# THE EFFECT OF DELAYED HARVEST ON THE YIELD OF CERTAIN VARIETIES OF OATS AND BARLEY

THESIS FOR THE DEGREE OF M. S.

Walter Frank Russow

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Farm crops

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THESIS

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## INTRODUCTION

The increase in numbers of combine harvesters in Michigan is a factor to be considered by those interested in the agriculture of this state. According to Sauvé (1930 and 1931), in 1927 there were seven combines in use in Michigan; by 1928 this number had been increased to thirty-three; 1929 to fifty-four; 1930 to eighty-nine and 1931 the total had reached one hundred and seventeen.

The use of the combine under suitable conditions significantly reduces the cost of harvesting small grains. Calculated on a basis that two hundred acres of grain will be cut each year, the harvesting costs for a combine are approximately $2.50 per acre compared to an expenditure of about $4.00 for cutting, binding and threshing (Sauvé 1930). As a general rule, the harvesting costs of the combine and the binder-thresher are about equal for an area ranging from one hundred to one hundred and fifty acres.

The combine, as has been the case with many other modern implements, has brought up new problems. Under average conditions, eight to fourteen days elapse from the time the grain may be harvested with the binder, until it may safely be harvested with the combine and put into storage.

During this period the grain must resist lodging, crinkling and shattering if it is to maintain as high a yield as could be secured by use of the binder.

Early experimenters were primarily concerned with soil and climatic factors in relation to the time and duration of the harvest period, but investigations carried on in more recent years have demonstrated that methods of culture, and varieties of grain grown, must be considered as materially influencing the method, time and duration of harvest.

The work of investigators in the past two years has tended to show somewhat of a variation between varieties and their ability to maintain a maximum yield over the duration of the combine period.

This problem was then inaugurated to determine, under Michigan conditions, the effect of delayed harvest on the yield of certain varieties of oats and barley adapted to this state.

## HISTORICAL

### Changes occuring in the composition of the kernel during the ripening period.

Although this problem is concerned largely with the effect of delayed harvest on the yield of grain, the changes that occur in the composition of the oat, barley and wheat kernel as they approach maturity are of considerable importance and are briefly reviewed here.

Kedzie in (1882) and (1893) was one of the first to publish data of this kind. Working with Clawson wheat, he found the carbohydrate content to increase gradually reaching its maximum when the kernels were in the hard dough stage and then remaining constant. The crude protein content decreased to a minimum in the milk stage, with little change thereafter. The crude fiber reached its minimum in the latter part of the hard dough stage, with little change afterwards. The fat content remained fairly constant throughout the ripening period.

Le Clerc and Breazeale (1908) in studying the effect of rain and dew on plants found that as the plants ripened, the salts held in the sap of the plants have a tendency to migrate from the dying to the living tissue. The salt exuded on the surface of the plant is then washed off and back into the soil by rain. They also found this migration to be upward and not downward, there being, in fact, little evidence to show excretion through the roots into the soil.

Brenchley (1912), working with the development of the grain at Rothamsted, found the weight of the whole plant to increase steadily until desiccation sets in about three weeks before harvest, after which a fall in weight is evident. The nitrogen, ash and phosphoric acid content increase until a maximum is reached about the time at which desiccation begins. Then while the nitrogen and phosphoric acid remain fairly constant, the ash decreases somewhat in quantity. The long growing period of barley gave a prolonged period of desiccation, during which certain maturation changes were evident.

Keitt and Tarbox (1912), studying the oat plant as it approached maturity, found that the increase in the total dry matter was very rapid during the first few days of the maturity of the plant, previous to that time the increase was regular, but not rapid. The protein in the seed increased until the milk stage, after which time the decrease was quite rapid. The water remained high and rather constant during the bloom stage, decreasing suddenly at the beginning of the milk stage, and remaining very constant until the oat started to mature, when there was another decrease in moisture content. The percent of sugar decreased during the milk stage, but increased slightly as the plant approached maturity.

Harlan (1920), studying daily development of the

barley kernel from flowering to maturity, found the increase in dry matter in the kernel to be very uniform throughout the period of growth. The percentage of water decreased uniformly from flowering to maturity. During growth carbohydrates increased most rapidly and the ash least rapidly.

Harlan and Anthony, in the same year, found the increase in dry matter of both normal and clipped spikes to be continuous throughout the period of growth, although the clipped spikes had a lower weight and smaller volume than do the normal spikes.

Harlan and Pope (1923), working with the water content of barley kernels during growth and maturation, found the average water content of the ovaries at flowering time to be about eighty per cent and that the per cent of water in the growing kernel decreases uniformly day by day until the average of a spike is about forty-two per cent, when all deposit of dry matter is interrupted and the kernels dry with great rapidity. This is the average of all kernels on the spike and not an exact point.

