

RELATION OF CERTAIN PHYSICAL CHARACTERS OF
PHALARIS ARUNDINACEAE (REED CANARY GRASS)
SEED TO GERMINATION

by

HAROLD ETHAN FINNELL

A THESIS

submitted to the


OREGON STATE AGRICULTURAL COLLEGE

in partial fulfillment of
the requirements for the
degree of


MASTER OF SCIENCE

June 1936


APPROVED:



Professor of Farm Crops
In Charge of Major



Chairman of School Graduate Committee



Chairman of College Graduate Council

ACKNOWLEDGEMENTS

The writer wishes to express his deep appreciation to Professor G. R. Hyslop, Head of the Farm Crops Department, for making this study possible and for his many kindly suggestions and aid in correction of the manuscript. Acknowledgement is also due Mrs. Grace Cole Fleischman, Assistant Botanist, in charge of the Cooperative Seed Testing Laboratory at the Oregon State Agricultural College, for her many suggestions and loaning of equipment. The writer is exceedingly grateful to other persons responsible in any way for any part of this study.

CONTENTS

| | |
|------------------------------------------------|----|
| Introduction | 1 |
| Upland Reed Canary Grass | 2 |
| Historical Sketch | 3 |
| Problem | 5 |
| Purpose | 5 |
| Approach | 5 |
| Procedure | 6 |
| Weight per Bushel and Volume Weight Studies | 6 |
| Volume Weight Method | 7 |
| Color Examination | 7 |
| Seed Condition | 8 |
| Germination Method | 8 |
| Discussion | 9 |
| Oregon Certification Standards | 9 |
| Origin of Standards | 11 |
| Laboratory Procedure | 11 |
| Germination | 12 |
| Counts | 13 |
| Special Testing Methods | 14 |
| Color and Weight per Bushel Studies | 16 |
| Volume Weight Data | 19 |
| Germination Test | 21 |

Discussion (continued)

| | |
|------------------|----|
| Musty Seed | 27 |
| Average Analysis | 29 |
| Harvest Methods | 31 |
| Conclusion | 33 |
| Exhibit A | 34 |
| Exhibit B | 35 |
| Exhibit C | 36 |
| Bibliography | 37 |

RELATION OF CERTAIN PHYSICAL CHARACTERS OF
PHALARIS ARUNDINACEAE (REED CANARY GRASS)
SEED TO GERMINATION

Introduction

Throughout the years of commercial production of Reed Canary grass seed (Phalaris arundinaceae) in Oregon, controversies have arisen between growers and buyers because of misunderstandings on seed quality, particularly with reference to germination. Sometimes these differences of opinion were very real in that the seed actually received by the buyers was very low in germination. Cases are known in which the seed delivered was not comparable with the sample on which the sale was made. In other words, there were cases of actual misrepresentation. It is also noted that lack of uniformity in testing methods used in various laboratories does result in difference in the results obtained. These differences are sometimes far in excess of the tolerances considered within the limits of experimental error.

On some occasions the seed was not falsely represented, but due to qualities apparently related to certain physical characters, seemed to produce low germination tests. In the latter case, it is believed that growers could have improved the seed immensely by subjecting it either to more favorable conditions at harvest or by cleaning the seed.

more carefully after curing.

Threatened loss of market led to agitation on the part of buyers and growers for improved conditions. Definite Oregon standards for purity and germination for certified seed were established in 1934. Since that time, there have been definite standards that could be used as a basis for buying and selling this seed. Better and more uniform methods of germination testing would be helpful.

There are numerous very distinct variations in the ordinary population of Reed Canary grass. The plants differ in size, shape, color, leaf, stem, and head characters and of particular importance is the considerable variation in time of maturing seed. Reed Canary grass appears heterozygous. Because of this variation in the field and the fact that the plants do not ripen at the same time, there is a lack of uniformity in seed condition at harvest which directly affects the percentage of germination.

In 1922, H. A. Schoth* discovered a plant of this grass that appeared to be different from the ordinary Reed Canary grass. On further study it was learned that this strain, now called Upland Reed Canary grass, was adapted to more dry land conditions than the ordinary kind and that it spread less by underground runners. It proved to be a

*Agronomist, Division of Forage Crops and Diseases, Bureau of Plant Industry, United States Department of Agriculture, stationed at Corvallis, Oregon.

better seeder and did not shatter as much as the ordinary Reed Canary grass. This Upland Reed Canary grass has proved to be a pure strain in that all plants have very similar vegetative characteristics. The seeds also are more uniform as to size and color. Upland Reed Canary seed tends to be lighter in shade of color and in weight per bushel than the ordinary seed. However it has been grown under drier conditions than the ordinary grass. This fact that it has not been grown under the usual moist condition and therefore does not have the late moisture to fill seeds, may be the reason for its being lighter in weight. The seed matures quite uniformly so that this strain is easier to handle at harvest. Because of these desirable characteristics, growers that have such seed are able to harvest it with machinery.

Historical

Reed Canary grass is native to the temperate portions of Europe, Asia, Africa and North America. The forage value of this grass was first observed and referred to by Hesselgren in 1749 in a study of this and other grasses in Sweden (1). It has been grown as a forage crop in England since 1824, and in Germany since 1850 according to Piper (3). Along the Atlantic Coast it probably has been grown since shortly after its early use in Europe, but has attracted little attention in that region. In the Coast

sections of Oregon, Washington, and northern California, this grass is of considerable importance. In later years native and introduced stands have become commercially important in the northern Mississippi Valley, particularly in Minnesota and Iowa.

According to Schoth (5) it was first cultivated in Coos County, Oregon, in the Coquille Valley in 1885.

