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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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.

The samples were bulked by dates, stations and varieties to make determinations of weight per measured bushel and 1000 kernel weight. A small sample of each variety at each date and station was ground and analyzed for nitrogen content. This work was done by the Grain Research Laboratory at Winnipeg.

EXPERIMENTAL RESULTS

The results obtained in the two year's experiments are presented in the accompanying series of tables. These list the mean values for yield in bushels per acre, weight per measured bushel, 1000 kernel weight, percent nitrogen, strength of straw, plant height, stem rust infection and days to mature by station, date and variety for both 1943 and 1944. Tables of means over all stations by individual years and combined years, dates and varieties are also included as are tables showing two year averages by date and variety at the stations Winnipeg Summerfallow, Winnipeg Second Crop Land and Arborg.

The 1943 results are incomplete for Winnipeg Summerfallow, where the heavy June rains caused flooding of the plots. As a result, very little of the third date seeding germinated. It was possible, however, to harvest a few plants of each variety from the second replicate third date block. The 1943 Winnipeg Summerfallow third date figures for weight per measured bushel, 1000 kernel weight and percent nitrogen are based on these samples.

At Arborg in 1943 the sixth replicate was lost when the upper end of the experimental field was inadvertently cultivated during farm weeding operations.

In 1944 all the tests were satisfactory; all plots could be harvested at every station.

Statistical Analysis of Results

The yield data obtained were analyzed along the lines of the analysis of variance outlined by Goulden (6) for Latin Squares and Split Plot Experiments. The individual steps will be evident from the tables of the analysis. For each year the analysis was first conducted by stations. These were then combined by years, which in turn were set up to give an analysis of stations over both years. Tables 5 to 9 inclusive indicate the various sections of the statistical analysis of the yield results.

The data for weight per bushel, 1000 kernel weight and percent nitrogen were obtained from bulked samples and could not be analyzed in the same way as the yield data. To test the significance of the station, variety and date means, these results were analyzed treating each station as a replicate. The tables of these analyses of variance are given immediately after the data to which they apply.

In the statistical analysis of the yield data of an individual station, the first step (after all the totals had been calculated) was to find the block sum of squares. Then the sums of squares for rows and

columns were calculated for each square and the sum of squares for the comparison of the two Latin Squares. Then the treatment (dates) sum of squares was determined and error (a) obtained by subtraction from the block sum of squares.

Then using the variety plots within blocks, the varieties and varieties by dates interaction sums of squares were calculated. Error (b) was obtained from the total sum of squares by subtraction. The examination of any of the 1944 individual station analyses (Table 6) will show the allocation of the degrees of freedom.

For Winnipeg Summerfallow (1943) and Arborg (1943) the standard form of analysis was not possible because of incomplete results at these stations, one treatment being missing in the one case and one row of blocks in the other. The Double Latin Square design could still be used satisfactorily by employing Yates' (33) method of analyzing incomplete Latin Squares. By this procedure the analysis of variance can be set up in the original form, except that the number of degrees of freedom for treatments or rows, error (a), varieties by treatments and error (b) is reduced, as will be seen in the analysis of variance for the two stations with incomplete data. Yates' method makes possible the determination of rows,

columns and Square I vs Square II sums of squares at both of these stations.

Yield (Tables 1 - 9)

1943

At the individual stations in 1943 the second date of seeding caused significantly lower yields only at Arborg. On Winnipeg Second Crop Land and Winnipeg Summerfallow the second date was almost identical with the first in yield performance.

In 1943 the interaction of varieties with dates of seeding was significant at every station. On Winnipeg Summerfallow, Rex at the first date led all the other varieties by a wide margin, but at the second date only O.A.C. 21 and Wisc. 38 were lower. O.A.C. 21 and Wisc. 38 were considerably higher at the second date than at the first, while the other varieties remained in similar positions. On Winnipeg Second Crop Land, Plush led all other varieties at the first date, but was not significantly different from Rex and Sanalta at the second date. At the third date Sanalta and Wisc. 38 were low. No variety suffered a significant reduction in yield until the third date was reached. At Arborg, O.A.C. 21 led at every date. It excelled all other varieties at the first date and was considerably higher even than

Trebi and Sanalta at the second date. At the third date, the three late maturing varieties, Plush, Wisconsin 38 and Sanalta did very poorly.

Concerning varietal performance by stations, on Winnipeg Summerfallow and on Winnipeg Second Crop Land, Plush, Rex, Sanalta and Trebi did not show significant differences in yield, but were higher than O.A.C. 21 or Wisconsin 38. At Arborg, however, O.A.C. 21 was the leader, with all varieties except Trebi falling into a lower class.

When the 1943 data for Arborg and Winnipeg Second Crop Land were combined, the early seeding date was distinctly favored. Only the variety Wisconsin 38 was significantly lower than Plush, the highest yielder. All varieties except Sanalta and Trebi were sharply reduced in yield at the second date; Sanalta, however, was lowest of all at the third date. O.A.C. 21, Rex and Trebi stood up better than the slow-maturing varieties under very late planting conditions. Early seeding was especially beneficial at Arborg, where O.A.C. 21 was favored over all other varieties. At Winnipeg Rex, Plush and Sanalta showed up well at the earlier planting dates.

Varietal Response of Barley to Planting Date
Manitoba 1943-44

Table 1. Average Yield in Bushels per Acre for 1943, by Stations, Dates and Varieties.

Winnipeg Summerfallow

Variety	Date 1	Date 2	Date 3	Mean
O.A.C.21	16.2	23.6	--	19.9
Plush	24.4	30.1	--	27.3
Rex	37.0	32.0	--	34.5
Sanalta	29.7	33.6	--	31.7
Trebi	30.5	26.2	--	28.4
Wisc.38	15.3	22.4	--	18.8
Mean	25.5	28.0	--	26.7

Winnipeg Second Crop Land

Variety	Date 1	Date 2	Date 3	Mean
O.A.C.21	29.4	32.5	14.7	25.6
Plush	53.4	50.8	15.7	40.0
Rex	40.8	44.8	19.8	35.1
Sanalta	47.0	50.1	10.4	35.8
Trebi	37.6	39.8	21.0	32.8
Wisc.38	35.0	35.0	11.2	27.0
Mean	40.5	42.2	15.4	32.7

Arborg

Variety	Date 1	Date 2	Date 3	Mean
O.A.C.21	53.0	37.5	22.0	37.6
Plush	43.2	27.3	8.9	26.5
Rex	41.2	26.8	15.6	27.9
Sanalta	42.1	33.9	3.4	26.5
Trebi	40.8	33.9	14.5	29.7
Wisc.38	46.5	21.8	3.0	23.8
Mean	44.4	30.2	11.3	29.6

Varietal Response of Barley to Planting Date
Manitoba 1943-44

Table 2. Average Yield in Bushels Per Acre for 1944, by Stations, Dates and Varieties

Winnipeg Summerfallow

Variety	Date 1	Date 2	Date 3	Mean
O.A.C.21	51.5	39.5	21.6	37.6
Plush	40.4	44.3	21.0	35.2
Rex	44.2	46.0	27.4	39.2
Sanalta	61.8	45.3	18.8	42.0
Trebi	42.9	40.5	20.4	34.6
Wisc.38	34.5	36.1	12.3	27.6
Mean	45.9	43.0	20.3	36.0

Winnipeg Second Crop Land

Variety	Date 1	Date 2	Date 3	Mean
O.A.C.21	40.7	35.6	25.9	34.1
Plush	36.3	43.2	36.5	38.7
Rex	35.5	37.9	32.8	35.4
Sanalta	40.7	43.6	38.0	40.8
Trebi	46.0	47.1	35.8	43.0
Wisc.38	41.3	40.1	32.5	38.0
Mean	40.1	41.3	33.6	38.3

Arborg

Variety	Date 1	Date 2	Date 3	Mean
O.A.C.21	51.1	35.5	24.1	36.9
Plush	44.5	39.6	29.2	37.7
Rex	39.3	27.4	21.8	29.5
Sanalta	53.6	47.6	33.3	44.8
Trebi	48.7	39.5	27.3	38.5
Wisc.38	41.9	33.9	26.6	34.1
Mean	46.5	37.2	27.1	36.7

Brandon

Variety	Date 1	Date 2	Date 3	Mean
O.A.C.21	43.0	62.3	55.9	53.7
Plush	52.3	67.8	48.4	56.1
Rex	41.1	56.5	52.8	50.1
Sanalta	58.7	85.9	62.0	68.9
Trebi	48.3	53.4	57.3	53.0
Wisc.38	46.9	55.4	36.1	45.6
Mean	48.4	63.5	51.8	54.6

Varietal Response of Barley to Planting Date Manitoba 1943-44

Table 3. Average Yield in Bushels per Acre over all Stations, by Years, Dates and Varieties

Mean Yields, 1943*

Variety	Date 1	Date 2	Date 3	Mean
O.A.C.21	41.2	35.0	18.4	31.6
Plush	48.3	39.0	12.3	33.2
Rex	41.0	35.8	17.7	31.5
Sanalta	44.6	42.0	6.9	31.2
Trebi	39.2	36.8	17.8	31.2
Wisc.38	40.6	28.4	7.1	25.4
Mean	42.4	36.2	13.4	31.2

Mean Yields, 1944

Variety	Date 1	Date 2	Date 3	Mean
O.A.C.21	46.6	43.2	31.9	40.6
Plush	43.3	48.7	33.8	41.9
Rex	40.0	41.9	33.7	38.5
Sanalta	53.7	55.6	38.0	49.1
Trebi	46.5	45.1	35.2	42.3
Wisc.38	41.2	41.4	28.4	36.3
Mean	45.2	46.0	33.2	41.5

Mean Yields, 1943 and 1944 combined*

Variety	Date 1	Date 2	Date 3	Mean
O.A.C.21	43.5	35.2	21.6	33.5
Plush	44.3	40.2	22.6	35.8
Rex	39.2	34.2	22.2	32.0
Sanalta	45.8	43.8	21.3	37.0
Trebi	43.2	40.0	24.6	36.0
Wisc.38	41.2	32.7	18.3	30.8
Mean	42.8	37.8	21.8	34.4

*Compiled from Winnipeg Second Crop Land and Arborg Data only.

Varietal Response of Barley to Planting Date
Manitoba 1943-44

Table 4. Average Yield in Bushels per Acre over both Years, by Stations, Dates and Varieties

Winnipeg Summerfallow*

Variety	Date 1	Date 2	Date 3	Mean
O.A.C.21	33.8	31.6	21.6	29.0
Plush	32.4	37.2	21.0	30.2
Rex	40.6	39.0	27.4	35.7
Sanalta	45.8	39.4	18.8	34.7
Trebi	36.7	33.4	20.4	30.2
Wisc.38	24.9	29.2	12.3	22.1
Mean	35.7	35.5	20.3	30.5

Winnipeg Second Crop Land

Variety	Date 1	Date 2	Date 3	Mean
O.A.C.21	35.0	34.0	20.3	29.8
Plush	44.8	47.0	26.1	39.4
Rex	38.2	41.4	26.3	35.2
Sanalta	43.8	46.8	24.2	38.3
Trebi	41.8	43.4	28.4	37.9
Wisc.38	38.2	37.6	21.8	32.5
Mean	40.3	41.8	24.5	35.5

Arborg

Variety	Date 1	Date 2	Date 3	Mean
O.A.C.21	52.0	36.5	23.0	37.2
Plush	43.8	33.4	19.0	32.1
Rex	40.2	27.1	18.2	28.7
Sanalta	47.8	40.8	18.4	35.6
Trebi	44.6	36.7	20.9	34.1
Wisc.38	44.2	27.8	14.8	29.0
Mean	45.4	33.7	19.2	33.2

*Not comparable with other stations. Only 1944 figures at the third date.