Bracken and Bailey (1928), in a study of the weight, volume and density of Kanred Wheat harvested at ten day periods after ripe, show that the weight of a kernel does not change when dried to a uniform moisture content after wetting.

Wilsie (1930), in Michigan found the moisture content of wheat to decrease gradually up to the time of maturity. Kiesselbach (1931), working in Nebraska confirmed these results. Burnett and Bakke (1930), found the same to be true under Iowa conditions.

## The effect of premature harvest.

A large amount of information has been published in regard to the effect of premature harvest of wheat, oats and barley.

Georgeson and Cottrell of Kansas (1890), working with oats made three different harvest cuttings, namely; dough stage, hard dough stage and ripe. They obtained the highest yield and weight per bushel when the grain was in the ripe stage. Working at the same station in 1891 Georgeson, et al, obtained the highest yield in the dough stage, a contradiction to the previous years results, heavy rainfall at maturity probably accounting for the variation.

A continuation of the studies published in 1894 by Georgeson, et al, gave results comparable to 1890, tending to show that results may vary from year to year with varying climatic and environmental conditions.

Bedford of Canada (1890), working with two wheat varieties, obtained the highest yield when the grain was in the ripe yellow stage. The weight per bushel was also correspondingly highest at this stage.

Arny of Minnesota (1926), in studying the influence of time of cutting on the quality of the crop, found a large number of factors must be considered. Among these are yield, quality, weather conditions at harvest time and differences in climatic and soil conditions in various locations. He states that harvesting crops grown for grain or seed before they have reached approximately full maturity does not improve the quality of the product.

Arny and Sun (1927), found in experiments with the premature harvesting of wheat and oats that the highest yield was obtained when the grain was mature. Lower weight per bushel resulted from premature cutting.

Zavitz of Canada (1927), in reporting work carried on with wheat for twenty-nine years, states that it is advisable to allow the crop to become fully ripened in order to secure the highest yield of grain. Cuttings of grain made when fully ripe also gave the highest weights per bushel.

Wilson and Raleigh (1929), studying the effect of premature harvest on Marquis wheat and Victory oats, found that both the quality and quantity of grain were greater when the plants were allowed to mature. Straw yields decreased toward maturity.

Kiesselbach (1931), summarizing eleven years work on wheat and ten years work on the premature harvesting of oats, states that the highest yield of wheat was obtained when the grain was in the ripe stage. The highest yield and test weight of oats were also obtained when the grain was ripe.

McDowell of Nevada (1895), working with wheat cutting at different dates, found that the maximum yield was obtained when the grain was in the hard dough stage. He suggests cutting in the stiff dough stage when the yield is nearly to the maximum that was obtained in the hard dough stage.

The effect of delayed harvest.

Schwantes, et al, (1930), carried on experiments with the combine harvester to settle questions regarding the ability of the different crops and recommended varieties of each crop to withstand lodging, crinkling and shattering, for varying periods after becoming dead ripe. The experiments were conducted at three different stations in Minnesota. The results secured at the different stations were not the same and their findings seemed to show that under Minnesota conditions there was little difference between the varieties of grain used in their ability to maintain a maximum yield through a delayed harvest period.

Wilsie (1931), working with the effect of delayed harvest on American Banner wheat, at the Michigan Station, found the yield to decrease as the harvest period lengthened, this loss in yield being largely due to shattering.

Burnett and Bakke (1930), carried on a very comprehensive study of the effect of delayed harvest on the yield of wheat, oat and barley varieties. Of the barley varieties studied, none seemed to have a sufficient length of harvest period to warrant a recommendation for combine harvesting under Iowa conditions. With the oat crop, varietal characteristics appeared to be among the chief factors controlling the time and length of the profitable harvest period.

## EXPERIMENTAL

### Barley and Oat Varieties Used.

Four barley varieties and four oat varieties, either established or being tested for possible use in Michigan, were selected for the test on delayed harvest. In order to present a clearer picture of the effect of delayed harvest on yield, a brief history and description of each of the varieties in the test is given below.

#### Spartan Barley.

Spartan barley which, according to Rather, et al, (1929), was developed from a cross between Michigan two-row and Michigan Black Barbless, is white, two-rowed, smooth-awned, stiff-strawed, and early in maturity. Its smooth beards thresh off the kernels easily. During the 1931 season a premium was paid for Spartan barley by commercial firms using it for malting purposes and the manufacture of other barley products. It is susceptible to loose smut and net blotch, but somewhat resistant to stripe and scab.