J. L. Smith, former County Agent in Coos County, Oregon, was the first grower to commercialize the handling of this seed in this state. Most of the early plantings of this seed in the Pacific Coast area and many introduced plantings of the Mississippi Valley can be traced to the first stands in the Coquille Valley. The production area has expanded rather rapidly so that now many areas in the North Pacific Coast and in the North Central states and in many sections of the Eastern United States that have suitable climatic conditions are raising this grass for forage and seed purposes.

The price that was formerly paid per pound of seed varied from \$1.00 to \$1.50. It has declined with increased seed harvest to about 25¢ per pound. This reduced price has been caused by the increase in seed production which has expanded faster than the demand. The total acreage of this grass in Oregon now is approximately 10,000 acres. About 200,000 pounds of seed were harvested in 1935. Much

of it was certified by the Oregon State Agricultural College.

Problem

The purpose of this study is to attempt to associate germinating power with certain readily usable physical characters in connection with certification and use of this seed that is gaining rapidly in commercial importance.

This problem was approached by observing and studying the following seed characters - weight, color, and seed condition.

Eight lots of seed that were different as to weight and color were selected. Weight per bushel tests were made in each lot with standard test weight equipment. Volume weight tests were determined on 15 c.c. of seed from many different lots.

Color determinations were made on the eight lots to determine the percentages of (a) dark grey or brown seeds, (b) light brown seeds, and (c) green colored seeds.

Seed condition was determined by ascertaining the odor of each sample. The presence of a musty odor as an indication of seed condition and the relationship of such seed condition to germination and volume weight were particularly observed.

Germination tests on 400 seeds selected without discrimination from each lot were completed. Checks through

reports and tests and examinations of the seed of identical samples kept on file in the Cooperative Seed Laboratory at the Oregon Agricultural Experiment Station were also made to show the effects of light weight and heavy seed on germination. Comparisons of the value of volume weight and seed color as an indicator of germination power as shown by official germination tests were also made.

Procedure

Weight per Bushel and Volume Weight Studies

All the bulk samples of Reed Canary grass seed of the 1935 crop that have been sent in to the college to have a purity and germination test made in connection with the college certification requirements were examined, and eight different lots of seed selected for this problem. In determining the test weight of this seed, the standard method of making the test weight per bushel as set up by the official grain standards of the United States (6) was followed with the following exception. A pint-sized kettle with its corresponding graduated beam was used instead of the standard quart-size kettle. This was necessary because of insufficient volume of seed to properly fill the quart-size kettle. The following conditions were particularly observed: approximately the same volume of seed was used in testing each lot; the seed was poured into a hopper with a round

opening exactly $1 \frac{1}{4}$ inches in diameter which was held exactly two inches above the center of the kettle; a hard wood stoker 12 inches long, $\frac{3}{8}$ inches thick and $1 \frac{3}{8}$ inches broad with rounded edges was placed lightly on the edge of the kettle with its sides held in a vertical position, then three full-length zigzag strokes were made across the kettle, striking off the excess seed. Throughout this process the kettle was not jarred in any way. After all these conditions had been met the kettle was weighed on the beam and the test weight recorded as in Table I.

Volume Weight Method

A volume weight method was devised and used. The samples were divided down by the Kny-Sheerer mechanical divider and 15 c.c. of seed from each group were measured out in a graduated cylinder. This volume was then weighed carefully on an accurate balance. These 15 c.c. volume weight tests were related to the standard test weights or weights per bushel as used in testing other seeds and grain and were made on the eight samples for comparison with samples too small for standard weight per bushel tests. The comparable figures are shown in Tables II and III.

Color Examination.

Eight lots of seed were examined and the percentages of different colored seeds in each lot were determined.

For this color examination, each sample was divided down with a Kny-Sheerer mechanical divider, so that a representative group of seeds could be examined; then an actual count was made without discrimination on 500 seeds and these were grouped as (a) dark brown and gray seeds (b) light brown seeds, and (c) green colored seeds. The color that is noted above is not in the seed itself but in the hull which surrounds the seed.

Seed Condition

The tabulated average purity reports of Reed Canary grass seed from 1930 to 1935 was studied to note the changes, if any, in the analysis over this period of years. The average germination from 1930 to 1935 was also examined. The musty seed reports for the 1935 crop were studied.

The effect of heating that resulted in the development of mustiness in the samples was observed. This condition was noted by a characteristic musty odor. The effect of such a seed condition on germination ability and volume weight can be observed in Table VIII.

Germination Method

From each of these eight lots 400 seeds were collected without discrimination to be used in the germination test. The medium used was a good grade of commercial absorbent cotton which was placed in petri dishes. This cotton was cut in 2 1/2 inch squares and each square placed

in the bottom of a petri dish. Each group of 400 seeds was divided into four parts of 100 seeds each; thus making four 100 seed tests. The germination reported was the average of the four 100 seed samples of each lot. The seeds were scattered on the cotton in the petri dishes so none were touching each other.

The cotton was then moistened with water and the top placed on each petri dish. They were placed in a germination chamber regulated to a temperature of 30 degrees Centigrade. The cotton was kept moist and tested every day for this point. These dishes were left in the chamber during all of each day and removed each night and left on a table in the testing room.

Counts on germination were made at the end of seven, fourteen, and twenty days. Only those seedlings that showed a growth of a plumule and some sign or evidence of root development were said to be germinated. The weak sprouts were not counted in these tests.

Discussion

Oregon Certification Standards

Oregon certified Reed Canary grass may now be certified in accordance with certain standards that include only tests for purity, seed condition, and germination. It is believed that the findings of this study may justify

the addition of certain other physical characters to the official standards for certification. The seed may now be tagged with three colors of tags which are shown in Exhibits A, B, and C.

The Blue tag grade, as can be seen from its analysis, is best. It may contain a minimum of 98% pure seed and 90% pure live seed. The pure live seed content is determined by multiplying the percentages of purity and germination together. It may have a maximum of 1% crop seeds. Only a trace of weed seeds is tolerated.