Varietal Response of Barley to Planting Date
Manitoba 1943-44

Table 5. Analysis of Variance of 1943 Yield Data, by Stations.

Winnipeg Summerfallow (Using Yates' method of analysis)

	S.S.	D.F.	M.S.	F	5%pt	N.D.
Rows	581.33	4	145.46	.27	2.25	
Columns	4,098.13	4	1,024.53	1.92	2.25	
Sq.I vs Sq.II	1,429.34	1	1,429.34	2.67	1.61	
Dates	110.02	1	110.02	.21	1.61	
Error (a)	532.12	1	532.12			
Varieties	2,358.72	5	471.74	12.14	2.40	10.2
Var x Dates	476.22	5	95.24	2.45	2.40	7.2
Error (b)	1,043.06	50	38.86			
Total	11,529.44	71				

Winnipeg Second Crop Land

	S.S.	D.F.	M.S.	F	5%pt	N.D.
Rows	114.05	4	28.51	.35	4.53	
Columns	94.63	4	23.66	.29	4.53	
Sq.I vs Sq.II	569.02	1	569.02	7.03	5.99	
Dates	16,164.40	2	8,082.20	99.89	5.14	5.2
Error (a)	485.47	6	80.91			
Varieties	2,735.90	5	547.18	18.55	2.34	10.0
Var x Dates	1,822.61	10	182.26	6.18	1.96	6.3
Error (b)	2,212.59	75	29.50			
Total	24,198.67	107				

Table 5. (continued)

Arborg (As a randomized block experiment)

	S.S.	D.F.	M.S.	F	5%pt	N.D.
Replicates	400.57	4	100.14	3.04	3.84	
Dates	16,607.08	2	8,303.54	251.85	4.46	3.4
Error (a)	263.76	8	32.97			
Varieties	1,717.85	5	343.57	14.93	2.37	8.5
Var x Dates	1,100.99	10	110.10	4.35	1.99	6.1
Error (b)	1,380.39	60	23.01			
Total	21,470.64	89				

Arborg (Double Latin Square using Yates' method of analysis)

	S.S.	D.F.	M.S.	F	5%pt	N.D.
Rows	379.01	3	126.34	6.59	6.59	
Columns	187.06	4	46.76	2.44	6.39	
Sq.I vs Sq.II	21.56	1	21.56	1.12	7.71	3.1
Dates	16,607.08	2	8,303.54	432.93	6.94	
Error (a)	76.70	4	19.18			
Varieties	1,717.85	5	343.57	14.93	2.37	8.5
Var x Dates	1,100.99	10	110.10	4.35	1.99	6.1
Error (b)	1,380.39	60	23.01			
Total	21,470.64	89				

Varietal Response of Barley to Planting Date
Manitoba 1943-44

Table 6. Analysis of Variance of 1944 Yield Data, by Stations.

Winnipeg Summerfallow

	S.S.	D.F.	M.S.	F	5%pt	N.D.
Rows	1,252.07	4	313.02	1.03	4.53	
Columns	4,892.75	4	1,223.19	4.03	4.53	
Sq.I vs Sq.II	302.67	1	302.67	.99	5.99	
Dates	13,717.61	2	6,858.80	22.59	5.14	10.1
Error (a)	1,821.96	6	303.66			
Varieties	2,173.84	5	434.77	8.99	2.34	6.4
Var x Dates	739.15	10	73.92	1.53	1.96	
Error (b)	3,626.65	75	48.36			
Total	28,526.70	107				

Winnipeg Second Crop Land

	S.S.	D.F.	M.S.	F	5%pt	N.D.
Rows	1,768.00	4	442.00	9.02	4.53	
Columns	344.35	4	86.09	1.76	4.53	
Sq.I vs Sq.II	1,155.10	1	1,155.10	23.46	5.99	
Dates	1,218.65	2	609.33	12.43	5.14	4.0
Error (a)	294.16	6	49.03			
Varieties	983.81	5	196.76	5.99	2.34	5.5
Var x Dates	546.82	10	54.68	1.66	1.96	
Error (b)	2,463.88	75	32.85			
Total	8,774.77	107				

Table 6. (continued)

Arborg

	S.S.	D.F.	M.S.	F	5%pt	N.D.
Rows	163.21	4	40.80	.45	4.53	
Columns	559.54	4	139.88	1.54	4.53	
Sq.I vs Sq.II	133.33	1	133.33	1.47	5.99	
Dates	6,812.76	2	3,406.38	37.59	5.14	5.5
Error (a)	543.77	6	90.63			
Varieties	2,322.48	5	464.50	13.37	2.34	5.1
Var x Dates	462.39	10	46.24	1.33	1.96	
Error (b)	2,605.17	75	34.74			
Total	13,602.65	107				

Brandon

	S.S.	D.F.	M.S.	F	5%pt	N.D.
Rows	414.69	4	103.67	1.19	4.53	
Columns	51.89	4	12.97	.15	4.53	
Sq.I vs Sq.II	290.16	1	290.16	3.33	5.99	
Dates	4,555.93	2	2,277.96	26.11	5.14	5.4
Error (a)	523.39	6	87.23			
Varieties	5,590.46	5	1,118.09	21.30	2.34	12.6
Var x Dates	2,871.04	10	287.10	5.47	1.96	8.4
Error (b)	3,936.63	75	52.49			
Total	18,234.19	107				

Varietal Response of Barley to Planting Date
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Table 7. Analysis of Variance of 1943 Yield Data, Arborg and Winnipeg Second Crop Land Combined.

	S.S.	D.F.	N.S.	F	5%pt	N.D.
Stations	815.78	1	815.78	not comparable		
Rows	493.06	7	70.44	1.25	3.14	
Columns	281.69	8	30.24	.54	3.07	
Sq.I vs Sq.II	590.58	2	84.40	1.50	4.10	
Dates	30,712.09	2	15,356.04	273.14	4.10	2.9
Sta x Dates	2,059.39	2	1,029.70	18.32	4.10	4.1
Error (a)	562.17	10	56.22			
Varieties	1,283.64	5	256.73	9.65	2.29	2.5 (11.3)*
Var x Dates	2,222.65	10	222.26	8.35	1.90	4.4
Var x Sta	3,170.11	5	317.01	11.91	2.29	3.7
V x D x S	700.95	10	70.10	2.63	1.90	6.5
Error (b)	3,592.98	135	26.61			
Total	46,485.09	197				

*Figure in brackets denotes Necessary Difference for varieties applicable under all conditions.

Varietal Response of Barley to Planting Date
Manitoba 1943-44

Table 8. Analysis of Variance of 1944 Yield Data, all Stations Combined.

	S.S.	D.F.	N.S.	F	5%pt	N.D.
Stations	25,040.69	3	8,346.90	not comparable		
Rows	3,597.97	16	224.87	1.70	2.09	
Columns	5,848.52	16	365.53	2.76	2.09	
Sq.I vs Sq.II	1,881.26	4	470.31	3.54	2.78	
Dates	14,869.41	2	7,434.71	56.05	3.40	12.6
Dates x Sta	11,435.53	6	1,905.93	14.37	2.51	5.6
Error (a)	3,183.29	24	132.64			
Varieties	6,852.14	5	1,370.43	32.55	2.24	5.9
Var x Sta	4,218.45	15	281.23	6.68	1.70	7.0
Var x Dates	1,412.69	10	141.27	3.35	1.86	5.0
V x D x S	3,206.71	30	106.89	2.54	1.50	6.7
Error (b)	12,632.31	300	42.11			
Total	94,178.97	431				

Varietal Response of Barley to Planting Date
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Table 9. Analysis of Variance of Arborg and Winnipeg Second Crop Land Yield Data, 1943 and 1944 Combined.

	S.S.	D.F.	M.S.	F	5%pt	N.D.
Years	4,703.17	1	4,703.17	98.31	4.30	
Stations	570.35	1	570.35	11.92	4.30	
Dates	31,811.61	2	15,905.80	332.48	3.44	1.7
Dates x Years	5,231.21	2	2,615.60	54.67	3.44	2.4
Dates x Sta	3,143.39	2	1,571.70	32.85	3.44	2.4
Sta. x Years	347.66	1	347.66	7.27	4.30	1.9
D x Y x S	964.34	2	482.17	10.08	3.44	3.4
Rows	2,424.27	15	161.62	3.38	2.16	
Columns	1,185.58	16	74.10	1.55	2.13	
Sq.I vs Sq.II	1,879.01	4	469.75	9.82	2.82	
Error (a)	1,052.44	22	47.84			
Varieties	2,296.21	5	459.24	15.04	2.24	1.9 (9.4)*
Var x Dates	1,066.78	10	106.68	3.49	1.86	3.2
Var x Sta	2,288.18	5	457.64	14.98	2.24	2.6
Var x Yrs	1,542.52	5	308.50	10.10	2.24	2.6
V x D x Y	1,999.67	10	199.97	6.55	1.86	4.5
V x S x Y	1,633.13	5	326.63	10.70	2.24	6.3
V x D x S x Y	518.70	10	51.87	1.70	1.86	
Error (b)	9,009.68	295	30.54			
Total	73,667.90	413				

*Figure in brackets denotes Necessary Difference for varieties applicable under all conditions.

1944

The first and second dates of seeding were not significantly different at either Winnipeg Station. At Arborg Date 2 was lower than Date 1, but at Brandon the second date was higher and the first and third dates approximately equal. At both Winnipeg stations and Arborg the third date of seeding was significantly lower than the second or first.

The interaction of varieties with dates was significant only at Brandon. All varieties except Trebi were much higher at the second date than at the first, but only Rex, Trebi and O.A.C. 21 did not show a decline at the third date; the highest yield of Trebi was actually obtained at the last seeding.

As far as the varieties at the stations went, Sanalta was first at Brandon, Arborg and Winnipeg Summerfallow. Trebi slightly exceeded Sanalta on Second Crop Land at Winnipeg. Wisconsin 38 and Trebi were significantly lower than Sanalta on Winnipeg Summerfallow. On Winnipeg Second Crop Land, Trebi and Sanalta were in a class by themselves. Sanalta was unchallenged at Arborg and Brandon, where all the other varieties were significantly lower.