#### Wisconsin Pedigreed Barley No. 9.

Wisconsin Pedigreed barley No. 9 (Leith 1930), a strain of Manchurian, was found growing on the University Farm at Madison, Wisconsin in 1900 under the name Mandscheuri. It gives a high yield, is six-rowed and stiff-strawed, and has good malting qualities. This variety is now being replaced by Pedigreed No. 5 (Oderbrucker) which is the same as No. 9, except that Oderbrucker is slightly more resistant to stripe. The main criticism of this variety, as shown in this test, is that the heads crinkle over and, as the combine harvester period lengthens, break off and fall to the ground, resulting in a considerable decrease in yield. The straw of Wisconsin No. 9 was the weakest of the varieties in the test.

## Glabron Barley.

Glabron barley, as reviewed from Arny and Wilson (1930), was developed from a cross made at the Minnesota Station between a smooth-awned selection and Manchuria. Glabron barley is six-rowed, hulled, smooth-awned and stiff-strawed. It is susceptible to scab and loose smut.

## Wisconsin Pedigreed No. 38.

Wisconsin Pedigreed barley No. 38 (Leith 1931), is a selection from a hybrid made at the Wisconsin station in 1926 between Oderbrucker and Lecorrynchum black, smooth barley. Repeated selections have brought forth No. 38, which is six-rowed, smooth-awned, bearded and white. It is very resistant to stripe disease, somewhat resistant to scab and susceptible to loose smut.

## Wolverine Oats.

The Wolverine variety of oats (Down 1931), which was developed as a plant selection from an unknown variety, is a tall, erect, stiff-strawed, open panicle white oat. Though a typical mid-season oat, it usually matures a few days earlier than most varieties of its class. The Wolverine variety is adapted to the upland soils of Michigan.

### Worthy Oats.

The Worthy variety of oats (Down 1931), which was developed as a plant selection from American Banner, resembles Wolverine in appearance, with the exception of a slightly coarser and stiffer straw. It is best suited to the heavy mineral soils of Michigan where lodging is a factor to consider.

### Markton Oats.

The Markton oat, as described by Stanton, et al, (1924), originated as a pure line from an unnamed oat (C. I. No. 357) at Oregon in 1911. It is a common type, mid-season oat with yellowish white grain and a large, open, drooping panicle. The straw of this variety is midlong and as illustrated in this experiment not quite as stiff as the Wolverine and Worthy varieties. The outstanding characteristic of the Markton oat is its high degree of resistance to covered smut and varies from the other three oat varieties of this test in that respect.

### Iogold Oats.

The Iogold oat, according to Burnett (1928), is the result of a single plant selection from the Kherson variety

made at the Iowa station in 1911. It is an early, short, erect, open-panicle, yellow oat with a stiff straw and a notable resistance to stem rust. This characteristic was very noticeable in 1931 when the Markton, Worthy and Wolverine varieties growing beside Iogold suffered severe infections of stem rust, whereas Iogold was unaffected. This was probably one factor that gave Iogold the advantage in yield. The Iogold oat (Churchill 1931), is recommended for use in the Upper Peninsula of Michigan where stem rust attacks are common and quite severe.

## General Experimental Procedure.

The plats were planted April 9th. on a very uniform area of Conover loam soil. The seed bed was compact and very well fitted before planting. Two hundred pounds per acre, of a 2-12-2 fertilizer was applied broadcast and worked into the soil.

The oat varieties were sown at the rate of two bushels per acre. Glabron, Wisconsin Pedigreed barley No. 9 and 38 were sown at the rate of one and one-half bushels per acre and Spartan at the rate of two. The rate of seeding Spartan was increased when a count made on the number of kernels per bushel revealed Spartan to have about twenty-five per cent less kernels than any of the other three varieties. The approximate twenty-five per cent increase in rate of seeding for Spartan should then place all the varieties on the same basis in regard to rate of seeding.

The planting was done with an eleven hole drill leaving an alley-way of fourteen inches between each plat. Each variety was replicated three times to decrease inter-plat competition to a minimum. (Fig. 1) When the varieties were nearing maturity the three replications were divided up into three series, as illustrated in Fig. 2, making in all, eleven replications on each date of harvest for each variety.

The grain was harvested at intervals of four days, conditions permitting. An area of fourteen square feet was harvested on each date, making a total of one hundred and forty-eight square feet for each variety on the six different dates that cuttings were made. The plat technique followed in making the harvestings is shown in Fig. 3. At the time of harvest, material for moisture determinations was taken from each replication. The harvested grain from each replication was capped with a heavy paper sack and shocked, as shown in Fig. 4, to avoid any further loss in handling. The first date of harvest for all the varieties was made when, from observation, the grain was considered to be in the hard dough or binder harvest stage.

Moisture determinations on each date of harvest was determined from the composite sample taken at the time of cutting. A Brown-Duvel moisture tester was used for the determination. The results are shown in the following tables.