The Red tag grade differs from Blue tag seed only in that the minimum pure live seed content is 80% rather than 90%. In both these grades, Blue tag and Red tag, the seed must be sound (free from musty or damaged seed) and may not contain any noxious weed seeds.

Yellow tag, the lowest grade of certified seed recognized, has requirements that differ from the other two grades. A minimum of 95% pure seed, a minimum of 50% pure live seed, a maximum of 1% crop seed, and a trace of weed seed are tolerated. The presence of musty or otherwise damaged seed is allowed in this grade provided the germination and purity are within the minimum. This is the only grade of Oregon Certified Reed Canary grass seed in which musty seeds are tolerated.

Origin of Standards

After observing the procedure of certification of Reed Canary grass in other states, these standards for Oregon were established on the basis of the study of the actual analysis of the seed previously made in the Oregon Seed Testing Laboratory and to meet competitive conditions.

In accordance with the requirements for Reed Canary grass certification all seed to be certified must be sampled by a representative of the college. Samples representing individual bags are drawn and sent to the Seed Certification service for examination and grouping into lots for testing. For example a grower may have 300 bags of seed weighing approximately 100 lbs. each. The individual envelop samples representing each bag are examined and compared. Composite samples are prepared by grouping individual samples that are closely similar. The composite samples are carefully labelled and turned over to the Cooperative Seed Testing Laboratory for analysis.

Laboratory Procedure

The first step in the seed testing laboratory is the assigning of a laboratory number and the preparation of the record card for the sample. The sample is then divided down on a Kny-Sheerer mechanical divider until approximately two grams remain. The entire examination is made on this two gram sample. It is put into a standard

vertical air-blast separator and blown to remove light and chaffy material. The amount of blowing depends on the needs of the particular sample and is done at the discretion of the analyst. Each blowing is tabulated and kept separate. The amount of weed seeds, inert matter, and crop seeds are figured by adding up the percentages of each contained in the various blowings. The chief reason for blowing a sample is that an analysis can be made much more quickly and more accurately by this method.

The procedure in analysis is to start with the best seed first and separate the lot into pure seed, inert matter, weed seeds, and crop seeds.

Inert matter is made up of dirt, pieces of stems, chaff and broken seeds (one-half or less in size). It is weighed and the percentage calculated and these figures with the character of the material are written on the record card. Weed seeds are those classified as such. Crop seeds are seeds of recognized crops other than Reed Canary grass seed. The total amounts of weed seeds and crop seed are weighed and the percentages of each are recorded on the report. Small numbers of the individual species are counted and listed as so many per pound of seed.

Germination

Four hundred seeds are selected without discrimination from the pure seed separation (blown sample) to be

used in the germination test. The medium used is a good grade of commercial absorbent cotton. This cotton is cut in 2 1/2 inch squares and each square is placed in a petri dish moistened with water. After gently squeezing each piece of cotton, the excess water is poured off. The seeds are then scattered at a rate of 100 per dish on the cotton so that none are touching each other. The top is placed on each petri dish, then they are placed in the germinator and subjected to standard germinating temperatures. The tests are left for about six hours in the germination chamber which is held at a temperature of 30 degrees Centigrade. Then they are removed at night and left in the testing room at a temperature of approximately 20 degrees Centigrade. These tests are checked each day to see if there is need for more water.

Counts

At least two germination counts (the maximum and final) are made. Only those seeds that show signs of root and plumule development are said to be germinated. Very weak and defective seedlings are not counted as germinated. The best samples that germinate 90 per cent or better can have a first count at the end of five days, and the final count about the tenth day. For samples that are slow to germinate, the first count is usually made on the ninth or tenth day and the last count about the twenty-first day.

Reed Canary grass seed seems to have a dormant period for a short time following harvesting and samples that are tested early in the season are a little slower in germinating. Some embryos of certain seeds have to go through a series of chemical changes before any growth can start. For testing such seeds, special equipment and methods have to be used to bring them out of this dormancy.

Special Testing Methods

Chemically treated blotters purchased from the Federal Seed Testing Laboratory at Washington, D. C. are used for the most satisfactory germination tests with other grasses as follows: Meadow fescue, (Festuca elatior), Smooth brome (Bromus inermis), English Rye Grass (Lolium perenne), Orchard Grass (Dactylis glomerata), Sudan Grass (Andropogon sorghum sudanensis), and Crested Wheat Grass (Agropyron cristatum). Paper towel discs placed four thicknesses in a petri dish may be used for germination test on Reed Canary seed also. In testing the smaller seeds, as the blue grasses and bent grasses, a better test can be made with petri dishes and cotton. For these smaller seeds, the cotton is more satisfactory than the paper towels in that it takes up the moisture and holds it so that the seed is not kept too wet. In all, it makes a more desirable seed bed. It appears that aeration is better with the cotton substratum than with the paper towel substratum, the

latter becoming excessively water-soaked in a test of many days duration. In some laboratories the equipment is so arranged that a soil test can be taken along with other germination tests. In all cases this soil test is considered final.

In germination tests made in the seed laboratory at Washington, D. C. the seeds are placed in a large daylight germinator. This is a large glass case in which are numerous shelves and a heating unit on the inside that keeps the temperature constant. Also, there is a free water surface pan to keep up the humidity, so the samples will not dry out. All the tests placed in the germinator are exposed to the daylight for given periods of time.

Sometimes the analyst has to use special treatments to break the dormancy of some seeds. Soaking the seeds in water or other solutions for different lengths of time is one method quite often used. Beet seeds are usually soaked in water for a time to make them germinate more quickly. A dilute solution of potassium nitrate is especially used in connection with the germination of Bermuda grass (Capriola dactylon). Sometimes it is necessary to pre-chill the seeds by means of refrigeration. Often, lettuce seed is handled in this way to break dormancy and stimulate more prompt germination. Occasionally the drying of seed by heat is used. This method is particularly practiced

with New Zealand spinach seed. Soaking lettuce seeds in water for a short time and then exposing them to direct sunlight for a few minutes is another method that is successfully used. In the case of the hard seeds of Sesbania macrocarpa, "wild hemp," the pouring of boiling water on the seed brings out the germination more satisfactorily than just soaking in paper towels.