Examining now the 1944 data, all stations combined, only the third date of seeding produced significantly lower yields. The variety Sanalta

was significantly higher than all other varieties, while Rex and Wisconsin 38 were especially low. Plush did better at the second date than at the first, but all varieties had lowered yields at the third date. At every date, Sanalta was significantly higher than the other varieties (Trebi approached it at the last date). The early date of seeding was best at every station but Brandon, where the second date was high.

1943 and 1944 Combined

When the Winnipeg Second Crop Land and Arborg Stations were combined over both years, the early date of seeding was distinctly favored, although at Winnipeg the second date equalled it. Sanalta, Trebi and Plush were significantly higher than the other varieties. O.A.C. 21 did well at the first date of seeding, where only Rex and Wisconsin 38 were low. O.A.C. 21, Wisconsin 38, Rex and Plush were significantly lower in yield at the second date than at the first, while Trebi and Sanalta did not show a similar decline until the third date was reached.

Quality Characters

(a) Weight per Measured Bushel (Tables 10 - 14)

Only the third date of seeding had a significant lowering effect on the weight per measured bushel. The values for the first and second date were very

Varietal Response of Barley to Planting Date
Manitoba 1943-44

Table 10. Average Weight in Pounds per Measured Bushel for 1943, by Stations, Dates and Varieties

Winnipeg Summerfallow

Variety	Date 1	Date 2	Date 3	Mean
O.A.C.21	50.5	48.9	38.2	45.9
Plush	51.4	49.3	34.2	45.0
Rex	54.5	53.6	40.2	49.4
Sanalta	53.2	52.4	24.4	43.3
Trebi	49.8	50.2	38.3	46.1
Wisc.38	49.9	48.6	31.4	43.3
Mean	51.6	50.5	34.4	45.5

Winnipeg Second Crop Land

Variety	Date 1	Date 2	Date 3	Mean
O.A.C.21	47.3	47.2	37.1	43.9
Plush	51.7	46.4	34.8	44.3
Rex	50.4	48.4	43.9	47.6
Sanalta	51.4	48.2	40.7	46.8
Trebi	48.7	49.0	38.4	45.4
Wisc.38	48.1	47.8	31.9	42.6
Mean	49.6	47.8	37.8	45.1

Arborg

Variety	Date 1	Date 2	Date 3	Mean
O.A.C.21	48.0	47.9	40.4	45.4
Plush	50.1	44.2	36.0	43.4
Rex	52.2	48.8	41.2	47.4
Sanalta	50.8	49.4	39.9	46.7
Trebi	50.6	47.8	38.4	45.6
Wisc.38	49.0	45.7	33.7	42.8
Mean	50.1	47.3	38.3	45.2

Varietal Response of Barley to Planting Date Manitoba 1943-44

Table 11. Average Weight in Pounds per Measured Bushel for 1944, by Stations, Dates and Varieties

Winnipeg Summerfallow

Variety	Date 1	Date 2	Date 3	Mean
O.A.C.21	48.3	48.2	48.0	48.2
Plush	47.0	49.0	46.0	47.3
Rex	51.7	51.4	49.3	50.8
Sanalta	52.0	51.0	45.0	49.3
Trebi	44.8	46.0	46.0	45.6
Wisc.38	48.0	48.1	44.2	46.8
Mean	48.6	49.0	46.4	48.0

Winnipeg Second Crop Land

Variety	Date 1	Date 2	Date 3	Mean
O.A.C.21	48.2	49.1	48.2	48.5
Plush	49.1	49.5	47.0	48.5
Rex	51.2	52.5	50.8	51.5
Sanalta	52.0	52.5	49.8	51.4
Trebi	48.9	49.0	46.8	48.2
Wisc.38	49.5	50.0	47.0	48.8
Mean	49.8	50.4	48.3	49.5

Arborg

Variety	Date 1	Date 2	Date 3	Mean
O.A.C.21	48.8	47.0	44.1	46.6
Plush	47.0	46.6	43.1	45.6
Rex	48.7	47.4	42.0	46.0
Sanalta	49.5	49.2	47.2	48.6
Trebi	47.0	45.8	40.4	44.4
Wisc.38	47.0	46.9	44.5	46.1
Mean	48.0	47.2	43.6	46.2

Brandon

Variety	Date 1	Date 2	Date 3	Mean
O.A.C.21	46.5	46.7	44.5	45.9
Plush	45.6	45.3	40.1	43.7
Rex	44.7	46.0	44.6	45.1
Sanalta	49.7	50.4	47.5	49.2
Trebi	44.0	40.3	40.2	41.5
Wisc.38	45.0	45.4	41.0	43.8
Mean	45.9	45.7	43.0	44.9

Varietal Response of Barley to Planting Date Manitoba 1943-44

Table 12. Average Weight in Pounds per Measured Bushel Over Both Years, by Stations, Dates and Varieties

Winnipeg Summerfallow

Variety	Date 1	Date 2	Date 3	Mean
O.A.C.21	49.4	48.6	43.1	47.0
Plush	49.2	49.2	40.1	46.2
Rex	53.1	52.5	44.8	50.1
Sanalta	50.9	51.7	34.7	46.3
Trebi	47.3	48.1	42.2	45.8
Wisc.38	49.0	48.4	37.8	45.0
Mean	50.1	49.8	40.4	46.8

Winnipeg Second Crop Land

Variety	Date 1	Date 2	Date 3	Mean
O.A.C.21	47.8	48.2	42.6	46.2
Plush	50.4	48.0	40.9	46.4
Rex	50.8	50.5	47.4	49.6
Sanalta	51.7	50.4	45.2	49.1
Trebi	48.8	49.0	44.6	46.8
Wisc.38	48.8	48.9	39.5	45.7
Mean	49.7	49.1	43.0	48.3

Arborg

Variety	Date 1	Date 2	Date 3	Mean
O.A.C.21	48.4	47.4	42.2	46.0
Plush	48.6	47.4	39.6	44.5
Rex	50.4	48.1	41.6	46.7
Sanalta	50.2	49.3	43.6	47.6
Trebi	48.8	46.3	39.4	45.0
Wisc.38	48.0	46.3	39.1	44.4
Mean	49.0	47.2	41.0	45.7

Varietal Response of Barley to Planting Date
Manitoba 1943-44

Table 13. Average Weight in Pounds per Measured Bushel Over All Stations, by Years, Dates and Varieties

Mean Weights per Bushel, 1943

Variety	Date 1	Date 2	Date 3	Mean
O.A.C.21	48.6	48.0	38.6	45.1
Plush	51.1	46.6	35.0	44.2
Rex	52.4	50.3	41.8	48.1
Sanalta	51.8	50.0	35.0	45.6
Trebi	49.7	49.0	38.4	45.7
Wisc.38	49.1	47.4	32.3	42.9
Mean	50.4	48.6	36.8	45.3

Mean Weights per Bushel, 1944

Variety	Date 1	Date 2	Date 3	Mean
O.A.C.21	48.0	47.8	46.2	47.3
Plush	47.2	47.6	44.0	46.3
Rex	49.1	49.3	46.7	48.4
Sanalta	50.8	50.8	47.4	49.6
Trebi	46.2	45.3	43.4	44.9
Wisc.38	47.4	47.6	44.2	46.4
Mean	48.1	48.1	45.3	47.2

Mean Weights per Bushel, 1943 and 1944 Combined*

Variety	Bate 1	Date 2	Date 3	Mean
O.A.C.21	48.5	48.0	42.7	46.4
Plush	49.4	47.5	40.2	45.7
Rex	51.4	50.4	44.6	48.8
Sanalta	51.5	50.4	41.2	47.7
Trebi	48.3	48.0	41.4	45.9
Wisc.38	48.6	47.8	38.8	45.1
Mean	49.6	48.7	41.5	46.6

*Excluding Brandon, 1944.

Varietal Response of Barley to Planting Date Manitoba 1943-44

Table 14. Analysis of Variance of Weight per Measured Bushel Data

1943 Results

	S.S.	D.F.	M.S.	F	5%pt	N.D.
Dates	1,950.32	2	975.16	39.85	6.94	4.6
Stations	1.65	2	0.82	.03	6.94	
Error (a)	97.88	4	24.47			
Varieties	136.99	5	24.25	4.63	2.53	3.3
Var x Dates	100.77	10	10.08	1.92	2.16	
Error (b)	157.05	30	5.24			
Total	2,444.66	53				

1944 Results

	S.S.	D.F.	M.S.	F	5%pt	N.D.
Dates	122.67	2	61.34	26.21	5.14	1.1
Stations	222.31	3	74.10	31.67	4.76	1.2
Error (a)	14.01	6	2.34			
Varieties	168.00	5	33.60	15.63	2.43	1.2
Var x Dates	8.93	10	.89	.41	2.05	
Error (b)	96.84	45	2.15			
Total	632.76	71				

1943 and 1944 Combined (Omitting Brandon 1944)

	S.S.	D.F.	M.S.	F	5%pt	N.D.
Years	188.81	1	188.81	22.72	5.32	1.3
Dates	1,437.85	2	718.92	86.51	4.46	1.6
Stations	45.24	2	22.62	2.72	4.46	
Y x Dates	603.41	2	301.20	36.25	4.46	2.2
Y x Sta	98.22	2	49.11	5.91	4.46	2.2
Error (a)	66.49	8	8.31			
Varieties	174.86	5	34.97	9.85	2.37	2.6
Var x Dates	64.01	10	6.40	1.80	1.99	2.7
Var x Y	55.13	5	11.03	3.11	2.37	2.7
V x D x Y	43.21	10	4.32	1.22	1.99	2.2
Error (b)	212.72	60	3.55			
Total	2,989.95	107				

similar. This applies to the individual years of the experiment as well as the average of the two years.

Stations showed differential effects only in 1944, but not in 1943 or the two year average. In 1944, the highest weights per bushel were given by the Second Crop Land at Winnipeg followed by Winnipeg Summerfallow, Arborg and Brandon in the order listed.

The variety Rex showed the highest weight per bushel in 1943, Plush and Wisconsin 38 being significantly lower. The next year Sanalta took the high position, all varieties except Rex being significantly lower. Over both years, Rex, Sanalta and O.A.C. 21 were not significantly different in bushel weight, with the other three varieties being in a lower class.

None of the individual varieties showed a significant decline between the first and second date. Between the second and third dates, however, every variety showed a marked drop. Only the variety Wisconsin 38 was heavier in 1944 than 1943.