After capping and shocking, the grain was allowed to stand until after the last date of harvest, it was then

| | Series A | Series B | Series C |
|---|---|---|---|
| | Edge | Edge | Edge |
| | Wolverine-Edge | Wolverine | Wolverine |
| Fourth Rep. | Iogold | Iogold | Iogold |
| | Markton | Markton | Markton |
| | Worthy | Worthy | Worthy |
| | Wolverine | Wolverine | Wolverine |
| Third Rep. | Iogold | Iogold | Iogold |
| | Worthy | Worthy | Worthy |
| | Markton | Markton | Markton |
| | Wolverine | Wolverine | Wolverine |
| Second Rep. | Worthy | Worthy | Worthy |
| | Markton | Markton | Markton |
| | Iogold | Iogold | Iogold |
| | Wolverine | Wolverine | Wolverine |
| First Rep. | Markton | Markton | Markton |
| | Iogold | Iogold | Iogold |
| | Worthy | Worthy | Worthy |
| | Wolverine | Wolverine | Wolverine |
| | Edge-Spartan | Edge | Edge |
| Fourth Rep. | Wisconsin # 38 | Wisconsin # 38 | Wisconsin # 38 |
| | Glabron | Glabron | Glabron |
| | Wisconsin # 9 | Wisconsin # 9 | Wisconsin # 9 |
| | Spartan | Spartan | Spartan |
| Third Rep. | Wisconsin # 38 | Wisconsin # 38 | Wisconsin # 38 |
| | Wisconsin # 9 | Wisconsin # 9 | Wisconsin # 9 |
| | Glabron | Glabron | Glabron |
| | Spartan | Spartan | Spartan |
| Second Rep. | Wisconsin # 9 | Wisconsin # 9 | Wisconsin # 9 |
| | Glabron | Glabron | Glabron |
| | Wisconsin # 38 | Wisconsin # 38 | Wisconsin # 38 |
| | Spartan | Spartan | Spartan |
| First Rep. | Glabron | Glabron | Glabron |
| | Wisconsin # 38 | Wisconsin # 38 | Wisconsin # 38 |
| | Wisconsin # 9 | Wisconsin # 9 | Wisconsin # 9 |
| | Spartan | Spartan | Spartan |
| | Edge | Edge | Edge |

Fig. 1.— The varieties were arranged in the three replications to eliminate inter-plat competition as much as possible. The series arrangement is illustrated in Fig. 2 on the following page.

Fig. 2. — When the grain was nearly mature the plats were divided up into three series making eleven replications for each variety on every date of harvest.

Fig. 3. — An area of fourteen square feet was harvested from each plat making a total of one hundred and forty-eight square feet per variety for each date of harvest. The technique followed in harvesting is also illustrated.

Fig. 4. — The harvested grain from each replication was kept separate, capped with paper sacks and shocked so that no loss would occur after harvesting.

threshed with a small experimental plat thresher and the yield in grams was recorded for each replication of a variety, on the six different dates of harvest. Moisture determinations were also made at this time for each date of harvest on all varieties. The yield from each replication was kept separate in order that the probable error might be determined. The final yield in bushels per acre was determined from the mean of the eleven replications. The yields, as presented in the following tables, are calculated on a twelve per cent moisture basis.

The probable error of each date of cutting was determined through the use of the following formulas:

$$\text{Standard Deviations} = \sqrt{\frac{\Sigma X^2 - NM^2}{N - 1}}$$

$$\text{P. E. of Mean} = \frac{.6745 \times \text{Standard Deviation}}{\sqrt{N}}$$

The probable error of the mean was determined in grams and, by the formula $\frac{\text{P. E. of Mean}}{\text{Mean}}$, the probable error in per cent of the mean was determined. The probable errors as reported in the following tables were then calculated by multiplying the probable error in per cent of the mean by the mean yield in bushels per acre.

All data are presented in the following charts and tables. The various tables show the yield, in bushels per acre, moisture content in per cent and the test weight in pounds per bushel, on any particular date of harvest. The reliability of the yields are indicated by their probable errors.

The relationship between yield, moisture content and date of harvest is presented graphically on the charts.

Moisture content is shown by connecting up the moisture percents on various dates of harvest in the form of a "curve".

Yields per acre are presented by a straight line of best fit as determined from the "law of averages". The maximum yield of each variety was used as a basis for the start of the trend line. When the maximum yield did not fall on the first date of cutting or binder harvest period, the result has been a break in the trend line. The maximum yield is taken to be the point where the superiority of the yield obtained is not due to chance alone. As a result, the highest yield for any particular variety was not always considered to be the maximum yield for that variety. "Breaking" the trend line at the second date of harvest, in the case of Spartan and Wisconsin Pedigreed barley No. 38, may draw some criticism, but in view of the fact that the break is so apparent it was deemed advisable to do this in the proper analysis of the data.