W. L. Goss*, Seed Supervisor of the State Seed Laboratory at Sacramento, California, uses many of the methods and treatments discussed above. With Canada bluegrass, (Poa compressa) he used petri dishes and absorbent cotton moistened with a .02 per cent potassium nitrate solution. Meadow fescue, Chewings fescue, English rye grass, and Orchard grass, are tested between the folds of moist blotting paper at the alternating temperatures of 30 degrees Centigrade during the day and 20 degrees Centigrade at night. Reed Canary grass is tested by either of the two methods with approximately equal success--absorbent cotton in petri dishes and Bell jars.

Color and Weight per Bushel Studies

Examination of Table I on groupings of the lots of seed as to color shows that there was a significant difference in the percentage of dark and light seeds in

*Taken from a letter received from W. L. Goss.

TABLE I

THE RELATION BETWEEN COLOR OF REED CANARY
GRASS SEED AND THE WEIGHT PER BUSHEL

| Sample No. | Color Examination | | | Weight per bushel Lbs. | Seed Description |
|---------------|--------------------|-----------------------------|---------------------------|---------------------------------|-------------------------------------------------------------------------------------------|
| | Green seed % | Light brown seed % | Dark grey seed % | | |
| 49514 | 4 | 4 | 92 | 33.0 | Plump dark grey seeds, few brown and light colored seeds. |
| 49729 | 2 | 9 | 89 | 32.5 | Dark fairly plump, grey and brown seeds, few light colored seeds. |
| 48882 | 4 | 9 | 87 | 32.0 | Dark grey fairly plump seeds, more light colored and green seeds than No. 49729. |
| 48629 | 3 | 15 | 82 | 31.5 | Plump grey seeds, many light colored seeds. |
| 49605 | 6 | 16 | 78 | 31.0 | Plump grey seeds, a few more light colored seeds than No. 49629. |
| 49519 | 2 | 16 | 82 | 30.0 | Plump grey seeds, many brown and light seeds. Musty odor. |
| 48608 | 4 | 16 | 80 | 29.5 | Small light grey and brown seeds, many light colored seeds. |
| 49601 | 15 | 65 | 20 | - | Few dark colored seeds, many green and light colored seeds. |

different lots. In comparing this data with the test weight or weight per bushel figures, the samples that had the larger percentages of dark-colored seed had also the higher test weight. As the percentage of light-colored seed increased the test weights were lowered. In the case of sample No. 49601, there was not enough seed available to take a test weight, however, in comparison with the other samples, No. 49601 had the highest percentages of green and light-colored seeds and also the lowest percentage of dark grey seeds. Careful observations of the seed itself lead to the conclusion that it was very light in weight and that had there been sufficient seed the test weight would have been much below that of the others.

The seed in the other lots observed weighed from 29.5 to 33.0 pounds per bushel. According to work done at the University of Minnesota Agricultural Experiment Station by Arny, Hanson, Hodgson, and Nesom (2) the weight per bushel for the 1928 crop of this seed varied from 33 to 36 pounds. Piper, in his bulletin on cultivated grasses (4), said that the seed weighs from 44 to 48 pounds per bushel. This figure was very high and must have been an estimate or if based on actual trial, must have been on an exceptionally good lot of seed. The weight per bushel will vary from season to season and as to the plumpness

and maturity of the seed when harvested.

Volume Weight Data

Table II shows that 15 c.c. of each of the eight samples with less than 80 per cent germination, weighed less than 6.0 grams. Sample No. 49601 with 23 per cent germination had a volume weight of 3.735 grams; this one was the lightest of the group.

TABLE II
COMPARISON OF THE WEIGHT IN GRAMS OF 15 c.c. OF
SEED AND THE WEIGHT PER BUSHEL AND THEIR
RELATION TO GERMINATION

| Sample No. | Weight of 15 c.c. gms. | Weight per bushel lbs. | Germination % |
|------------|---------------------------|---------------------------|------------------|
| 49601 | 3.735 | - | 23 |
| 49519 | 5.526 | 30.0 | 67 |
| 48608 | 5.663 | 29.5 | 70 |
| 49605 | 5.945 | 31.0 | 86 |
| 48629 | 6.011 | 31.5 | 84 |
| 49729 | 6.188 | 32.5 | 90 |
| 48882 | 6.292 | 32.0 | 88 |
| 49514 | 6.329 | 33.0 | 93 |

It can be observed in Table III on volume weight of some other samples of 1935 seed that all the weights of 15 c.c. of seed were below 6.0 grams. The percentages of germination on all these samples were below 70; in most

TABLE III

RELATION OF VOLUME WEIGHT TO THE PERCENTAGE OF
GERMINATION AS DETERMINED BY THE SEED LABORATORY

| Sample No. | Germination % | Weight of 15 c.c. gms. |
|---------------|------------------|---------------------------|
| 48464 | 56 | 3.927 |
| 48383 | 26 | 4.633 |
| 49518 | 40 | 4.778 |
| 47730 | 41 | 5.036 |
| 47893 | 53 | 5.196 |
| 47731 | 57 | 5.390 |
| 47732 | 39 | 5.401 |
| 49431 | 67 | 5.618 |
| 47727 | 44 | 5.655 |
| 47695 | 30 | 5.659 |
| 47867 | 47 | 5.666 |
| 49520 | 67 | 5.769 |
| 49536 | 61 | 5.838 |
| 49605 | 58* | 5.876 |

*The writer secured 86% germination on this sample.

cases because of the presence of light, immature seed. Each sample was measured out and weighed according to the volume weight method. Reed Canary grass seed was not certified by the Oregon State Agricultural College in 1932

and the presence of musty seed was not recorded on the record cards. Much musty seed was observed that year and a number of the samples received were in a musty condition. Because of the low germination percentage and the rather high volume weight obtained it is believed that the musty condition reduced germination. Most of the samples that had weighed at least 6 grams showed a germination of 90 per cent or more.

