A Study of Differential Response of Six Barley Varieties to Date of Seeding with Respect to Agronomic and Quality Characters

by

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Thesis

Submitted to the Graduate Studies Committee
in partial fulfillment of the requirements
for the degree of

Master of Science

The University of Manitoba

April 1945.

Acknowledgments

The writer is greatly indebted to Dr. P.J. Olson, head of the Plant Science Division, University of Manitoba, who suggested the problem and has followed the work with constant interest. Dr. C.H. Goulden of the Dominion Laboratory of Cereal Breeding contributed the design of the experiment and gave valuable suggestions regarding the statistical treatment of the results. Thanks are due to Mr. W.H. Johnston, Assistant Superintendent of the Dominion Experimental Farm, Brandon, Manitoba and to Mr. Gunnar Simundson, Arborg, Manitoba for cooperation in the conduction of the tests at these points, as well as to Mr. Levi and the staff of the Grain Research Laboratory at Winnipeg for making the nitrogen determinations on the barley samples. The assistance and cooperation of Mr. A.J. Lejeune and members of the staff of the Agronomy Department of the University of Manitoba is gratefully acknowledged.

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INTRODUCTION

Barley production has long been a major cereal enterprise in Manitoba. Large areas of the province are better suited to the production of coarse grains than of wheat, due to a short growing season, adequate soil moisture in normal years and soil type. Over the ten year period from 1935 to 1944, Manitoba was first among the Canadian provinces in barley production, with an average annual crop of 40,010,000 bushels from 1,591,000 acres. The greater portion of this crop never leaves the farm. Of the barley marketed, a considerable amount is used for malting purposes; the remainder utilized in the feeding of livestock.

Since the greater portion of the Manitoba barley crop is used for feed, and since the wartime expansion in coarse grain production was aimed in the direction of more grain for livestock, the position of the feed barley varieties is of great importance among the cereals. This makes information regarding their culture and performance under different conditions valuable. While considerable information is available regarding the culture of malting varieties as a result of an extensive study conducted by the University of Manitoba from 1936 to 1939 on the varieties O.A.C. 21,

Mensury and Gartons, the feed barleys have not received a similar measure of attention. The results of that work, which indicated not only the lowering of yield by delayed seeding, but also a differential response of the different varieties tested, showed the desirability of obtaining information of a similar nature concerning some of the feed barley varieties commonly grown and recommended in Manitoba.

In the production of feed barley as distinguished from malting barley, high yield is the main objective. Quality is usually only a minor consideration, especially if the grain is fed on the farm. However, quality, as measured in weight per bushel, will assume importance if the crop passes into commercial channels, and its importance as a measure of feeding value is also recognized.

Similarly, certain agronomic qualities, such as the disease reaction and straw strength of the crop, are important since they may exert a profound modifying influence on yield and quality in certain seasons. Some of the ways in which this may occur are the reduction of total plant yield, the lowering of grain quality and the reduced ease and efficiency with which the crop may be harvested.

In Western Canada, barley is usually sown after wheat and oats, because it is recognized that early seeding is essential for the latter two cereals if satisfactory yields are to be obtained. Since barley is often sown on second crop land, further seeding delays may be occasioned by the necessity of working the land for weeds before planting can be done. Farmers generally share the opinion that barley will be able to stand late seeding better than other cereal crops.

It has been shown that for the production of malting barley, early seeding is essential. Later seedings result in reduced yields and lowered grain quality. The extent to which this applies to the feed barleys, where the quality criteria are not so strictly defined, was one of the questions initiating the present study. The other was the degree to which different varieties would show a differential response at different dates of seeding.

The crowded nature of seeding operations on Western farms makes such information highly desirable. If the conditions under which favorable yields of feed barley sown later in the season could be ascertained, along with information regarding the best variety under the circumstances, the problem of the

farmer who has a large acreage to handle, with limited resources of time and machinery, could be considerably eased.

This information was sought for six barley varieties: O.A.C. 21, Trebi, Plush, Wisconsin 38, Rex and Sanalta, in the years 1943 and 1944, at several locations in Manitoba.

REVIEW OF LITERATURE

While the amount of published information regarding the differential response of barley varieties to date of seeding is very limited, a considerable amount of work has been done on the effect of the time of seeding on single varieties of barley. Numerous studies have been made involving comparisons of varieties and varietal characters.