Table 1. Moisture, yield and test weight of Spartan barley on different dates of harvest.

| Harvest Date | Moisture Percent | Bu. per Acre Yield | Test Weight |
|---|---|---|---|
| July 9, 1931 | 33.5 | 47.0 ± .74 | 47.2 lbs |
| 14 | 20.9 | 51.8 ± .73 | 46.9 " |
| 17 | 14.0 | 50.3 ± .77 | 47.1 " |
| 21 | 15.9 | 48.4 ± .74 | 47.3 " |
| 25 | 10.8 | 44.6 ±1.05 | 47.0 " |
| 29 | 10.2 | 47.1 ± .50 | 46.8 " |

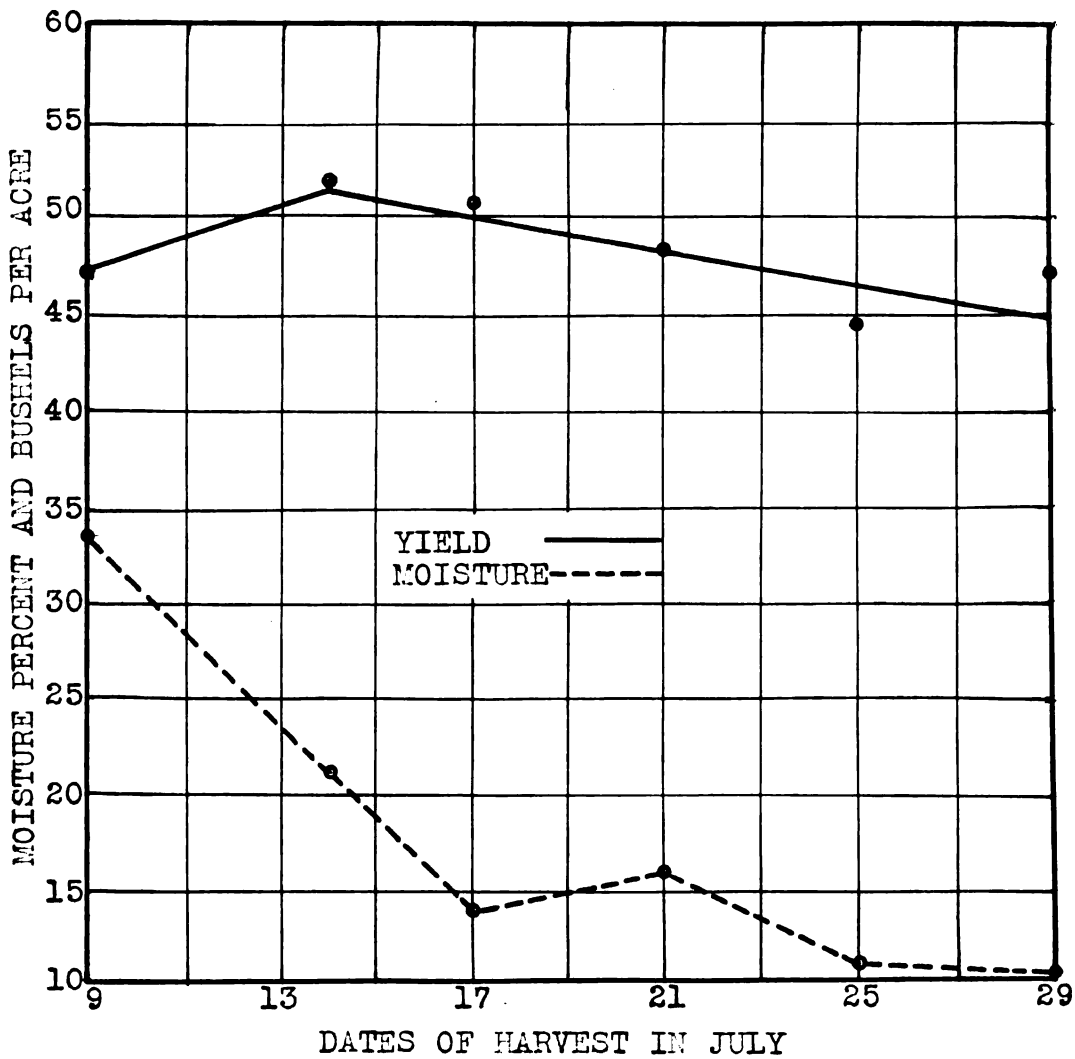


Chart 1. Showing the relationship between moisture and yield of Spartan barley to date of harvest.

