other animals than corrosive sublimate and does not corrode metals.

4. Corrosive sublimate goes into solution with difficulty. This objection is obviated by the use of formaldehyde.

Precautions to Be Observed in Use of Hot Formaldehyde

1. In treatment, the solution must be maintained between the prescribed temperatures (121 to 125 degrees Fahrenheit). Below 121 degrees Fahrenheit the solution will not entirely con-
control the disease, and a solution which is too hot (above 125 degrees Fahrenheit) will injure potatoes. Accurate control of temperature within the specified limits is absolutely imperative.

2.—Only a reliable thermometer of mercury-bulb type should be used. Before using, this should be tested for accuracy.

3.—The quantity of solution should be maintained constant by replacements from reserve stock.

4.—Only such sources of heat as will allow of accurate control of the temperature of the treating solution should be employed.

OTHER HELPS IN DISEASE CONTROL

Seed treatment either with corrosive sublimate or hot formaldehyde kills the organisms which cause Rhizoctonia, scab, blackleg, and dry-rot before the tuber is planted, and if the soil is not previously infested both soil infection and disease of the resulting crop are thereby prevented.

It must be remembered, however, that tuber disinfection is only one means of potato-disease control and that no method of seed treatment will prevent infection from the disease organism present in the soil before the crop is planted; therefore, a proper system of crop rotation is absolutely essential as an aid in successfully combating the various disease described in this circular. Practice has demonstrated that it is inadvisable to grow potatoes on the same soil oftener than every third or fourth year, and where scab becomes serious a longer rotation is desirable.

Badly bruised, scabbed, cut, or decayed tubers under no circumstances should be used for seed as the disease-producing organisms lodge in such roughened areas and escape unharmed the process of seed treatment.

It is also well to discard tubers having very large or numerous sclerotia of Rhizoctonia. All tubers showing internal necrosis or browning should be discarded.

CLEAN POTATO SEED PLANTED IN CLEAN SOIL GIVES A CLEAN POTATO CROP!
# LIST OF AVAILABLE PUBLICATIONS

## BULLETINS

120—Chemical Composition of Crops as Affected by Different Quantities of Irrigation Water.
121—Soil of Southern Experiment Farm
122—Nature of Dry-farm Soils of Utah
124—Fruit Variety Tests on Southern Experiment Farm.
125—Chemical Milling and Baking Value of Utah Wheats.
128—Blooming Periods and Yields of Fruit in Relation to Minimum Temperatures.
132—Minor Dry-land Crops at Nephi Experiment Farm.
133—Irrigation and Manuring Studies, Pt. 1.
134—Nitric Nitrogen Content of Country Rock.
137—Quality of Home-grown Wheat vs. Imported Wheat.
138—How to Control Grasshoppers.
139—Movement of Soluble Salts with Soil Moisture.
140—Summer Pruning of a Young Bearing Apple Orchard.
141—Variation in Minimum Temperatures due to Topography of a Mountain Valley in Relation to Fruit-growing.
142—Irrigation of Peaches.
143—Irrigation of Sugar-beets.
144—Water Table Variations.
145—Soil Alkali Studies.
146—Irrigation of Wheat.
147—Alkali Content of Irrigation Waters.
150—Further Studies on Nitric Nitrogen Content of Country Rock.
151—Freezing of Fruit Trees.
152—Effect of Soil Moisture on Certain Factors in Wheat Production.
153—Selecting Dairy Bulls by Performance.
155—The Beet Leaf Hopper.
156—The Irrigation of Sugar-beets.
157—Irrigation of Potatoes.
158—Soil Moisture Studies under Dry-farming.
159—Soil Moisture Studies under Irrigation.
160—Important Factors in Operation of Irrigated Farms.
161—Orchard Heating.
163—Composition of Irrigation Waters of Utah.
165—Labor Costs and Seasonal Distribution of Labor in Irrigated Crops.
166—Climate of Utah.
167—Irrigation of Oats.
168—Relative Resistance of Various Crops to Alkali.
169—Use of Alkali Water for Irrigation.
178—Irrigation of Barley.
181—Irrigation Experiments in Sugar-beets.
184—Irrigation Experiments in Potatoes.
188—Irrigation Experiments in Potatoes.
188—Maintaining the Productivity of the Soil.
189—Ridding the Land of Wild Morning Glory.
190—Corn Silage in the Dairy Ration.
191—Oedipodinae of Utah (Technical).
193—Cache County Water Conservation District No. 1.
194—The Influence of Storage on the Composition of Flour (Technical).
CIRCULARS

8—Varieties of Fruit Recommended for Utah.
9—Pruning the Apple Orchard.
10—Control of Alfalfa Weevil.
12—Thinning Apples.
13—Fruit for Exhibition.
16—Better Seed.
17—Number and Distribution Licensed Stallions and Jacks, 1913.
18—Better Horses for Utah.
19—Licensed Stallions in Utah, 1915.
21—Dry-farming in Utah.
22—Some Sources of Potassium.
23—Seed Situation in Utah.
24—Licensed Stallions in Utah, 1916.
26—Storing Vegetables for Winter.
27—Licensed Stallions in Utah, 1917.
28—Contagious Abortion in Mares and Cows.
29—Control of Rodent Pests.
30—Codling Moth.
31—Alfalfa Weevil.
32—Feeding Farm Animals.
34—Sugar-beet Production in Utah.
35—Licensed Stallions in Utah, 1918.
37—Field Beans.
39—A Day at the Utah Agr. Exp. Station (contains complete List of Publications from 1890-1918, inclusive).
41—Soil Alkali.
44—Agriculture of Utah.
48—Rural Credits in Utah.
49—This Public Domain of Ours.
50—Feeding and Brooding Chicks.
51—Foot-and-Mouth Disease.
52—Rules and Regulations, First Intermountain Egg-Laying Contest.
54—The More Important Insects Injurious to the Sugar-beet in Utah.
57—Economy in Harvesting Sugar-beets.
58—Potato Production in Utah (Revision of Circular 40 now out of print).
59—Control of Stinking Smut of Wheat with Copper Carbonate.
60—Seed-Potato Treatment.

Address: Publications Division,
Utah Experiment Station,
Logan, Utah, U. S. A.