(b) 1000 Kernel Weight (Tables 15 - 19)

In 1943 and 1944, only the third date of seeding gave significantly lower 1000 kernel weight values than the first or second dates of seeding. Higher kernel weights were obtained at the Winnipeg stations

Varietal Response of Barley to Planting Date
Manitoba 1943-44

Table 15. 1000 Kernel Weights in Grams for 1943 by Stations, Dates and Varieties

Winnipeg Summerfallow

Variety	Date 1	Date 2	Date 3	Mean
O.A.C.21	35.19	34.67	30.34	33.40
Plush	37.70	36.43	26.16	33.43
Rex	44.83	42.70	33.73	40.42
Sanalta	43.97	40.58	24.35	36.30
Trebi	42.40	46.93	31.14	40.16
Wisc.38	36.52	36.41	25.00	32.64
Mean	40.10	39.62	28.45	36.06

Winnipeg Second Crop Land

Variety	Date 1	Date 2	Date 3	Mean
O.A.C.21	36.42	36.26	20.23	30.97
Plush	39.94	35.16	23.98	33.03
Rex	46.16	45.41	29.46	40.34
Sanalta	53.38	46.19	24.62	41.40
Trebi	47.17	46.06	27.96	40.40
Wisc.38	36.26	35.66	25.10	32.34
Mean	43.22	40.79	25.23	36.41

Arborg

Variety	Date 1	Date 2	Date 3	Mean
O.A.C.21	32.36	31.40	22.66	28.81
Plush	33.93	28.43	21.74	28.03
Rex	37.10	33.85	26.10	32.35
Sanalta	42.23	39.14	23.48	34.95
Trebi	43.35	37.49	25.44	35.43
Wisc.38	33.31	31.05	20.90	28.42
Mean	37.05	33.56	23.39	31.33

Varietal Response of Barley to Planting Date
Manitoba 1943-44

Table 16. 1000 Kernel Weights in Grams for 1944 by Stations, Dates and Varieties

Winnipeg Summerfallow

Variety	Date 1	Date 2	Date 3	Mean
O.A.C.21	35.24	34.02	31.32	33.53
Plush	36.22	39.70	33.82	36.58
Rex	40.18	42.30	39.55	40.68
Sanalta	44.01	45.33	36.76	42.03
Trebi	43.37	43.01	39.14	41.84
Wisc.38	35.60	34.95	30.95	33.83
Mean	39.10	39.88	35.26	38.08

Winnipeg Second Crop Land

Variety	Date 1	Date 2	Date 3	Mean
O.A.C.21	34.10	34.26	33.74	34.04
Plush	39.21	38.42	36.28	37.97
Rex	43.38	43.75	42.39	43.17
Sanalta	48.58	47.19	44.06	46.61
Trebi	46.89	47.07	42.25	45.40
Wisc.38	34.81	35.39	34.36	34.86
Mean	41.16	41.02	38.85	40.34

Arborg

Variety	Date 1	Date 2	Date 3	Mean
O.A.C.21	32.44	31.60	28.04	30.70
Plush	37.67	34.37	31.96	34.58
Rex	43.82	33.47	30.35	35.88
Sanalta	45.86	40.66	39.38	41.96
Trebi	41.80	40.65	33.09	38.51
Wisc.38	31.79	31.76	31.27	31.61
Mean	38.90	35.42	32.35	35.55

Brandon

Variety	Date 1	Date 2	Date 3	Mean
O.A.C.21	31.48	32.43	28.66	30.86
Plush	33.60	33.66	28.29	31.85
Rex	31.70	37.28	30.70	33.23
Sanalta	42.28	45.45	39.46	42.40
Trebi	37.97	34.47	31.86	34.77
Wisc.38	30.93	33.74	28.30	30.99
Mean	34.66	36.17	31.21	34.02

Varietal Response of Barley to Planting Date
Manitoba 1943-44

Table 17. 1000 Kernel Weights in Grams Over Both Years, by Stations, Dates and Varieties

Winnipeg Summerfallow

Variety	Date 1	Date 2	Date 3	Mean
O.A.C.21	35.21	34.39	30.83	33.46
Plush	36.96	38.06	29.99	35.01
Rex	42.50	42.50	36.64	40.55
Sanalta	43.99	42.95	30.56	39.27
Trebi	42.89	44.97	35.14	41.00
Wisc.38	36.06	35.68	27.97	33.24
Mean	39.60	39.75	31.86	37.07

Winnipeg Second Crop Land

Variety	Date 1	Date 2	Date 3	Mean
O.A.C.21	35.26	35.26	26.99	32.50
Plush	39.58	36.79	30.13	35.50
Rex	44.77	44.58	35.93	42.76
Sanalta	50.98	46.69	34.26	44.00
Trebi	47.03	46.56	35.11	42.90
Wisc.38	35.53	35.53	29.73	33.60
Mean	42.19	40.90	32.04	38.38

Arborg

Variety	Date 1	Date 2	Date 3	Mean
O.A.C.21	32.40	31.50	25.35	29.75
Plush	35.80	31.40	26.85	31.31
Rex	40.46	33.66	28.23	34.12
Sanalta	44.04	39.90	31.43	38.45
Trebi	42.58	39.07	29.26	36.97
Wisc.38	32.55	31.40	26.08	30.01
Mean	37.97	34.49	27.87	33.44

Varietal Response of Barley to Planting Date
Manitoba 1943-44

Table 18. 1000 Kernel Weights in Grams over all Stations, by Years, Dates and Varieties

1000 Kernel Weight, 1943

Variety	Date 1	Date 2	Date 3	Mean
O.A.C.21	34.66	34.11	24.41	31.06
Plush	37.19	33.34	23.96	31.50
Rex	42.70	40.65	29.77	37.71
Sanalta	46.53	41.97	24.15	37.55
Trebi	44.31	43.49	28.18	38.66
Wisc.38	35.36	34.37	23.67	31.13
Mean	40.12	37.99	25.67	34.59

1000 Kernel Weight, 1944

Variety	Date 1	Date 2	Date 3	Mean
O.A.C.21	33.31	33.08	30.44	32.28
Plush	36.68	36.54	32.59	35.27
Rex	39.77	39.20	35.75	38.24
Sanalta	45.18	44.66	39.91	43.25
Trebi	42.51	41.30	36.58	40.13
Wisc.38	33.28	33.96	31.22	32.82
Mean	38.46	38.15	34.42	37.00

1000 Kernel Weight, 1943 and 1944 Combined*

Variety	Date 1	Date 2	Date 3	Mean
O.A.C.21	34.29	33.72	27.72	31.91
Plush	37.45	35.42	28.99	33.94
Rex	42.58	40.25	33.60	39.14
Sanalta	46.34	43.18	32.08	40.58
Trebi	44.16	43.53	33.17	40.29
Wisc.38	34.71	34.20	27.93	32.28
Mean	39.92	38.38	30.59	36.30

*Excluding Brandon, 1944.

Varietal Response of Barley to Planting Date Manitoba 1943-44

Table 19. Analysis of Variance of 1000 Kernel Weight Data

1943 Results

	S.S.	D.F.	M.S.	F	5%pt	N.D.
Dates	2,188.54	2	1,094.27	51.84	6.94	4.26
Stations	290.71	2	145.36	6.89	6.94	
Error (a)	84.43	4	21.11			
Varieties	621.61	5	124.32	27.44	2.53	4.32
Var x Dates	168.96	10	16.90	3.73	2.16	3.54
Error (b)	135.82	30	4.53			
Total	3,490.07	53				

1944 Results

	S.S.	D.F.	M.S.	F	5%pt	N.D.
Dates	240.04	2	120.02	12.37	5.14	2.20
Stations	419.00	3	139.67	14.40	4.76	2.54
Error (a)	58.22	6	9.70			
Varieties	1,122.55	5	224.51	46.29	2.43	2.10
Var x Dates	22.19	10	2.22	.46	2.05	
Error (b)	218.37	45	4.85			
Total	2,080.37	71				

1943 and 1944 Combined (omitting Brandon, 1944)

	S.S.	D.F.	M.S.	F	5%pt	N.D.
Years	304.68	1	304.68	18.17	5.32	
Dates	1,781.16	2	990.58	59.07	4.46	2.22
Stations	473.46	2	236.73	14.12	4.46	2.22
Sta. x Y	28.79	2	14.40	.86	4.46	
Dates x Y	549.13	2	224.56	13.39	4.46	3.16
Error (a)	134.15	8	16.77			
Varieties	1,480.40	5	246.73	58.89	2.37	2.81
Var x Dates	143.40	10	14.34	3,42	1.99	2.88
Var x Y	66.87	5	13.37	3.19	2.37	2.34
V x D x Y	49.43	10	4.94	1.18	1.99	
Error (b)	251.51	60	4.19			
Total	5,262.98	107				

in 1944 as compared to Arborg and Brandon. Arborg gave higher kernel weight values in 1944 than in 1943. The third date values for 1944 were higher than those for 1943.

The two-rowed varieties produced very high 1000 kernel weight values especially at the early dates of seeding. Trebi did well, even at the third date. Thus the varieties in order of 1000 kernel weight in 1943 were Trebi, Rex, Sanalta (no significant difference), Plush, Wisconsin 38 and O.A.C. 21. In 1944 the same order held, but Sanalta had taken first place. The varieties Rex and Sanalta were up in 1944 over 1943. All varieties were down at the third date, especially Wisconsin 38.

(c) Nitrogen Content (Tables 20 - 24)

The results of the analysis for nitrogen content of duplicate samples from each variety at each date, station and year are given in the accompanying series of tables, together with the statistical analysis.

An examination of the 1943 data will reveal a decline in nitrogen content with delayed seeding. This is noticeable at all stations, but is not constant enough to be significant. For 1944, the same trend can be noted at Arborg and Brandon, but not

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Table 20. Percent Nitrogen for 1943, by Stations, Dates and Varieties

Winnipeg Summerfallow

Variety	Date 1	Date 2	Date 3	Mean
O.A.C.21	2.28	2.12	1.93	2.11
Plush	2.37	2.06	2.03	2.15
Rex	2.26	2.12	2.13	2.17
Sanalta	2.28	1.86	2.17	2.10
Trebi	2.00	2.00	1.97	1.99
Wisc.38	2.41	2.14	2.05	2.20
Mean	2.27	2.05	2.05	2.12

Winnipeg Second Crop Land

Variety	Date 1	Date 2	Date 3	Mean
O.A.C.21	2.11	2.12	1.98	2.07
Plush	2.03	2.00	2.04	2.02
Rex	2.17	2.11	2.15	2.14
Sanalta	2.36	1.98	1.98	2.11
Trebi	1.94	1.95	1.94	1.94
Wisc.38	1.90	2.04	2.04	1.99
Mean	2.08	2.03	2.02	2.05

Arborg

Variety	Date 1	Date 2	Date 3	Mean
O.A.C.21	2.61	2.65	2.40	2.55
Plush	2.62	2.66	2.34	2.54
Rex	2.80	2.52	2.21	2.51
Sanalta	2.80	2.54	2.48	2.61
Trebi	2.56	2.67	2.35	2.53
Wisc. 38	2.47	2.27	2.48	2.41
Mean	2.64	2.55	2.38	2.52

Varietal Response of Barley to Planting Date
Manitoba 1943-44

Table 21. Percent Nitrogen for 1944, by Stations, Dates and Varieties

Winnipeg Summerfallow

Variety	Date 1	Date 2	Date 3	Mean
O.A.C.21	2.37	2.28	2.41	2.35
Plush	2.20	2.34	2.25	2.26
Rex	2.33	2.29	2.54	2.39
Sanalta	2.39	2.24	2.24	2.29
Trebi	2.18	1.98	2.26	2.14
Wisc.38	2.37	2.28	2.20	2.28
Mean	2.31	2.24	2.32	2.29