Table 2. Moisture, yield and test weight of Wisconsin Pedigreed No. 9 barley on different dates of harvest.

| Harvest Date | Moisture Percent | Bu. per Acre Yield P.E. | Test Weight |
|---|---|---|---|
| July 11, 1931 | 27.0 | 44.3 ± 1.49 | 40.4 lbs |
| 15 | 15.9 | 41.2 ± 1.00 | 38.2 " |
| 18 | 13.2 | 41.6 ± .93 | 39.5 " |
| 23 | 10.3 | 30.3 ± 1.18 | 39.1 " |
| 27 | 10.3 | 29.3 ± 1.47 | 36.9 " |
| 31 | 10.7 | 29.5 ± 1.26 | 38.8 " |

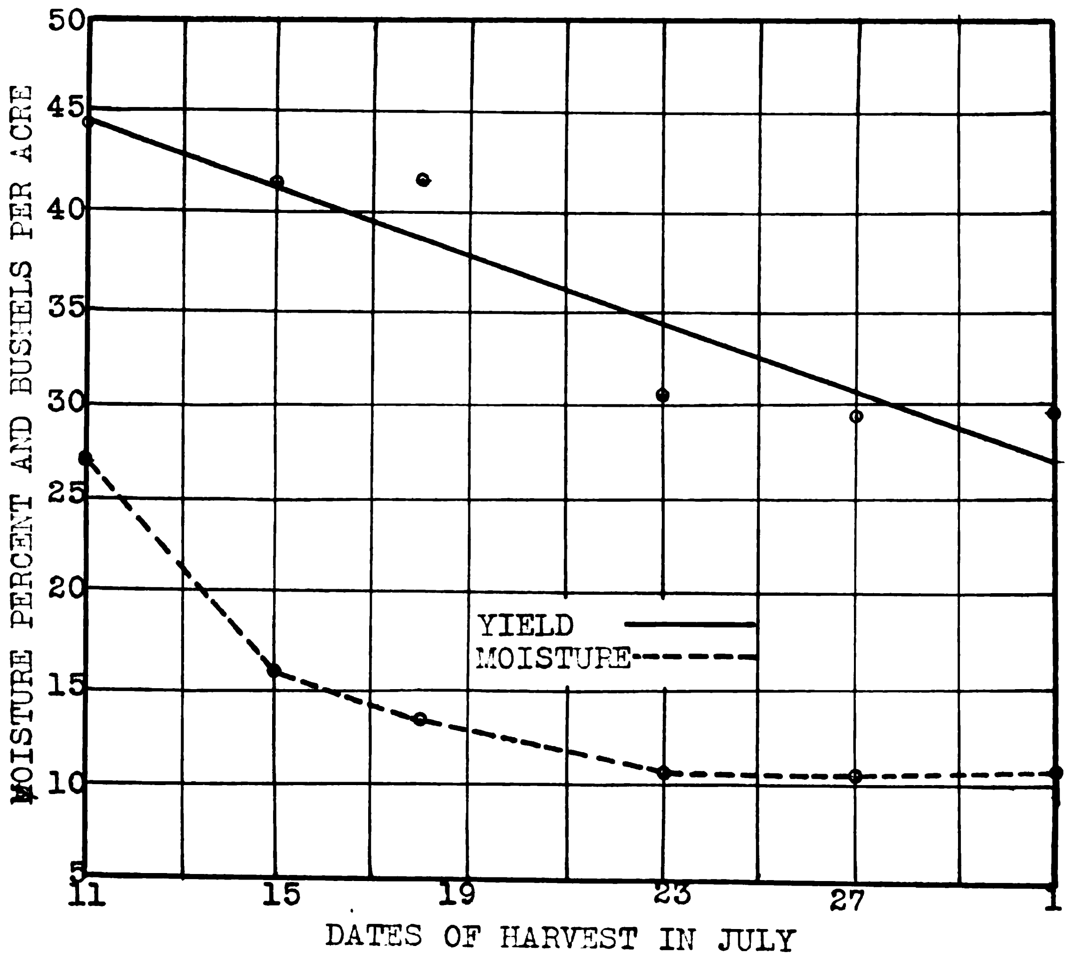


Chart 2. Showing the relationship between moisture and yield of Wisconsin Pedigreed No. 9 barley to date of harvest.