(A) Differential Response of Varieties to Date of Seeding

An experiment involving nine varieties of barley sown at three dates two weeks apart was conducted by Burnett and Reddy (3) at Ames, Iowa, over the four year period 1930 - 1933. The first date was at the beginning of April. The varieties used were Colsess, Glabron, Manchuria, Minsturdi, O.A.C. 21, Spartan, Trebi, Velvet and Wisc. 38. It was found that the yields of all varieties were depressed by late sowing, notably so for Trebi, Wisc. 38 and Spartan, a two row smooth awned variety. The other varieties showed only a slight decline in yield at the second date, as compared to the first. From the second to the third date of seeding, Trebi and O.A.C. 21 showed less decline in yield than the other varieties. Over all varieties, a delay in seeding of two weeks past

the first of April resulted in a reduction of the yield per acre by 13.5%, a retarding of ripening by only 3 days and a reduction of weight per bushel, but the delay had very little effect on plant height and lodging. From the second to the third date, yield was reduced a further 21.7%, ripening was retarded 8 days past the first date, and height of plant, weight per bushel and the degree of lodging were all considerably reduced.

Olson, Meredith, Leidlaw and Lejeune (25) studied the differential response of varieties of barley to date of seeding with respect to yield using the varieties O.A.C. 21, Mensury Ottawa 60 and Gartons. The tests were conducted over the four year period 1936 - 1939 at Winnipeg, Carman, Newdale and Swan River, Manitoba, and involved 3 dates of seeding, 2 weeks apart. O.A.C. 21 and Mensury were found closely similar in behaviour, but Gartons displayed a radically different reaction. At the first two seeding dates, O.A.C. 21 was first in yield, followed closely by Mensury. Gartons, however, took first place by a wide margin at the third date. The differential rust reaction of Gartons (partly resistant) as compared to O.A.C. 21 and Mensury (susceptible) was considered partially responsible for the differential yield response of Gartons as compared to the other two varieties.

Over all varieties, early seeding produced the highest yields under most conditions, there being a reduction in yield from the first to the last date. This reduction in yield, however, was much less for Gartons than for the other two varieties.

Meredith, Olson and Rowland (22) reported on the effect of date of seeding on malting quality, noting that seeding delays caused a progressive reduction in malting quality. Only barley grown at the first date, early in May, was found eligible for admission to the malting grades. Gartons was found to be less affected by delayed seeding as regards to quality than were O.A.C. 21 or Mensury. Delayed seeding reduced the kernel weight for all varieties, as well as the percentage of heavy grade barley and the yield of malt extract. In one of the two years the analytical determinations were conducted, date of seeding had no significant effect on nitrogen content for any variety; the other year, delayed seeding caused increases in nitrogen content. The environmental effects on malting quality decline associated with late seeding were found to be important, especially for barley grown at Carman and Winnipeg. The decline in quality accompanying late seeding is further stressed in the summary of cultural studies with barley by Meredith and Olson (21).

(B) Effect of Data of Seeding

Cerealists in Canada and the spring barley region of the United States generally recommend the earliest possible seeding of barley in order to secure maximum yields. In a review of the state varietal and seeding recommendations for spring barley, Harlan and Wiebe (8) recommend seeding as early as the condition of the land will permit, not only in the dry farming areas of the Great Plains, such as North Dakota, Montana and Wyoming, but even in the more humid areas, in states like Michigan, Wisconsin and Minnesota.

In Canada, recommendations usually favor early seeding, although the earliest possible date is not stressed. A survey of recommendations for Canadian conditions made by Canadian authorities and collected by Wiebe, Cowan and Reinbach-Welch (32) shows that for Manitoba, early May is usually considered satisfactory, while May, preferably the second week, is held best for Saskatchewan, and early May is specified for Alberta. May is generally held as the best time to seed barley in the other provinces of the Dominion.

These recommendations are based on date of seeding experiments carried on at various experiment stations. Harrington (10) notes that at Saskatoon late

May and early June seedings yield very much less than early May sowings. Harlan (7) reports on compiled data from dates of seeding tests made at various experiment stations in the Great Plains Area which indicate that early planting is best for barley. Seedings later than the first of May never produced mazimum yields. The depression in yield for seeding after April 25th on the Great Plains is more than 1% per day. The last date of seeding for maximum returns in barley varies with the particular state, being a week later in Montana than in central North Dakota. The effect of season on yields of barley sown at different dates is mentioned: cool summers permit later seeding.