On observing Tables II, III, and IV* showing volume weight in all the data obtained the samples that weighed 6 grams for 15 c.c. had close to 90 per cent germination or better. There were a few figures that did not check on the above statement because of the presence of seed damaged in handling or storage to the extent that it had become musty.

Germination Test

The samples showing the fastest and the best germination were those which had the higher percentages of dark colored seed in them. The average total germination figures in Table V show that the data obtained in this problem check closely with the results obtained in the seed testing laboratory. Considerable variation in the percentage of germination may occur in samples tested at different periods. This point is plainly demonstrated in

*The data in Table IV were compiled in 1932 by Marjorie Masters, an analyst in the Cooperative Seed Testing Laboratory.

TABLE IV
RELATION OF WEIGHT IN GRAMS OF 15 c.c. OF SEED
AND THE GERMINATION PERCENTAGE ON SAMPLES OF
THE 1932 CROP OF REED CANARY GRASS SEED

| Sample No. | Germination % | Weight of 15 c.c. gms. |
|---------------|------------------|---------------------------|
| 37772 | 38.25 | 3.040 |
| 37901 | 84.50 | 4.265 |
| 37898 | 70.50 | 4.820 |
| 37430 | 90.25 | 5.035 |
| 38044 | 75.00 | 5.135 |
| 37974 | 77.75 | 5.295 |
| 38080 | 82.25 | 5.300 |
| 37524 | 90.50 | 5.345 |
| 38527 | 83.50 | 5.370 |
| 37417 | 78.50 | 5.460 |
| 37964 | 81.75 | 5.590 |
| 37771 | 94.00 | 5.705 |
| 37426 | 22.00 | 5.725 |
| 38045 | 84.00 | 5.730 |
| 38360 | 87.50 | 5.760 |
| 37428 | 2.00 | 5.840 |
| 37776 | 89.25 | 5.845 |
| 37527 | 85.00 | 5.945 |
| 38229 | 96.50 | 5.980 |
| 37900 | 92.25 | 6.000 |

TABLE IV CONTINUED

| Sample No. | Germination % | Weight of 15 c.c. gms. |
|---------------|------------------|---------------------------|
| 37541 | 89.50 | 6.015 |
| 37542 | 91.00 | 6.075 |
| 37973 | 93.25 | 6.160 |
| 37509 | 98.25 | 6.170 |
| 37902 | 83.75 | 6.175 |
| 38490 | 90.75 | 6.175 |
| 37899 | 97.25 | 6.220 |
| 38541 | 84.25 | 6.230 |
| 38237 | 94.25 | 6.260 |
| 37739 | 92.75 | 6.330 |
| 37863 | 96.50 | 6.445 |

The general trend in the above table is toward a higher percentage of germination for the heavier seed. However, there are some striking exceptions probably due to musty seed of which there were many samples but none of which were noted for that year.

TABLE V

SHOWING THE EXTENT OF GERMINATION AT THE END OF CERTAIN PERIODS
ON 4 REPLICATIONS OF 100 SEED SAMPLES FROM 8 LOTS OF REED CANARY GRASS SEED

| Percent of Germination | | | | | | | | | | | | | | | | | |
|------------------------|--------|----|----|----|---------|---|---|---|---------|---|---|---|-------|----|----|----|---------|
| Sample | 7 Days | | | | 14 Days | | | | 20 Days | | | | Total | | | | Average |
| No. | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 | |
| 49514 | 85 | 88 | 90 | 86 | 2 | 4 | 5 | 4 | 1 | 2 | - | 2 | 88 | 94 | 95 | 92 | 93 |
| 49729 | 82 | 82 | 82 | 83 | 10 | 5 | 9 | 4 | - | 1 | 1 | - | 92 | 88 | 92 | 87 | 90 |
| 48882 | 80 | 81 | 80 | 84 | 6 | 8 | 5 | 3 | 2 | - | 1 | - | 88 | 89 | 86 | 87 | 88 |
| 49605 | 82 | 79 | 83 | 83 | 5 | 5 | 3 | 2 | - | - | 1 | - | 87 | 84 | 87 | 85 | 86 |
| 48629 | 74 | 81 | 86 | 77 | 4 | 2 | 4 | 4 | 1 | 2 | - | - | 79 | 85 | 90 | 81 | 84 |
| 48608 | 65 | 60 | 66 | 60 | 5 | 9 | 6 | 3 | 2 | - | 4 | - | 72 | 69 | 76 | 63 | 70 |
| 49519 | 50 | 66 | 53 | 67 | 13 | 5 | 8 | 6 | 3 | - | - | 4 | 66 | 71 | 61 | 71 | 67 |
| 49601 | 11 | 21 | 19 | 15 | 6 | 2 | 6 | 4 | 1 | 2 | 3 | - | 18 | 25 | 28 | 19 | 23 |

Table VI in the percentages of germination obtained on sample No. 49605. Table VI shows that in most cases the figures obtained by the analyst were slightly higher which probably is due to the fact that the seed used by the testing laboratory had been blown to get the extremely light seed out, and a germination test made on the seed left. However, in this problem the seed used was not selected from blown seed but after dividing the samples down the seeds were counted out without discrimination. Selecting a test in this way would be a little more true to that obtained in the field because the grower in planting does not discriminate against certain seeds in a sack but plants it as is.