Winnipeg Second Crop Land

Variety	Date 1	Date 2	Date 3	Mean
O.A.C.21	1.92	2.13	2.17	2.07
Plush	1.89	1.94	2.15	1.99
Rex	2.16	2.19	2.24	2.20
Sanalta	2.07	2.05	2.20	2.11
Trebi	1.78	1.85	1.90	1.84
Wisc.38	1.88	1.96	2.10	1.98
Mean	1.95	2.02	2.13	2.03

Arborg

Variety	Date 1	Date 2	Date 3	Mean
O.A.C.21	2.52	2.43	2.38	2.44
Plush	2.53	2.42	2.57	2.51
Rex	2.60	2.50	2.49	2.53
Sanalta	2.65	2.59	2.55	2.60
Trebi	2.39	2.53	2.47	2.46
Wisc.38	2.59	2.44	2.45	2.49
Mean	2.55	2.48	2.48	2.51

Brandon

Variety	Date 1	Date 2	Date 3	Mean
O.A.C.21	2.39	2.32	2.39	2.37
Plush	2.62	2.44	2.43	2.50
Rex	2.60	2.66	2.42	2.56
Sanalta	2.58	2.51	2.35	2.48
Trebi	2.51	2.54	2.48	2.51
Wisc.38	2.46	2.46	2.34	2.42
Mean	2.51	2.49	2.40	2.47

Varietal Response of Barley to Planting Date
Manitoba 1943-44

Table 22. Percent Nitrogen over All Stations, by Years, Dates and Varieties

Percent Nitrogen, 1943

Variety	Date 1	Date 2	Date 3	Mean
O.A.C.21	2.33	2.30	2.10	2.24
Plush	2.34	2.24	2.14	2.23
Rex	2.41	2.25	2.16	2.27
Sanalta	2.48	2.13	2.21	2.27
Trebi	2.17	2.21	2.09	2.15
Wisc.38	2.26	2.15	2.19	2.20
Mean	2.33	2.22	2.15	2.23

Percent Nitrogen, 1944

Variety	Date 1	Date 2	Date 3	Mean
O.A.C.21	2.30	2.29	2.34	2.31
Plush	2.31	2.28	2.35	2.32
Rex	2.42	2.41	2.42	2.42
Sanalta	2.42	2.35	2.34	2.37
Trebi	2.22	2.22	2.28	2.24
Wisc.38	2.32	2.28	2.27	2.29
Mean	2.32	2.31	2.32	2.32

Percent Nitrogen, 1943 and 1944 combined*

Variety	Date 1	Date 2	Date 3	Mean
O.A.C.21	2.30	2.29	2.21	2.27
Plush	2.27	2.24	2.23	2.25
Rex	2.39	2.29	2.29	2.32
Sanalta	2.42	2.21	2.27	2.30
Trebi	2.14	2.16	2.15	2.15
Wisc.38	2.27	2.19	2.22	2.23
Mean	2.30	2.23	2.23	2.25

*Omitting Brandon, 1944.

Varietal Response of Barley to Planting Date
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Table 23. Percent Nitrogen over Both Years, by Stations, Dates and Varieties

Winnipeg Summerfallow

Variety	Date 1	Date 2	Date 3	Mean
O.A.C.21	2.32	2.20	2.17	2.23
Plush	2.28	2.21	2.14	2.21
Rex	2.30	2.20	2.33	2.28
Sanalta	2.34	2.05	2.20	2.20
Trebi	2.09	1.99	2.12	2.06
Wisc.38	2.39	2.21	2.12	2.24
Mean	2.29	2.16	2.18	2.20

Winnipeg Second Crop Land

Variety	Date 1	Date 2	Date 3	Mean
O.A.C.21	2.02	2.12	2.08	2.07
Plush	1.96	1.97	2.10	2.01
Rex	2.16	2.15	2.20	2.17
Sanalta	2.22	2.02	2.09	2.11
Trebi	1.86	1.90	1.92	1.89
Wisc.38	1.89	2.00	2.07	1.98
Mean	2.02	2.02	2.08	2.04

Arborg

Variety	Date 1	Date 2	Date 3	Mean
O.A.C.21	2.56	2.54	2.39	2.50
Plush	2.58	2.54	2.46	2.52
Rex	2.70	2.51	2.35	2.52
Sanalta	2.72	2.56	2.52	2.60
Trebi	2.48	2.60	2.41	2.50
Wisc.38	2.53	2.38	2.48	2.46
Mean	2.60	2.52	2.43	2.52

Varietal Response of Barley to Planting Date
Manitoba 1943-44

Table 24. Analysis of Variance of Percent Nitrogen Values

1943 Results

	S.S.	D.F.	M.S.	F	5%pt	N.D.
Dates	0.3122	2	0.1561	5.55	6.94	
Stations	2.3731	2	1.1866	42.23	6.94	.15
Error (a)	0.1124	4	0.0281			
Varieties	.0974	5	.0195	1.57	2.53	
Var x Dates	.1811	10	.0181	1.46	2.16	
Error (b)	.3715	30	.0124			
Total	3.4477	53				

1944 Results

	S.S.	D.F.	M.S.	F	5%pt	N.D.
Dates	.0103	2	.0052	.18	5.14	
Stations	2.5470	3	.8490	29.48	4.76	.14
Error (a)	.1729	6	.0288			
Varieties	.2310	5	.0462	5.19	2.43	.08
Var x Dates	.0367	10	.0037	.42	2.05	
Error (b)	.4002	45	.0089			
Total	3.3981	71				

1943 and 1944 Combined (omitting Brandon, 1944)

	S.S.	D.F.	M.S.	F	5%pt	N.D.
Years	.0525	1	.0525	2.00	5.32	
Dates	.1200	2	.0600	2.29	4.46	
Stations	4.1956	2	2.0978	30.07	4.46	.09
Sta. x Y	.1974	2	.0987	3.77	4.46	
Dates x Y	.2288	2	.1144	4.37	4.46	
Error (a)	.2098	8	.0262			
Varieties	.3345	5	.0669	6.43	2.37	.08
Var x Dates	.1212	10	.0121	1.16	1.99	
Var x Y	.0280	5	.0056	.54	2.37	
V x D x Y	.0941	10	.0094	.90	1.99	
Error (b)	.6218	60	.0104			
Total	6.2037	107				

at Winnipeg, where the highest nitrogen content is associated with barley seeded at the third date.

A comparison of the different station data over both years indicates that Second Crop Land gives significantly lower nitrogen values than Summerfallow. The nitrogen percentages for Arborg are very much higher than those for either of the two Winnipeg Stations. Brandon 1944 shows a tendency to fall in line with Arborg.

Concerning varietal performance over both years, Rex, Sanalta and O.A.C. 21 were not significantly different in nitrogen content, Plush, Wisconsin 38 and Trebi being lower. Trebi was significantly lower than all the rest. In 1943, varieties were not significantly different while in 1944 Rex and Sanalta were high, the other varieties being in a lower class.

None of the interactions for either year or over both years even approaches significance.

(c) Agronomic Characters (Tables 25 - 33)

The values for strength of straw are shown by stations, dates and varieties in each year and both years, as well as by years with all stations combined. Lodging was severe in 1944 at Brandon and Arborg, where heavy rains beat down the third date of planting. A small effect of increased strength of

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Table 25. Average Strength of Straw for 1943, by Stations, Dates and Varieties
Scale: 10.0-0.0, 10.0 best.

Winnipeg Summerfallow

Variety	Date 1	Date 2	Date 3	Mean
O.A.C.21	5.7	8.3	--	7.0
Plush	7.0	8.7	--	7.8
Rex	7.0	8.7	--	7.8
Sanalta	8.3	9.0	--	8.6
Trebi	2.7	7.7	--	5.2
Wisc.38	6.0	9.0	--	7.5
Mean	6.1	8.6	--	7.4

Winnipeg Second Crop Land

Variety	Date 1	Date 2	Date 3	Mean
O.A.C.21	5.2	4.7	4.5	4.8
Plush	5.8	6.7	8.3	6.9
Rex	7.0	6.8	4.7	6.2
Sanalta	6.5	8.5	9.3	8.1
Trebi	5.7	6.2	3.3	5.1
Wisc.38	5.5	6.3	8.7	6.8
Mean	6.0	6.5	6.5	6.3

Arborg

Variety	Date 1	Date 2	Date 3	Mean
O.A.C.21	6.3	3.3	8.8	6.3
Plush	7.3	1.3	8.8	5.8
Rex	8.0	3.0	10.0	7.0
Sanalta	7.7	5.3	10.0	7.7
Trebi	5.7	2.0	6.5	4.7
Wisc.38	5.7	1.7	8.5	5.3
Mean	6.8	2.8	8.8	6.3

Varietal Response of Barley to Planting Date
Manitoba 1943-44

Table 26. Average Strength of Straw for 1944, by Stations, Dates and Varieties. Scale: 10.0-0.0, 10.0 best.

Winnipeg Summerfallow

Variety	Date 1	Date 2	Date 3	Mean
O.A.C.21	5.3	7.7	9.0	7.3
Plush	6.2	7.7	8.0	7.3
Rex	8.3	9.7	9.0	9.0
Sanalta	9.3	9.5	9.0	9.3
Trebi	4.2	8.3	7.6	6.7
Wisc.38	4.0	8.3	7.8	6.7
Mean	6.2	8.5	8.4	7.7

Winnipeg Second Crop Land

Variety	Date 1	Date 2	Date 3	Mean
O.A.C.21	8.3	8.3	8.0	8.2
Plush	9.7	9.3	9.3	9.4
Rex	10.0	9.3	9.0	9.4
Sanalta	10.0	9.7	9.7	9.8
Trebi	9.3	9.0	7.3	8.7
Wisc.38	8.3	9.0	7.7	8.3
Mean	9.3	9.1	8.5	9.0

Arborg

Variety	Date 1	Date 2	Date 3	Mean
O.A.C.21	6.7	6.0	3.0	5.2
Plush	6.3	6.0	2.3	4.9
Rex	6.3	5.7	3.7	5.2
Sanalta	8.3	7.0	5.3	6.9
Trebi	5.3	5.3	2.0	4.2
Wisc.38	3.7	5.0	3.7	4.1
Mean	6.1	5.8	3.3	5.1

Brandon

Variety	Date 1	Date 2	Date 3	Mean
O.A.C.21	3.2	7.1	7.2	5.8
Plush	1.7	6.3	7.3	5.1
Rex	3.6	8.1	5.0	5.6
Sanalta	5.6	6.2	7.2	6.3
Trebi	1.2	3.0	3.2	2.5
Wisc.38	2.2	6.5	5.5	4.7
Mean	2.9	6.2	5.9	5.0

Varietal Response of Barley to Planting Date
Manitoba 1943-44

Table 27. Average Strength of Straw Over All Stations by Years, Dates and Varieties.
Scale: 10.0-0.0, 10.0 Best

Mean Strength of Straw, 1943

Variety	Date 1	Date 2	Date 3	Mean
O.A.C.21	5.7	5.4	6.6	5.9
Plush	6.7	5.6	8.6	7.0
Rex	7.3	6.2	7.4	7.0
Sanalta	7.5	7.6	9,8	8.3
Trebi	4.7	5.3	4.9	5.0
Wisc.38	5.7	5.7	8.6	6.7
Mean	6.3	6.0	7.6	6.6

Mean Strength of Straw, 1944

Variety	Date 1	Date 2	Date 3	Mean
O.A.C.21	5.9	7.3	6.8	6.6
Plush	6.0	7.3	6.7	6.7
Rex	7.5	8.2	6.7	7.3
Sanalta	8.3	8.1	7.8	8.1
Trebi	5.0	6.4	5.0	5.5
Wisc.38	4.6	7.2	6.2	6.0
Mean	6.1	7.4	6.5	6.7

Mean Strength of Straw, 1943 and 1944 combined*

Variety	Date 1	Date 2	Date 3	Mean
O.A.C.21	6.3	6.4	6.6	6.4
Plush	7.0	6.6	7.6	7.1
Rex	7.8	7.2	7.3	7.4
Sanalta	8.4	8.2	8.9	8.5
Trebi	5.5	6.4	5.2	5.8
Wisc.38	5.5	6.6	7.5	6.6
Mean	6.8	6.9	7.2	7.0

*excluding Brandon, 1944.