Hughes and Henson (14) summarize the results of similar tests at certain stations in Canada and the United States. Of the twelve tests cited, seven show highest yields resulting from seeding at the earliest possible date, four at the second date and only one at the third date of seeding.

Albright (1) at Beaverledge found that over a five year period, the medium-early date of seeding (1 to 2 weeks after work on the land was possible) gave the highest yields. Similar results were obtained at Rosthern. Matthews (19) reports work continued at Ottawa through 13 years in which

seedings of wheat, oats and barley were made at weekly intervals, beginning as soon as it was possible to get on the land. A slight reduction in yield associated with the later seedings was not as evident in the case of barley as with wheat and oats. Similar results were recorded by E.S. Hopkins (12) after four years' experimental work at Ottawa. At Guelph, Ontario, Keegan (16) has found the earliest possible seeding to result in the highest yields.

Generally, experiments in the Great Plains region of the United States show yield results favorable to the earliest possible seeding of barley. Thus Linfield (17) at Montana noted that the yield of barley was decreased 1.5% for each day seeding was delayed after the period from April 29th to May 16th. Towle and Williams (31) who conducted a dates of seeding test on dry land at Sheridan, Wyoming from 1918 through 1931 obtained decreased yields with delayed seeding. Sowing up to 15 days after field work became general gave only slight depressions in yield, increases over the first date being recorded in some years. Greatly reduced returns were obtained when the crop was put in more than a month after farm work got underway. However, in two years of very favorable moisture conditions, high yields were produced by the late seeded barley. In dry years on the other hand, the late

sowings failed entirely. Jones (15) at Cheyenne, Wyoming, seeded Svanhals barley at the three dates for three years. His results inclined him towards early seeding in years of limited moisture, although he observed that under adequate rainfall, the late seedings were favored.

Early seeding is advocated by Swanson and Laude (30) of the Fort Hays Station, Kansas, who cite a five year experiment in which Club Mariout was sown at five dates from February 15th to April 15th. The March 15th seeding gave the best results.

Robertson and his co-workers (26) at Fort Collins, Colorado, feel that satisfactory results can be attained from relatively late planting of barley, provided poor weather does not interfere with seeding operations. They recommend very early seeding on dry land only when soil moisture conditions are favorable. This is also the opinion of Barbee (2) at Pullman, Washington, who considers barley a good yielder under late planting conditions. He places emphasis on the long season barleys for high yields and high weight per bushel at late seedings.

In a review of the Rothamsted Barley experiments of 1852 - 1937, Russell and Watson (28) noted only small differences in yield resulting from a comparison of late and early seeding. Late sowings shortened the

growth period and reduced yield, but increased the nitrogen content of the grain, showing that the nitrogen uptake of the plant is less affected by date of seeding than the yield. A delay of seeding of 20 days caused an addition of 0.10% to the nitrogen content of the grain. They concluded that for malting barley production, medium early seeding is best. These findings are emphasized by the results of the work of the Institute of Brewing Research Scheme; Russell and Bishop (27) noted marked increases in nitrogen content with delayed seeding, which was found to lower the kernel weight as well as the yield.

(C) Reactions of Varieties

Yield tests of barley varieties are conducted annually on a very extensive scale so that relatively little of the vast available information can be presented. All of the varieties used in this study have been tested extensively in Canada and the United States. While the yield performance of a variety varies considerably with the station and season, a general synopsis of the results presented by Wiebe, Cowan and Reinbach-Welch (32) indicates Wisconsin Ped. 38 and Plush to be well adapted to Manitoba conditions. Trebi is shown to register high yields even under unfavorable conditions. Sanalta was found to vary

greatly in performance at the different Western Canadian Stations: it yields very well in favorable seasons. Harrington (10) has recently shown Rex to be equal in yield to Hannchen and Trebi, while O.A.C. 21 was found to be lower yielding under Saskatchewan conditions.

The Manitoba Plant Breeder's Cooperative Tests (18) of 16 barley hybrids and varieties conducted annually at 17 stations throughout the Province have shown Plush to be very high yielding, holding first rank twice and tied for second place once in the last four years it has been on test. Wisconsin 38 has also shown up well on these tests. O.A.C. 21 has been found near average in yield in most years. Sanalta has yielded exceptionally well the last year, (first year on test) being first of the standard varieties. The 1944 results for the Cooperative Test indicate this yield order: Sanalta, Plush, O.A.C. 21, Rex and Wisconsin 38. In 1943, the Manitoba Regional Barley test indicated this order: Sanalta, Plush, Rex, O.A.C. 21 and Wisconsin 38. Trebi which was not included in these tests has given remarkable yield performances in Manitoba at Morden and Brandon under certain conditions. At Saskatoon the varieties in this study had this order in 1944: Plush, Trebi, Sanalta, Wisconsin 38, Rex and O.A.C. 21.