In these results on germination, the lot that had the highest percentage of light-colored seed gave the lowest test. Most of the seeds in that particular sample were harvested too immature. Simple cleaning or blowing out of certain immature seeds will produce a better lot of seed and the test can be raised considerably. Sample No. 49519 had next to the lowest percentage of germination. This sample was subjected to unfavorable drying conditions after harvest, thus causing it to heat and develop mustiness and mold. As can be observed, such treatment results in a lower germination. Such conditions, if allowed to go to the extreme, will cause the germination to be very low, even as low as two per cent.

TABLE VI

SHOWING THE WEIGHT PER BUSHEL, VOLUME WEIGHT, PERCENTAGES OF DIFFERENT COLORED SEEDS FOUND IN EACH OF THE 8 LOTS OF REED CANARY GRASS SEED AND A COMPARISON OF THE PERCENTAGES OF GERMINATION AS DETERMINED BY THE SEED ANALYST WITH THOSE OBTAINED IN THIS STUDY

| Sample No. | Weight per bushel lbs. | Weight of 15 c.c. gms. | Germination | | Color Examination | | |
|------------|------------------------|------------------------|-------------|-------------------|--------------------|--------------------|------------------|
| | | | By author % | By seed analyst % | Light green seed % | Light brown seed % | Dark grey seed % |
| 49514 | 33.0 | 6.329 | 93 | 95 | 4 | 4 | 92 |
| 49729 | 32.5 | 6.188 | 90 | 94 | 2 | 9 | 89 |
| 48882 | 32.0 | 6.292 | 88 | 90 | 4 | 9 | 87 |
| 48629 | 31.5 | 6.011 | 84 | 87 | 3 | 15 | 82 |
| 49605 | 31.0 | 5.945 | 86 | 58 | 6 | 16 | 78 |
| 49519* | 30.0 | 5.526 | 67 | 69 | 2 | 16 | 82 |
| 48608 | 29.5 | 5.663 | 70 | 79 | 4 | 16 | 80 |
| 49601** | - | 3.735 | 23 | 23 | 15 | 65 | 20 |

*Musty seed

**The sample of seed was not large enough to take a test weight.

The data obtained from the volume weight and germination test showed that there was a relationship between these two and that this should be considered in the certification of this seed.

The germination of seeds of various grades of color as listed in Table VII was observed by Arny, Hanson, Hodgson, and Nesom (2) at the University of Minnesota, Agricultural Experiment Station. Their data showed that the percentage of germination of seeds that were entirely green or with only a trace of green in the hulls was much less than that of the dark mature seeds. Also, the weight of 1000 seeds of the dark seed samples was approximately twice as much as the weight of 1000 seeds of the green samples. Their data tend to corroborate the data in Table VI as in both cases significantly higher germination was obtained in those samples that had a larger percentage of dark colored seeds. It is also striking that in both cases the weights of the samples decreased as the percentages of light seed increased.

Musty Seed

At the time of harvest, the water content of the seed and panicles is often rather high. Care must therefore be taken in the handling of this product to avoid heating and mustiness or molding. If this point is not watched closely, germination is frequently lowered considerably. After cutting, this material is spread on a drying canvas

TABLE VII

SHOWING THE EFFECT OF COLOR OF REED CANARY GRASS SEED ON THE WEIGHT OF 1000 SEEDS AND THE GERMINATION PERCENTAGE

| Color of hulls | Weight per 1,000 seeds | Germina- tion in 16 days |
|-----------------------------------|---------------------------|--------------------------------|
| | gms. | % |
| Entirely grey or brown | 0.865 | 91.0 |
| Down to 75 per cent grey or brown | 0.775 | 83.5 |
| Down to 50 per cent grey or brown | 0.691 | 83.0 |
| Down to trace grey or brown | 0.574 | 72.5 |
| Entirely green | 0.452 | 51.5 |
| Trace of green | 0.358 | 36.5 |

or floor to cure. It is very necessary to stir the cut heads frequently (at least daily) so they can dry without heating unduly and without development of mustiness or mold.

In Table VIII this problem of moldy and musty seed affecting germination is brought out quite plainly. All this seed came to the laboratory with a distinct musty odor. The germination test on each was below that of the better samples observed, just because of the improper care during the drying or storage of the seed. This Table shows that the volume weights of musty seed do not have as close a correlation to the percentage of germination as the weights of the non-musty seed. These live seeds were

slower in germinating but the germination of the sample did not continue for as many days. Test Nos. 48331, 48332, and 48342 were counted on the thirteenth day. They were checked again on the 21st day, but no additional germination was observed. The other tests had final counts made

TABLE VIII

RELATION OF VOLUME WEIGHT OF MUSTY SEED TO PERCENTAGE
OF GERMINATION AND LENGTH OF TEST

| Sample No. | Weight of 15 c.c. gms. | Germination % | Length of Test days |
|---------------|---------------------------|------------------|------------------------|
| 48342 | 5.314 | 35 | 21 |
| 48332 | 5.409 | 28 | 21 |
| 48331 | 5.459 | 33 | 21 |
| 49533 | 5.507 | 76 | 16 |
| 49519 | 5.526 | 69 | 17 |
| 49532 | 5.670 | 74 | 16 |
| 48406 | 5.990 | 40 | 14 |

as listed in the Table. It was not necessary to carry these for 21 days as the germination was complete by the end of the time indicated in the final count. These results are very significant in that they show the effect of musty seed on volume weight and the disastrous effects on the germinating power of the seed.