Table 3. Moisture, yield and test weight of Wisconsin Pedigreed No. 38 barley on different dates of harvest.

| Harvest Date | Moisture Percent | Bu. per Acre Yield | Test Weight |
|---|---|---|---|
| | | P.E. | |
| July 13, 1931 | 33.9 | 54.4 ± 1.26 | 40.0 lbs |
| 17 | 15.8 | 59.4 ± .98 | 40.4 " |
| 21 | 14.9 | 58.9 ± .84 | 39.9 " |
| 25 | 10.0 | 56.1 ± 1.02 | 39.8 " |
| 29 | 9.4 | 51.7 ± 1.30 | 39.2 " |
| Aug. 1 | 11.5 | 53.0 ± .70 | 39.1 " |

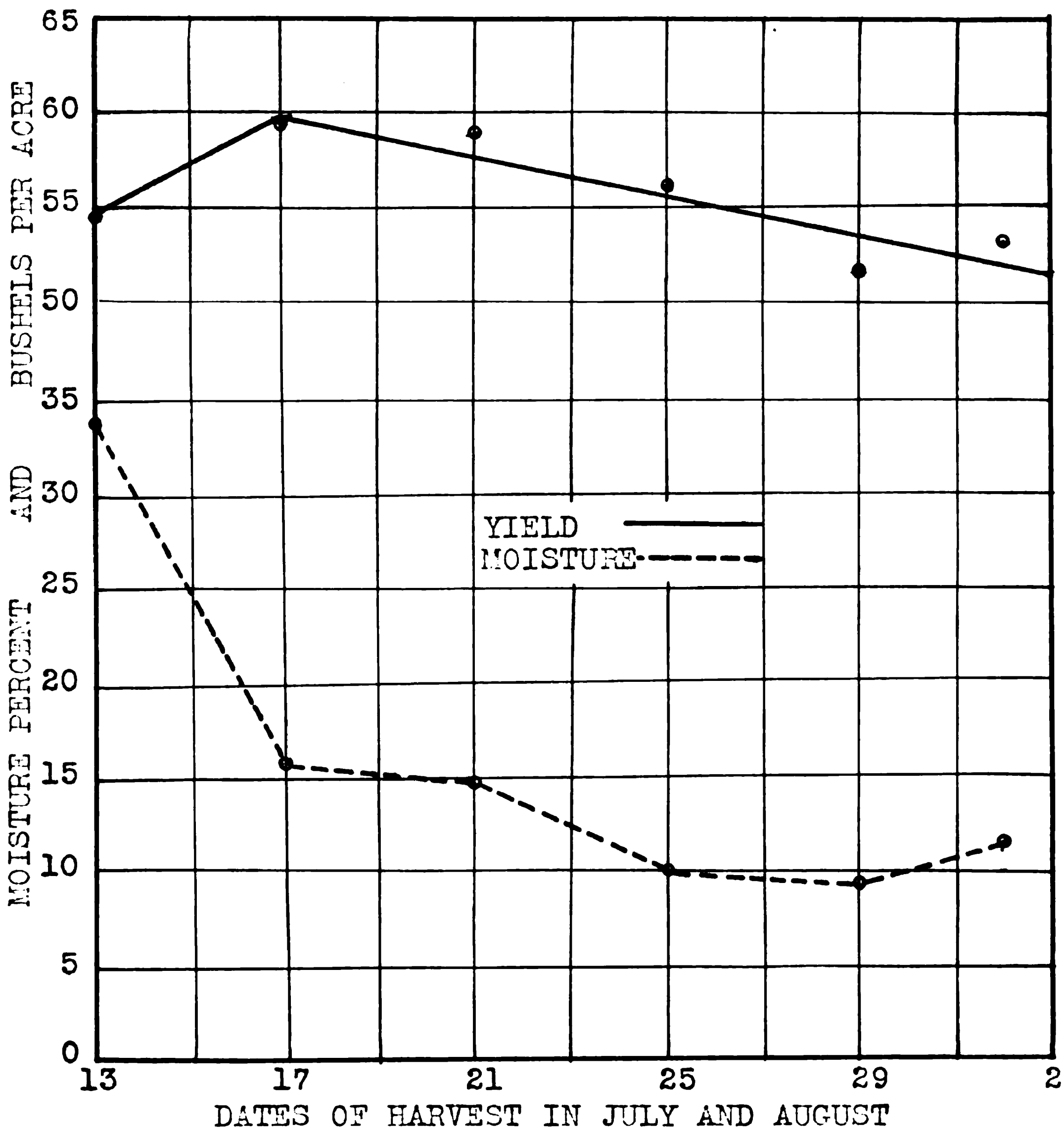


Chart 3. Showing the relationship between moisture and yield of Wisconsin Pedigreed No. 38 barley to date of harvest.