The experimental station variety test results thus indicate that all the varieties included in this study, with the possible exception of O.A.C. 21, are capable of high yields under Manitoba conditions.

MATERIALS AND METHODS

The experiment involved the seeding of six varieties of barley at three different dates over the two year period 1943 and 1944 at three and four stations in the respective years. A detailed survey of the methods of the experiment, together with a brief description of the varieties, is given below.

1. Varieties.

The varieties of barley included in this experiment were:

(1) O.A.C. 21	C.A.N. 1086
(2) Plush	C.A.N. 1117
(3) Rex	C.A.N. 1113
(4) Sanalta	C.A.N. 1088
(5) Trebi	C.A.N. 1115
(6) Wisconsin Pedigree 38	C.A.N. 1101

Plush, Wisconsin Pedigree 38, Rex and Sanalta are the feed barleys recommended at the present time by the Cereal Committee of the Manitoba Agronomists (18) for this province. O.A.C. 21 is the standard malting variety. It was included as a check, since its response to date of seeding was established by extensive experiments conducted by the University a few years ago (25). Trebi was included because it is still widely grown and because it has proven itself an outstanding yielder over a period of years (32).

Description of Varieties

(1) O.A.C. 21, the standard variety of malting barley in Canada, is a selection of Manchuria made by Dr. C.A. Zavitz of the Ontario Agricultural College. O.A.C. 21 is a nodding, six-rowed, rough awned variety with a greenish-blue aleurone. It is resistant to covered smut, susceptible to stem rust and loose smut. It is mid-early, tall, weak-strawed and weak-necked.

(2) Plush (Brandon 1099) originated at the Dominion Experimental Farm, Brandon, from a cross of Lion by Bearer made by Mr. S.J. Sigfusson. Plush is a mid-dense, erect, six-rowed, smooth awned variety with a white aleurone. Plush has yielded very well in Manitoba and Saskatchewan. It has strong necks, does not rust badly, but is attacked by smuts and may lodge severely in wet years, especially on summer-fallow.

(3) Rex (Sask. 266) was selected at the University of Saskatchewan by Dr. J.B. Harrington from the cross of Velvet with Hannchen. It is nodding, two-rowed, smooth awned variety with a white aleurone. It is strong strawed and hence recommended for seeding on summerfallow. The heads of Rex are long and lax.

It is described as having high yielding ability and bushel weight, as well as early maturity.

(4) Sanalta originated at Lacombe, Alberta from a cross of Smooth Awn by Duckbill (considered identical with Canada Thorpe). It is a late, erect, two-rowed, smooth awned barley with strong straw, and therefore recommended for growing on fallow. Sanalta has dense heads and a white aleurone. It has shown up well in yield trials in Manitoba and has gained favor as a combine barley because it does not shatter until after the dead-ripe stage. It is grown extensively around Rivers, Manitoba.

(5) Trebi is described by Harlan, Pope and Martini (9) as a pure line selection made in 1907 from an importation of barley from Samsoun, Asiatic Turkey, in 1905. Trebi is six-rowed, dense, rough awned, with a greyish-blue aleurone. It is short, early and weak strawed. First distributed in 1917, it has shown outstanding merit as a high yielding barley, even under unfavorable conditions.

(6) Wisconsin Pedigree 38 (11) originated at the Wisconsin Experimental Station from a cross of Oderbrucker (Wisc. Ped. 5) by Lion made by B.D. Leith in 1917. It is a lax, six-rowed, smooth awned barley,

resistent to stripe disease (Helnimthosporium graminium Rabh.) and to covered smut. It is listed as having high yielding ability with long, lax spikes and a white aleurone. The plants are tall and weak-strawed. Wisconsin Pedigree 38 is now officially registered under the name Barbless in the United States (11).