Average Analysis

The average analysis of this seed from 1930 to 1935,

inclusive in Tables IX and X show that the purity and germination tests varied somewhat from year to year. In fact, considering only the averages one year, the 1932-33 crop showed reasonably fair seed, and would have been capable of making red tag. All the others were too low in pure live seed content and made only yellow tag seed. This Table was prepared under the direction of the Farm Crops Department. In the early stages, the germination was seriously affected by unthreshed seed heating in a pile

TABLE IX

REED CANARY GRASS

Average Percentage of Purity of Years

1930-31 - 1934-35, and July 1-Dec. 13, 1935

| Year | No. of Samples | Ave. % Pure Seed | Ave. % Crop Seed | Ave. % Inert Matter | Ave. % Weed Seed |
|-----------|-------------------|---------------------|---------------------|------------------------|---------------------|
| 1930-1931 | 9 | 95.81 | 0.104 | 4.077 | 0.011 |
| 1931-1932 | 32 | 97.853 | 0.174 | 1.923 | 0.0506 |
| 1932-1933 | 34 | 98.065 | 0.0809 | 1.817 | 0.039 |
| 1933-1934 | 41 | 97.501 | 0.036 | 2.465 | 0.048 |
| 1934-1935 | 143 | 95.646 | 0.315 | 4.002 | 0.0397 |
| 1935- | 103 | 98.033 | 0.0774 | 1.8544 | 0.03495 |

after cutting; now with nearly everyone familiar with the problem, the germination is principally affected most by the failure to clean out enough of the lighter seed after harvesting.

Seed that has a 99 per cent purity to make a Blue tag grade must have at least 91 per cent germination and to make Red tag grade at least 81 per cent germination. If the sample has 98 per cent purity, it must have a minimum of 92 per cent germination to make the Blue tag grade and 82 per cent germination to make the Red tag grade. If the purity is below 98 per cent and over 95 per cent the seed

TABLE X

REED CANARY GRASS

Average Percentage of Germination of Years
1930-31 - 1934-35, and July 1-Dec. 13, 1935

| Year | No. of Samples | Av. % of Germination |
|-----------|----------------|----------------------|
| 1930-1931 | 9 | 73.555 |
| 1931-1932 | 145 | 54.74 |
| 1932-1933 | 72 | 82.507 |
| 1933-1934 | 69 | 70.80 |
| 1934-1935 | 156 | 79.48 |
| 1935- | 108 | 74.944 |

falls into the Yellow tag grade providing the pure live seed content is at least 50 per cent.

Harvest Methods

Most of the Oregon crop of Reed Canary grass seed is harvested by hand and because of the fact that it shatters rather easily it must be harvested at rather an

immature stage. The seeding habits of this plant make it difficult to harvest large acreages by this method. The seed matures first at the tip of the panicle and it just takes a few days before the panicle is fully ripened and shattering. Because of this point the crop must be watched rather closely during the season of ripening. At the time of harvest the panicles are cut off at the base or stripped, then put in tight cloth bags which are suspended over the picker's neck, of pickers on foot, or from the saddle of those who ride. The contents of the filled bags are usually emptied on a canvas in the open air or under cover or on the barn floor to dry. During this drying process the seed must be stirred often because it must dry without heating unduly or it will develop mustiness and mold. As soon as the panicles are dry, the seed can be threshed out with a flail or a thresher. The panicles and straw are taken out and the seed is further dried prior to cleaning.

In some sections of Minnesota the panicles are cut by machines and threshed in a threshing machine. Such a method usually results in a germination that is low because of excessive threshing injury to the seed.

A method used on small patches of this grass for individual use consists of shaking the panicles over a pan during the ripening period every day. This method can just be used on a small scale.

Conclusion

The following things have been observed in the relation of certain physical characters of Reed Canary grass seed to germination.

1. As the percentage of dark seed increased, the weight per bushel increased, and as the percentage of light and brown seed increased, the weight per bushel decreased.

2. The germination ability varied directly with the per cent of dark seed except as affected by mustiness.

3. The effect of heating of the seed that resulted in mustiness and mold caused a significant decrease in the germinating power of the seed.

4. A correlation was calculated by Pearson's formula, ungrouped method, on the 1935 data given in Tables II and III. A correlation of $r = .701 \pm .073$ was found between the volume weight of 15 c.c. of seed and the percent of germination.

5. These data indicate that some application of volume weight, or test weight method should be used in the certification procedure.

6. Early studies and records showed that germination was seriously affected by conditions that resulted in mustiness in the seed.

7. Since handling methods have been generally improved to avoid mustiness, germination is affected most now by the failure to clean out the light colored and light weight seed properly in the cleaning process.

EXHIBIT A

OREGON CERTIFIED
REED CANARY GRASS or PHALARIS
Phalaris arundinaceae


Oregon Certified Reed Canary grass may be tagged with three colors of tags:

(1) Blue tag, certified or top grade seed, is sound and may contain a minimum of 98% pure seed and 90% pure live seed, a maximum of 1% crop seed and not more than a trace of weed seeds;

(2) Red tag seed is sound and may contain a minimum of 98% pure seed, and 80% pure live seed, a maximum of 1% of crop seed and not more than a trace of weed seed;

(3) Yellow tag seed may contain a minimum of 95% pure seed and 50% pure live seed, a maximum of 1% crop seed, and not more than a trace of weed seed. Yellow tag seed may be musty.

A statement of purity, germination and condition is shown on each tag. No noxious weeds are permitted in any grade.