Varietal Response of Barley to Planting Date
Manitoba 1943-44

Table 28. Average Strength of Straw over Both Years, by Stations, Dates and Varieties. Scale: 10.0-0.0, 10.0 best.

Winnipeg Summerfallow

Variety	Date 1	Date 2	Date 3*	Mean
O.A.C.21	5.5	8.0	9.0	7.5
Plush	6.6	8.3	8.0	7.6
Rex	7.6	9.3	9.0	8.6
Sanalta	8.7	9.2	9.0	9.0
Trebi	3.4	8.0	7.6	6.3
Wisc.38	5.0	8.7	7.8	7.2
Mean	6.2	8.6	8.4	7.7

Winnipeg Second Crop Land

Variety	Date 1	Date 2	Date 3	Mean
O.A.C.21	6.8	6.5	6.2	6.5
Plush	7.8	8.0	8.7	8.2
Rex	8.5	8.0	6.8	7.6
Sanalta	8.2	9.1	9.5	8.9
Trebi	7.5	7.6	5.3	6.9
Wisc.38	6.9	7.6	8.2	7.6
Mean	7.7	7.8	7.5	7.7

Arborg

Variety	Date 1	Date 2	Date 3	Mean
O.A.C.21	6.5	4.6	5.9	5.8
Plush	6.8	3.6	5.6	5.4
Rex	7.1	4.4	6.8	6.1
Sanalta	8.0	6.2	7.6	7.3
Trebi	5.5	3.6	4.2	4.4
Wisc.38	4.7	3.4	6.1	4.7
Mean	6.4	4.3	6.0	5.7

*For 1944 only.

Varietal Response of Barley to Planting Date
Manitoba 1943-44

Table 29. Average Height in Inches of Plants for 1943, by Stations, Dates and Varieties

Winnipeg Summerfallow

Variety	Date 1	Date 2	Date 3	Mean
O.A.C.21	42	29	--	36
Plush	37	30	--	33
Rex	38	32	--	35
Sanalta	40	33	--	36
Trebi	37	24	--	30
Wisc.38	36	31	--	34
Mean	38	30	--	34

Winnipeg Second Crop Land

Variety	Date 1	Date 2	Date 3	Mean
O.A.C.21	34	33	24	30
Plush	30	30	27	29
Rex	33	32	26	30
Sanalta	33	30	26	30
Trebi	26	24	22	24
Wisc.38	24	32	26	31
Mean	33	30	25	29

Arborg

Variety	Date 1	Date 2	Date 3	Mean
O.A.C.21	39	39	36	38
Plush	33	36	34	35
Rex	38	36	32	35
Sanalta	39	40	37	39
Trebi	29	29	28	29
Wisc.38	38	37	35	37
Mean	36	36	34	35

Varietal Response of Barley to Planting Date
Manitoba 1943-44

Table 30. Average Height in Inches of Plants for 1944, by Stations, Dates and Varieties

Winnipeg Summerfallow

Variety	Date 1	Date 2	Date 3	Mean
O.A.C.21	41	40	35	39
Plush	38	40	30	36
Rex	40	39	33	37
Sanalta	42	41	34	39
Trebi	32	31	25	29
Wisc.38	40	40	29	36
Mean	39	38	31	36

Winnipeg Second Crop Land

Variety	Date 1	Date 2	Date 3	Mean
O.A.C.21	40	39	38	39
Plush	36	37	34	36
Rex	37	38	35	37
Sanalta	38	40	39	39
Trebi	29	30	29	30
Wisc.38	38	38	35	37
Mean	36	37	35	36

Arborg

Variety	Date 1	Date 2	Date 3	Mean
O.A.C.21	45	44	40	43
Plush	40	41	37	39
Rex	42	41	37	40
Sanalta	44	44	38	42
Trebi	35	32	30	32
Wisc.38	43	43	36	41
Mean	42	41	36	39

Brandon

Variety	Date 1	Date 2	Date 3	Mean
O.A.C.21	44	38	39	40
Plush	41	36	34	37
Rex	42	38	38	39
Sanalta	42	42	40	41
Trebi	35	30	32	32
Wisc.38	42	40	34	39
Mean	41	37	36	38

Varietal Response of Barley to Planting Date Manitoba 1943-44

Table 31. Average Height in Inches of Plants Over All Stations, by Years, Dates and Varieties

Mean Height of Plants, 1943

Variety	Date 1	Date 2	Date 3	Mean
O.A.C.21	38	34	30	34
Plush	33	32	30	32
Rex	36	33	29	33
Sanalta	37	34	32	34
Trebi	31	26	25	27
Wisc.38	36	33	31	33
Mean	35	32	29	32

Mean Height of Plants, 1944

Variety	Date 1	Date 2	Date 3	Mean
O.A.C.21	42	40	38	40
Plush	39	38	34	37
Rex	40	39	36	38
Sanalta	42	42	38	40
Trebi	33	31	29	31
Wisc.38	41	40	34	38
Mean	39	38	35	38

Mean Height of Plants, 1943 and 1944 Combined*

Variety	Date 1	Date 2	Date 3	Mean
O.A.C.21	41	37	34	37
Plush	36	36	32	34
Rex	38	36	32	35
Sanalta	39	38	34	37
Trebi	31	29	27	29
Wisc.38	38	37	32	35
Mean	37	36	32	35

*Excluding Brandon, 1944.

Varietal Response of Barley to Planting Date
Manitoba 1943-44

Table 32. Average Days from Seeding to Maturity at Winnipeg in 1943, by Dates and Varieties

Winnipeg Summerfallow

Variety	Date 1	Date 2	Date 3	Mean
O.A.C.21	84	85	--	84
Plush	91	93	--	92
Rex	87	90	--	88
Sanalta	93	91	--	92
Trebi	85	91	--	88
Wisc.38	95	89	--	93
Mean	89	90	--	89

Winnipeg Second Crop Land

Variety	Date 1	Date 2	Date 3	Mean
O.A.C.21	80	75	78	78
Plush	84	85	88	86
Rex	81	76	83	80
Sanalta	86	86	87	86
Trebi	81	72	79	77
Wisc.38	84	85	89	86
Mean	82	80	84	82

Varietal Response of Barley to Planting Date Manitoba 1943-44

Table 33. Average Days from Seeding to Maturity at Winnipeg and Brandon in 1944, by Dates and Varieties

Winnipeg Summerfallow

Variety	Date 1	Date 2	Date 3	Mean
O.A.C.21	87	80	76	81
Plush	89	82	82	84
Rex	87	84	80	84
Sanalta	93	89	83	88
Trebi	87	78	78	81
Wisc.38	92	88	83	88
Mean	89	84	80	84

Winnipeg Second Crop Land

Variety	Date 1	Date 2	Date 3	Mean
O.A.C.21	90	80	78	83
Plush	94	85	82	87
Rex	92	82	79	84
Sanalta	98	87	83	89
Trebi	92	82	77	84
Wisc.38	97	86	82	88
Mean	94	84	80	86

Brandon

Variety	Date 1	Date 2	Date 3	Mean
O.A.C.21	90	80	78	83
Plush	92	87	88	89
Rex	90	82	82	85
Sanalta	94	89	89	91
Trebi	90	81	79	83
Wisc.38	93	87	88	89
Mean	92	84	84	87

straw at the later seedings will be noted, as will a tendency towards reduced lodging on Second Crop Land at Winnipeg.

The varieties showed a very consistent performance. Sanalta and Rex displayed the greatest resistance to lodging, but Trebi and Wisconsin 38 were weak, especially under unfavorable conditions.

Height of plant data are also presented. Height varied little between stations and years. Delayed seeding caused a considerable shortening of plants, especially of the tall varieties. Second Crop Land plants were not as tall as those grown on Summerfallow.

O.A.C. 21, Wisconsin 38 and Sanalta were taller than Plush and Rex, while Trebi was very short, especially at the third date. The height of varieties varied little in relation to each other, but was most affected by date of seeding and season.

Days required to maturity are summarized from the stations where heading and ripening notes could be taken. They indicate a very pronounced effect of date of seeding on the length of time required by barley to reach maturity. Thus barley sown at the second date did not take as long to mature as barley sown at the first date and again the third date barley did not take quite as much time to ripen as the barley sown at the second date. Where the third date seeding

was very late, time required to reach maturity was fairly long, because the cool fall nights and dull weather slowed up the final growth stages.

The varieties showed up as expected, ripening in the order Trebi, O.A.C. 21, Rex, Plush, Wisconsin 38 and Sanalta. The effect of delayed seeding in hastening maturity was especially notable on the varieties Trebi and O.A.C. 21 which are relatively mid-early in growth habit.

(d) Relationship of Strength of Straw and 1000 Kernel Weight

A preliminary examination of the results indicated the existence of some degree of relationship between strength of straw and 1000 kernel weight. Field observations had led to the opinion that lodging reduces the weight of a given number of grains by causing imperfect filling of the kernels. To discover to what extent this was the case, correlation coefficients were calculated for strength of straw with 1000 kernel weight at each date of seeding. The results obtained are as follows:

Correlation Between Straw Strength (x) and 1000 KW (y).

	r_{xy}	DF	t	t at 5%pt.
Date 1	.4956	40	3.61	2.02
Date 2	.7065	40	6.31	2.02
Date 3	.0508	34	0.30	2.03

At the first and second date of seeding, there was a high correlation between strength of straw and 1000 kernel weight. For the third date, no significant correlation was noted. This would indicate that with late planting, when lodging is generally not serious, factors other than strength of straw are responsible for variations in 1000 kernel weight.

Fungus Diseases (Tables 34 - 37)

Stem rust of wheat, Puccinia graminis (Pers.) tritici Eriks., and Henn. was noted on the barley at every station over the two years of the experiment. At Winnipeg, all the barley plots were under conditions of an artificial epidemic in both years, rust spores being applied during the third week of June. At Arborg and Brandon natural infection conditions prevailed.