2. Experimental Design

The plan of the experiment was suggested by Dr. C.H. Goulden and consists of a double 3 x 3 Latin Square, dates being orthogonal with blocks. Each square consisted of 9 blocks in a 3 x 3 arrangement. Each block contained the six varieties studied, so that each of the two squares contained 54 plots, making a total of 108, with 36 plots at each date, and 6 for each variety at each date. The double Latin Square arrangement provided for error control by the removal of sums of squares for rows, columns and the comparison of the two squares.

Each individual plot consisted of four 18½ foot rows of which only the center two were harvested. A foot was cut off at each end of the plot at harvest time, leaving the harvested rows one rod long. Rows were spaced nine inches apart. Two rows of O.A.C. 21 were sown at each end of the block as guards, making

a total of 28 rows per block. Thus the total dimensions of each block were 20¼' by 18½'. The distance between blocks was 1½'. Alleyways between the replicates were 4' wide. The dimensions of a complete set of these field plots were 131 by 63¾ feet.

Both the blocks (orthogonal with dates) and the varieties within each block were completely randomized. A sample field plan of one experiment is shown as Table 39.

3. Stations

The test was conducted in both 1943 and 1944 on summerfallow at Winnipeg at the University of Manitoba and at Arborg, as well as on second crop land at Winnipeg. It was also carried out on summerfallow at Brandon in 1944, in order to get a wider range of environmental conditions. The Winnipeg tests were planned to get a comparison between the response of varieties on summerfallow as compared to second crop land. Winnipeg can be considered fairly typical of the Red River Valley. Arborg was chosen because it is the center of a fairly large barley growing area and because, in the past, results obtained at Arborg have been applicable to the Swan River country as well. Brandon may be considered fairly representative of a large area of the black soils of Western Manitoba.

4. Seasions

The two years in which the tests were conducted could hardly be called average seasons. Not only was there a considerable variation between the two years, but both years were also considerably different from normal. Precipitation, especially in the spring and summer months, was considerably above normal, so that moisture conditions were favorable. Flooding of plots was serious at Winnipeg in 1943. The temperature and precipitation data for the two years of the test are summarized in Table 38.

5. Dates of Seeding

It was the original intention to plant the first date around the first of May, the second about the 15th, and the third near the end of the month, so that there would be a two week interval between each date. In 1943 this plan could not be adhered to because neavy spring rains held up all work on the land for considerable periods of time, with the heavy clays at Winnipeg and Arborg drying up very slowly. As a result, the actual dates of seeding in 1943 were delayed by at least two weeks, the third dates not being seeded until the latter part of June.

In 1944, the early spring weather was more favorable and the actual dates of seeding correspond closely to the original schedule. The following are the actual dates of seeding at each of the stations in each year.

Seeding dates, 1943

	Date 1	Date 2	Date 3
Winnipeg Summerfallow	May 12	May 30	June 28
Winnipeg Second Crop Land	May 18	June 3	June 28
Arborg	May 21	June 8	June 25

Seeding dates, 1944

Winnipeg Summerfallow	May 2	May 15	May 31
Winnipeg Second Crop Land	April 27	May 13	May 27
Arborg	May 9	May 27	June 9
Brandon	May 4	May 18	June 3

6. Seeding

Seeding was at the rate of 375 kernels per 18½ foot row. This corresponds to a rate of 1½ bushels per acre for ordinary sized kernels. The constant number of kernels in every rod row prevents differences in stand from distorting the yield picture, since such varieties as Trebi and Sanalta have relatively large kernels which would result in a reduced stand if weight were used as a basis of seeding rate.

The land was prepared for seeding by harrowing, and was in good condition in every case. A Kemp V-belt seeder was employed.

7. Summer Care

The plots were trimmed and hoed about a month after seeding. After this date, further hoeing was not necessary. Wild oats were the one serious weed, especially at Arborg in 1944.

Notes were taken in the field on the heading and maturity time of the different varieties at the different dates. Records were also kept of the percent of rust infection and the appearance of smut and leaf rust. Observations on other diseases, such as powdery mildew and net and spot blotch of barley, were also made where these appeared. Straw strength and height of plant data were taken at harvest time.

8. Harvesting and Assembly of Data

The plots were harvested when ripe, after a foot had been cut off the plot ends. Only the two center rows of each plot were harvested. After the barley had been cut, each plot sheaf was wrapped in a cotton cover (to prevent loss of grain and mixing) and labelled. The samples were threshed in a rod row thresher; the yield in grams was recorded. From these figures the yield in bushels per acre was calculated.