| | | | | | | | | | | | | | | | | | | | | | | | | |
|---------------------------------------------------------------------------------------------------|------------|------|-----------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|------------|-----------------|--------|-----------------|--------|------------|--|--------------------|--------|------------------|--------|-------------------|--------|-------|-------|-------|-------|-----------------|-------|
| Sealed  | 1006 | Crop | Inspector | <p>Oregon Certified Reed Canary seed is harvested from well established stands. Each bag of each grower-lot is sampled, examined, tested, sealed and tagged with a numbered temporary tag by a representative of the Oregon State Agricultural College. Samples of similar quality from each lot are segregated into groups. A composite sample representative of each group is prepared. It is tested at the Experiment Station Seed Laboratory, and if the test proves it to be up to the standard each sealed bag comprising the group is tagged with a permanent certification tag which indicates the grade of each group and the analysis of the composite sample representing it.</p> <p>The analysis of the official composite sample is as follows:</p> <table border="0" style="width: 100%;"> <tr> <td>Test No.</td> <td>Date</td> </tr> <tr> <td>Pure seed</td> <td>.....%</td> </tr> <tr> <td>Crop seed</td> <td>.....%</td> </tr> <tr> <td>Kind</td> <td></td> </tr> <tr> <td>Inert matter</td> <td>.....%</td> </tr> <tr> <td>Weed seeds</td> <td>.....%</td> </tr> <tr> <td>Germination</td> <td>.....%</td> </tr> <tr> <td>.....</td> <td>.....</td> </tr> <tr> <td>.....</td> <td>.....</td> </tr> <tr> <td>Condition</td> <td>.....</td> </tr> </table> | Test No. | Date | Pure seed |% | Crop seed |% | Kind | | Inert matter |% | Weed seeds |% | Germination |% | | | | | Condition | |
| Test No. | Date | | | | | | | | | | | | | | | | | | | | | | | |
| Pure seed |% | | | | | | | | | | | | | | | | | | | | | | | |
| Crop seed |% | | | | | | | | | | | | | | | | | | | | | | | |
| Kind | | | | | | | | | | | | | | | | | | | | | | | | |
| Inert matter |% | | | | | | | | | | | | | | | | | | | | | | | |
| Weed seeds |% | | | | | | | | | | | | | | | | | | | | | | | |
| Germination |% | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | |
| Condition | | | | | | | | | | | | | | | | | | | | | | | | |

SAMPLES OF BLUE TAGS FOR OREGON CERTIFIED REED CANARY GRASS

EXHIBIT B

OREGON CERTIFIED
REED CANARY GRASS or PHALARIS
Phalaris arundinaceae

Oregon Certified Reed Canary grass may be tagged with three colors of tags:

(1) Blue tag, certified or top grade seed, is sound and may contain a minimum of 98% pure seed and 90% pure live seed, a maximum of 1% crop seed and not more than a trace of weed seeds;

(2) Red tag seed is sound and may contain a minimum of 98% pure seed, and 80% pure live seed, a maximum of 1% of crop seed and not more than a trace of weed seed;

(3) Yellow tag seed may contain a minimum of 95% pure seed and 50% pure live seed, a maximum of 1% crop seed, and not more than a trace of weed seed. Yellow tag seed may be musty.

A statement of purity, germination and condition is shown on each tag. No noxious weeds are permitted in any grade.

841

Sealed

Crop

Inspector

Oregon Certified Reed Canary seed is harvested from well established stands. Each bag of each grower-lot is sampled, examined, tested, sealed and tagged with a numbered temporary tag by a representative of the Oregon State Agricultural College. Samples of similar quality from each lot are segregated into groups. A composite sample representative of each group is prepared. It is tested at the Experiment Station Seed Laboratory, and if the test proves it to be up to the standard each sealed bag comprising the group is tagged with a permanent certification tag which indicates the grade of each group and the analysis of the composite sample representing it.

The analysis of the official composite sample is as follows:

| | |
|--------------------|------------|
| Test No. | Date |
| Pure seed | % |
| Crop seed | % |
| Kind | |
| Inert matter | % |
| Weed seeds | % |
| Germination | % |
| Condition | |

SAMPLES OF RED TAGS FOR OREGON CERTIFIED REED CANARY GRASS

EXHIBIT C

OREGON CERTIFIED
REED CANARY GRASS or PHALARIS
Phalaris arundinaceae

Oregon Certified Reed Canary grass may be tagged with three colors of tags:

(1) Blue tag, certified or top grade seed, is sound and may contain a minimum of 98% pure seed and 90% pure live seed, a maximum of 1% crop seed and not more than a trace of weed seeds;

(2) Red tag seed is sound and may contain a minimum of 98% pure seed, and 80% pure live seed, a maximum of 1% of crop seed and not more than a trace of weed seed;

(3) Yellow tag seed may contain a minimum of 95% pure seed and 50% pure live seed, a maximum of 1% crop seed, and not more than a trace of weed seed. Yellow tag seed may be musty.

A statement of purity, germination and condition is shown on each tag. No noxious weeds are permitted in any grade.

994

Sealed

Crop

Inspector

Oregon Certified Reed Canary seed is harvested from well established stands. Each bag of each grower-lot is sampled, examined, tested, sealed and tagged with a numbered temporary tag by a representative of the Oregon State Agricultural College. Samples of similar quality from each lot are segregated into groups. A composite sample representative of each group is prepared. It is tested at the Experiment Station Seed Laboratory, and if the test proves it to be up to the standard each sealed bag comprising the group is tagged with a permanent certification tag which indicates the grade of each group and the analysis of the composite sample representing it.

The analysis of the official composite sample is as follows:

| | |
|--------------------|------------|
| Test No. | Date |
| Pure seed | % |
| Crop seed | % |
| Kind | |
| Inert matter | % |
| Weed seeds | % |
| Germination | % |
| Condition | |

SAMPLES OF YELLOW TAGS FOR OREGON CERTIFIED REED CANARY
 GRASS

BIBLIOGRAPHY

1. Alway, Frederick J. Early trials and use of reed canary grass as a forage plant, Jour. Amer. Soc. Agron., 23:64-66, 1931.
2. Army, A. C.; Hansen, M. C.; Hodgson, R. E.; and Nesom, G. H. Reed canary grass, Univ. Minn. Agric. Exp. Sta. Bul. No. 252. 1929.
3. Piper, C. V. Forage plants and their culture. Rev. ed. Macmillan and Co., 1924.
4. ——— Cultivated grasses of secondary importance. U. S. D. A. Far. Bul. No. 1433. 1925.
5. Schoth, H. A. Reed canary grass, U. S. D. A. Far. Bul. No. 1602. 1929.
6. U. S. D. A. Bur. Agric. Econ. Handbook of official grain standards of the United States. U. S. G. S. A. - Form No. 90. Rev. May, 1935.