The tables on stem rust infection indicate that as seeding is delayed, the severity of stem rust infection increases. While all the varieties studied were susceptible to stem rust, the varieties O.A.C. 21, Rex and Sanalta showed a higher degree of stem rust infection than Plush, Wisconsin 38 and Trebi.

As would be expected, stem rust infection was much more severe at Winnipeg than at Arborg or Brandon. The very low degree of infection at the third date at Arborg in 1943 as well as no noticeable infection at the same date in 1944 is noteworthy.

Varietal Response of Barley to Planting Date
Manitoba 1943-44

Table 34. Percent Stem Rust Infection for 1943, by Stations, Dates and Varieties

Winnipeg Summerfallow

Variety	Date 1	Date 2	Date 3	Mean
O.A.C.21	13	15	--	14
Plush	10	10	--	10
Rex	5	7	--	6
Sanalta	15	13	--	14
Trebi	10	23	--	16
Wisc.38	15	13	--	14
Mean	11	14	--	12

Winnipeg Second Crop Land

Variety	Date 1	Date 2	Date 3	Mean
O.A.C.21	14	17	50	27
Plush	3	5	37	15
Rex	7	10	37	18
Sanalta	22	17	39	29
Trebi	5	7	23	12
Wisc.38	3	6	46	18
Mean	9	10	39	19

Arborg

Variety	Date 1	Date 2	Date 3	Mean
O.A.C.21	7	20	T	9
Plush	T	8	4	4
Rex	T	18	2	7
Sanalta	4	13	T	6
Trebi	T	2	T	1
Wisc.38	T	8	T	3
Mean	2	12	1	5

Varietal Response of Barley to Planting Date
Manitoba 1943-44

Table 35. Percent Stem Rust Infection for 1944, by Stations, Dates and Varieties

Winnipeg Summerfallow

Variety	Date 1	Date 2	Date 3	Mean
O.A.C.21	22	30	46	33
Plush	5	6	32	14
Rex	17	19	48	28
Sanalta	22	21	48	30
Trebi	12	18	23	18
Wisc.38	5	6	38	16
Mean	14	17	39	23

Winnipeg Second Crop Land

Variety	Date 1	Date 2	Date 3	Mean
O.A.C.21	20	50	43	38
Plush	5	23	37	22
Rex	18	32	40	30
Sanalta	13	28	37	26
Trebi	15	35	15	22
Wisc.38	5	28	32	22
Mean	13	33	34	26

Arborg

Variety	Date 1	Date 2	Date 3	Mean
O.A.C.21	23	13	0	12
Plush	12	5	0	6
Rex	22	15	0	12
Sanalta	14	13	0	8
Trebi	15	7	0	7
Wisc.38	12	12	0	8
Mean	16	11	0	9

Brandon

Variety	Date 1	Date 2	Date 3	Mean
O.A.C.21	T	3	46	16
Plush	0	2	25	9
Rex	T	6	46	17
Sanalta	T	4	33	12
Trebi	0	2	23	8
Wisc.38	0	2	26	9
Mean	T	3	33	12

Varietal Response of Barley to Planting Date
Manitoba 1943-44

Table 36. Percent Stem Rust Infection Over All Stations, by Years, Dates and Varieties

Mean Stem Rust Infection, 1943, Pct.

Variety	Date 1	Date 2	Date 3	Mean
O.A.C.21	11	17	25	17
Plush	5	8	20	11
Rex	4	12	20	9
Sanalta	14	14	20	16
Trebi	5	11	12	10
Wisc.38	6	9	23	12
Mean	7	12	20	12

Mean Stem Rust Infection, 1944 Pct.

Variety	Date 1	Date 2	Date 3	Mean
O.A.C.21	16	24	34	25
Plush	6	9	24	13
Rex	14	18	34	22
Sanalta	12	17	30	19
Trebi	8	15	15	14
Wisc.38	6	16	24	14
Mean	11	16	26	18

Mean Stem Rust Infection, Pct., 1943 and 1944 Combined*

Variety	Date 1	Date 2	Date 3	Mean
O.A.C.21	16	24	28	22
Plush	6	10	22	12
Rex	12	17	25	16
Sanalta	15	16	24	19
Trebi	10	15	12	13
Wisc.38	7	12	23	14
Mean	11	16	22	15

*Omitting Brandon, 1944

Varietal Response of Barley to Planting Date
Manitoba 1943-44

Table 37. Average Leaf Rust Readings at Winnipeg on Summerfallow and Second Crop Land, for 1943 and 1944, by Dates and Varieties

Summerfallow, 1943

Variety	Date 1	Date 2	Date 3	Mean
O.A.C.21	23	40	--	32
Plush	50	35	--	42
Rex	22	30	--	26
Sanalta	43	40	--	42
Trebi	25	42	--	34
Wisc.38	30	27	--	28
Mean	32	36	--	34

Second Crop Land, 1943

Variety	Date 1	Date 2	Date 3	Mean
O.A.C.21	10	28	30	33
Plush	16	46	50	37
Rex	23	43	50	39
Sanalta	10	48	50	36
Trebi	27	35	60	41
Wisc.38	8	35	40	28
Mean	16	39	48	35

Summerfallow, 1944

Variety	Date 1	Date 2	Date 3	Mean
O.A.C.21	7	17	24	16
Plush	10	21	42	24
Rex	12	29	60	34
Sanalta	17	12	60	26
Trebi	14	19	49	27
Wisc.38	11	20	30	20
Mean	12	20	42	24

Second Crop Land, 1944

Variety	Date 1	Date 2	Date 3	Mean
O.A.C.21	22	12	33	22
Plush	12	15	47	25
Rex	7	23	60	30
Sanalta	12	14	37	21
Trebi	7	20	33	20
Wisc.38	7	8	23	13
Mean	12	15	39	22

Leaf rust of barley, Puccinia anomala Rostr. occurred at Winnipeg in both years, as well as at Arborg in 1943. The severity of leaf rust infection appeared to be higher at the later than at the earlier dates of seeding, as seen from the table on the average leaf rust readings on the Winnipeg plots in 1943 and 1944, by date and variety.

In 1943, a very limited amount of loose smut Ustilago nuda (Jens) K. and S. occurred on the variety Sanalta. Since foundation stock was used as the source of seed, smut did not occur on the other varieties. In 1944, however, Rex, Sanalta, Plush and Wisc. 38 showed loose smut infection in moderate to slight amounts (10 - 1 plants per plot).

Very little covered smut, Ustilago hordei (Pers.) K. and S. could be found.

Ergot, Claviceps purpurea (Fr.) Tul. occurred to a limited extent on Winnipeg plots in 1943 of the varieties Plush, Rex and Wisc. 38.

Powdery mildew of barley, Erisiphe graminis hordei Marchal. occurred on the Winnipeg Summerfallow plots in 1944. It was first noted about the second week of August. It affected the barley sown at the third date. Varietal differences in disease reaction could not be distinguished.

The appearance of net blotch of barley, Helminthosporium teres Sacc. was noted on Winnipeg plots in both years. Usually a few of the lower leaves of the barley plants showed disease symptoms. It occurred on all varieties. Net blotch also occurred on the Arborg plots in 1944.

Varietal Response of Barley to Planting Date
Manitoba 1943-44

Table 38. Meteorological Data for the Summer Months at Winnipeg, 1943 and 1944*

	Temperature °F			Precip.	Rel. of Prec. to	Sun-	Rel. of Sunshine Hrs. to
	Mean	Max	Min	Ins.	Normal	shine Hours	Normal
1943							
May	49	87	21	3.20	+.99	202	-41
June	59	83	32	3.81	+.74	210	-39
July	71	92	53	3.46	+.55	338	+40
August	65	87	40	2.90	+.43	274	+12
September	53	85	22	1.57	-.66	207	+29
1944							
May	56	89	18	1.91	- .30	202	-42
June	60	80	36	6.74	+3.67	204	-46
July	66	92	42	1.58	-1.37	313	+15
August	64	86	38	5.44	+2.95	239	-24
September	55	76	31	1.53	- .67	134	-44

*Taken from the Man. Crop. Report, 1943 and 1944.

Table 39. Field Plan, Dates of Seeding Test
Winnipeg Second Crop Land, 1944

	Date 2						Date 1						Date 3					
Var. No.	2	5	6	4	1	3	3	4	1	6	2	5	6	5	1	4	2	3
Plot No.	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108

	Date 1						Date 3						Date 2					
Var. No.	3	6	1	2	4	5	4	1	6	3	2	5	3	4	1	5	6	2
Plot No.	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90

	Date 3						Date 2						Date 1					
Var. No.	1	3	4	5	2	6	3	1	4	2	6	5	6	2	4	3	1	5
Plot No.	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72

	Date 2						Date 1						Date 3					
Var. No.	6	5	2	4	1	3	5	1	4	2	6	3	3	1	4	6	5	2
Plot No.	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54

	Date 1						Date 3						Date 2					
Var. No.	1	4	3	2	6	5	5	2	4	6	3	1	1	2	6	4	3	5
Plot No.	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36

	Date 3						Date 2						Date 1					
Var. No.	2	6	1	3	5	4	2	5	3	6	4	1	6	5	2	4	3	1
Plot No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18

Key to Varieties

1. O.A.C.21
2. Plush
3. Wisc.38
4. Trebi
5. Rex
6. Sanalta

DISCUSSION

Any evaluation of the experimental results just presented must be made with the realization that the two years of the experiment, 1943 and 1944, could not be considered climatically normal years. Seasonal effects had been considerable, because very favorable moisture conditions prevailed during the growing season. This will readily be seen by examining Table 38 which presents the meteorological data at Winnipeg during the growing season of these two years.

In 1943 precipitation was above normal during the growing season. Fairly high temperatures prevailed during the latter part of the summer. The first frost at Winnipeg came on September 14th.

In 1944, after a relatively dry May, June was extremely wet. More moderate conditions prevailed then until the third week in August, when very heavy rains fell. Temperatures were nearly normal, but the hours of sunshine were low.

In both years of the experiment, moisture was never a serious limiting factor.

These favorable water relations are undoubtedly partly responsible for the results obtained. It is hardly probable that under conditions of partial drought the second date of seeding would have done

as well compared to the first date as it did in 1943 or 1944. Thus Jones (15) at the Cheyenne station noted that in years of adequate moisture, the late seeding dates did very well, while Olson, Meredith, Laidlaw and Lejeune (25) found that under partial drought conditions, later dates of seeding greatly curtailed yields as compared to the first.

The same applies to performance of the varieties. Under dry conditions, the two-row varieties which did so well in those tests might show up differently. Changes in yield position of varieties associated with different seasons are seen in the report of Wiebe, Cowan and Reinbach-Welch (32).

It is therefore doubtful whether the results, especially as far as date of seeding is concerned, are completely applicable in average seasons. During the two years of the test, seedings as late as the third week in May gave yields as high as or even higher than plantings at the beginning of May or late April. This might not have been the case had moisture conditions been less favorable. However, it must be noted that while the results indicate that high yields can be obtained from relatively late seedings, they in no way militate against early seeding, except at one station in one year.

Before discussing varieties, it should be noted that the method of harvesting experimental plots is apt to favor the week-strawed varieties such as Trebi and Wisc. 38 by virtue of recovering a much greater portion of the heads than would be harvested by the farmer using power machinery. Under farm conditions the strong strawed, two-rowed varieties are likely to show up more favorably as compared to the weak-strawed varieties, than would be the case on rod row test plots.

The outstanding performance of the variety Sanalta in 1944 cannot be overlooked. Seasonal effects are probably linked with these high yields. Plush has shown up well on Second Crop Land. The previous work at this station regarding O.A.C. 21 is confirmed: early seeding is absolutely essential if satisfactory yield and quality are to be obtained; any delays in seeding have very adverse effects on O.A.C. 21.

The variety Trebi has done quite well. Its value to the farmer must be considered limited, since it is discriminated against commercially nor held to be as desirable a feed barley as the smooth awned varieties from the standpoint of handling and livestock feed.

The performance of Wisc, Ped. 38 has been rather disappointing, except at the Arborg station. Lodging may be partly responsible, yet Wisc. 38 did poorly at Winnipeg in 1944, where lodging was not serious. Seasonal effects are probably largely responsible, for the unpublished results of the 1944 Manitoba Plant Breeders' Cooperative Tests of barley hybrids and varieties indicate a poor yield performance for Wisc. 38 over all the 17 stations of the test.

The variety means obtained over two years thus indicate that satisfactory results from a yield and malting point of view can only be obtained with O.A.C. 21 if early seeding is practiced. If, for reasons of weather, weed control or limited farm equipment, seeding of barley has to be delayed, the chances of produring malting barley are forfeited and only feed barley can be grown. In order to obtain high yields under late seeding conditions, Plush, Sanalta or Rex should be grown. Plush commends itself as the best variety for seeding under restricted moisture conditions as on second crop land. Sanalta would be the logical choice on summerfallow, where it would outyield Plush. Sanalta would not be likely to lodge on summerfallow. If seeding should have to be delayed into June, a more early maturing variety, such as Rex, would be preferable.

The weight per bushel values show the two-row varieties to be highest, especially at the early dates. O.A.C. 21 and Plush are of average weight per bushel. The low figures for Trebi, especially in 1944, are due to the failure of that variety to thresh closely, a weakness which has also been noted by Swanson and Laude (30).

The decrease in weight per bushel with delayed seeding applies to all varieties, but especially to the late maturing varieties, the third date samples of which in 1943 would be considered as immature. Rex and Trebi show up fairly well on weight per bushel at the third date.

The lower bushel weight values for the late planting dates are obviously due to poor filling of the grain, especially in view of the abbreviated growth period of all varieties at the later seedings.

A similar explanation can be advanced for the diminution of 1000 kernel weight values under retarded planting conditions. A few values in the tables appear out of line, such as that of Trebi at the second date on Winnipeg Summerfallow in 1943. Here the second date values are considerably higher than those at the first date. The explanation for this will be found in the strength of straw data. Trebi at the first date had partially lodged, but

was standing up at the later date of seeding. Other examples of lodging having an adverse effect on 1000 kernel weight are evident. The highly significant correlation coefficients between strength of straw and 1000 kernel weights at the first and second dates of seeding emphasize this relationship.

The analysis of the barley samples for nitrogen content has produced some surprising results. The nitrogen values are very low, but this is probably related to the heavy summer rainfall during the two years of the experiment. Yates and Watson (34) at Rothamsted noted that every extra inch of rain during the early part of the growing season lowered the nitrogen content of barley by .04%. However they noted increases in the nitrogen content with delayed seeding, which is not evidenced in the results presented. J.W. Hopkins (13) also found the protein content of cereal grains to vary inversely with the total rainfall. While this may indicate why the nitrogen values are generally low, it does not suggest any reason why there should be lower nitrogen values under late seeding conditions as compared to early seeding, especially on summerfallow.

While Gericke (4, 5) found that plants absorbed nitrogen from the soil right up to maturity, noting that highest protein values in wheat resulted from

cultures to which sodium nitrate had been applied up to maturity, he also noted that if the nitrogen supply of plants were low at certain critical growth periods, the nitrogen content of the grain would be low. Neidig and Snyder (24) noted that high moisture well distributed throughout the growing period was responsible for low nitrogen content and high yields in Marquis wheat. McCalla (20) has shown that organic nitrogen produced in the vegetative parts of cereals after heading time is not synthesized to grain proteins, but accumulates in the vegetative tissues. Miller (23) points out that the greatest portion of the nutrients drawn from the soil is taken in by the plant in the first ten weeks of growth.

There would therefore seem a possibility that the low nitrogen content of the late-sown barley can in some way be linked with the climatic conditions prevailing during the growing season. The heavy rains probably tended to depress soil nitrates at a critical growth period.

The very low nitrogen content of barley grown on second crop land is probably due to less nitrates being available in the soil, since the supply of nitrogen in the soil and the amount in the grain are related (23). The higher nitrogen values at Brandon may be due to lighter soil, Russell and Watson having

found a higher nitrogen content in barley grown on light soil at Woburn as compared to the heavy soil at Rothamsted. They also noted that high temperatures in the early growing season lowered the nitrogen content of barley. Since the early part of the growing season for barley sown at the third date would be June and July, when temperatures are fairly high, a partial explanation for the low nitrogen content of the third date crop may perhaps be advanced on this basis. However, Meredith, Olson and Rowland (22) noted no significant effect of date of seeing on nitrogen content of barley in 1937, and an examination of the analysis of variance data for nitrogen content as presented will indicate that the same applies in this case.

All varieties tested are susceptible to stem rust. The varieties Plush and Wisconsin 38 appeared to be less affected by stem rust than the other varieties, notably at the early seedings. However, Rex, Sanalta, O.A.C. 21 and Trebi were all heavily infected, especially at the late dates. If stem rust had any effect on yield and quality, it must have had a similar effect for all varieties since a differential response due to stem rust cannot be noted, except perhaps in the case of Plush.

The increased infection of the barley varieties by stem rust as the date of seeding advances has previously been mentioned by Olson, Meredith, Laidlaw and Lejeune (21). The greater prevalence of uredospores of stem rust later in the season is probably responsible. The absence of stem rust at the late date of seeding at Arborg in both years is very difficult to explain since it occurred on the earlier date plantings growing only a few feet away.

Similarly, the severity of barley leaf rust infection was highest on the late-sown barley. Since the late-sown barley matured under late summer conditions, with high humidity and cool nights, which are optimum conditions for Puccinia anomala Rostr., this is to be expected. The increased amount of spores in the air as the season advanced may also be related to the heavy leaf rust infection on the third date crop.

As Burnett and Reddy (3) noted previously, lodging, plant height and time required to maturity are all reduced with delayed seeding. This is borne out by the results obtained. There are, of course, exceptions. In 1944 lodging was very heavy at all dates at Brandon, while at Arborg the late date of seeding was blown over by a heavy rainstorm. The

strength of straw or absence of lodging may be related to the availability of nitrogen in the soil, a view held by Miller (23). Thus lodging was least on Winnipeg Second Crop Land where the available nitrogen, as indicated by the protein content of the grain, was not as high as at the other stations. All varieties showed tendencies towards weak straw at Arborg and Brandon where the soil nitrogen, as indicated by the amount present in the barley, must have been more readily available.

Barley sown at the later dates of seeding was much shorter than barley sown at the earlier date. This may be due to the shortened growing period of the late planted crop, as well as the higher temperatures which are probably the main factors hastening maturity.

The shortened growth period of late sown barley appears to have its limitations. Thus the time required for the third date seeding to mature is longer than that required for the second date crop. This may be partially due to the reduction in heat energy obtained by plants as the season progresses past the middle of August. Thus the maturity of the late-sown barley, especially that of the slow-maturing varieties, may be considerably delayed.

CONCLUSIONS

Under the climatic conditions prevailing during the two years the experiments were conducted, the following general conclusions can be made.

1. Delayed seeding causes a reduction in yield, which may be noted at varying time intervals, depending on the season, the location and the soil. Under Winnipeg and Brandon conditions the second date of seeding gave yields fully as satisfactory as the first, and in instances, even significantly higher yields. At Arborg, however, the early planting definitely outclassed the later seeding dates. The very late date of seeding produced much lower yields under all conditions and at all stations.

2. Differential response to date of seeding has been demonstrated. The variety O.A.C. 21 yields well only under early planting conditions. The varieties Plush and Sanalta do not show a significant decline in yield until the third seeding date is reached. Under very late seeding, Rex seems to be satisfactory.

3. Delayed seeding causes a reduction in quality, as evidenced by lower bushel and 1000 kernel weight values. The lowering of quality at the second date

is not severe, although it is clearly demonstrable, but it is very serious under very late planting conditions.

4. Differential response of varieties as regards effect of date of seeding on quality can be seen. Thus the two-rowed barleys do not show a serious decline in quality up to the third date. O.A.C. 21 and Wisc. Ped. 38 are very stable and show little degradation, even at the third date of seeding. Plush occupies an intermediate position. Under very late seeding conditions, the quality of the slow-maturing varieties is very poor.

5. No significant effect of date of seeding on the nitrogen content of barley could be found nor were differential responses of varieties to date of seeding as regards percent protein noted.

6. The degree of lodging, the height of the plants and the time from seeding to maturity were all reduced by delayed planting. The weak strawed varieties at the late dates stood up almost as well as Sanalta and Rex.

7. Late-sown barley is more likely to be infected with stem and leaf rust. Barley sown at the third

date showed a much higher degree of rust infection as compared to the crop sown at the early date.

8. Planting recommendations that appear evident are that if O.A.C. 21 is to be grown, early seeding is absolutely essential. Early seeding is best for any variety, but if seeding is delayed for any reason, Sanalta would be best for fallow land and Plush for seeding on second crop land.

ABSTRACT

An experiment was conducted on the differential response to date of seeding of the barley varieties O.A.C. 21, Plush, Rex, Sanalta, Trebi and Wisc. Ped. 38. Barley was sown at three dates, about two weeks apart, the first about the time when field work became general. Tests were conducted in 1943 and 1944 on summerfallow at Winnipeg and Arborg, on second crop land at Winnipeg, as well as on fallow at Brandon in 1944 only.

No serious reduction in yield accompanied seedings as late as the third week in May. Delayed seeding caused a reduction in quality as evidenced by lower bushel and kernel weight, but caused little appreciable difference in protein content of the grain. The late-sown barley was shorter, matured more quickly and lodged less than the early sown crop. It was, however, more liable to stem and leaf rust.

Early seeding was best for O.A.C. 21, the malting barley. For later seedings, Plush and Sanalta appeared to recommend themselves. The latter is especially suitable for summerfallow seeding, where moisture is ample for high yields and strong straw is a valuable asset. Wisconsin Ped. 38 has not shown much

merit under any test conditions. The differential effect of locality should be noted: Winnipeg appears very favorable to the variety Plush, Brandon to Sanalta, but O.A.C. 21 has done well at Arborg, especially under early seeding conditions.

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