Table 4. Moisture, yield and test weight of Glabron barley on different dates of harvest.

| Harvest Date | Moisture Percent | Bu. per Acre Yield | P.E. | Test Weight |
|---|---|---|---|---|
| July 11, 1931 | 33.7 | 52.3 | ± .84 | 42.0 lbs |
| 15 | 17.9 | 50.1 | ± .74 | 42.0 " |
| 18 | 14.4 | 53.5 | ± 1.31 | 42.3 " |
| 23 | 11.1 | 46.9 | ± .73 | 40.9 " |
| 27 | 11.0 | 46.3 | ± .73 | 39.6 " |
| 31 | 10.6 | 42.5 | ± .72 | 40.7 " |

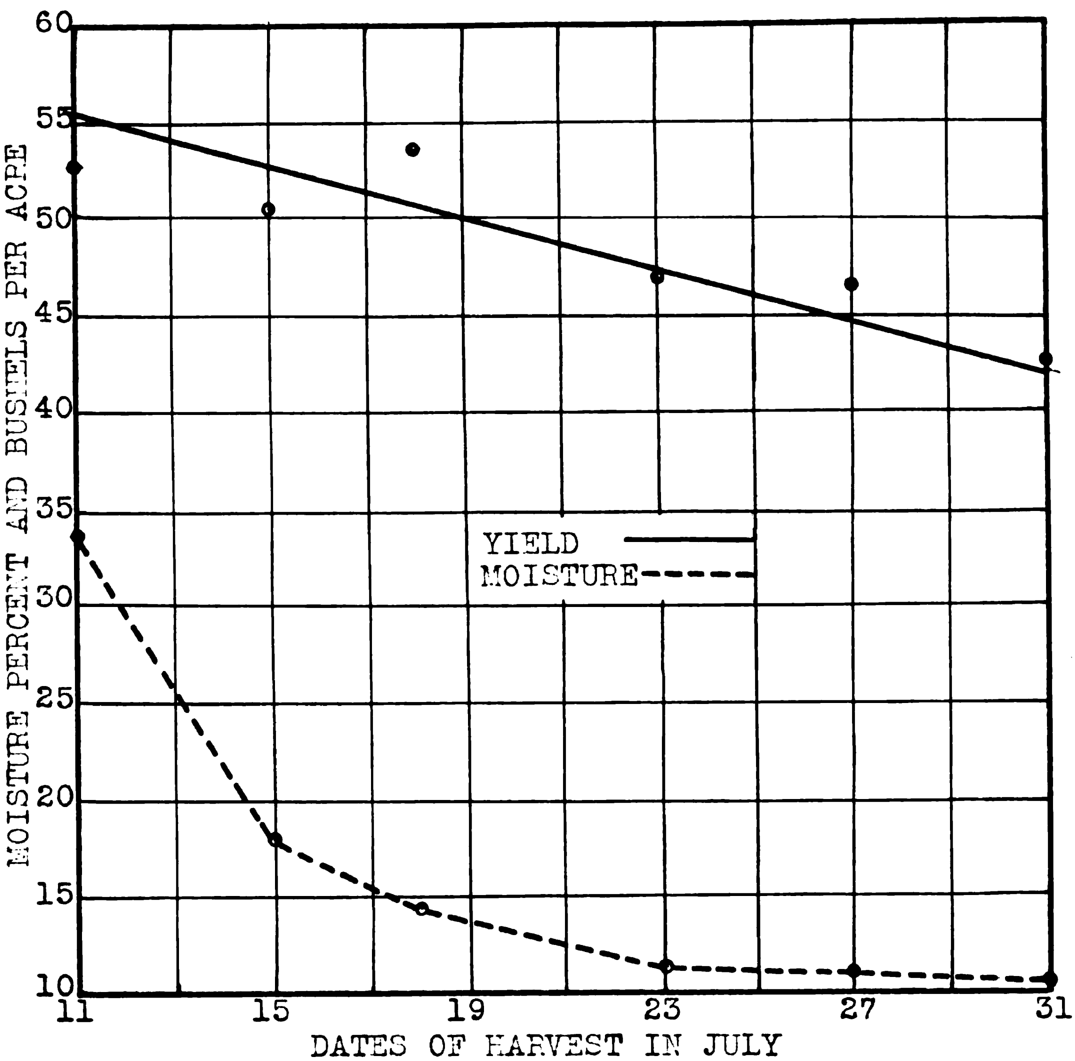


Chart 4. Showing the relationship between moisture and yield of Glabron barley to date of harvest.

Table 5. Moisture, yield and test weight of Wolverine oats on different dates of harvest.

| Harvest Date | Moisture Percent | Bu. per Acre Yield P.E. | Test Weight |
|---|---|---|---|
| July 21, 1931 | 26.7 | 90.1 ± 2.28 | 32.1 lbs |
| 25 | 12.0 | 82.4 ± 1.59 | 31.1 " |
| 29 | 9.8 | 76.7 ± 2.35 | 31.9 " |
| Aug. 1 | 13.9 | 78.6 ± 2.59 | 31.5 " |
| 6 | 13.1 | 76.1 ± 2.46 | 30.7 " |
| 10 | 14.8 | 70.1 ± 2.51 | 30.7 " |

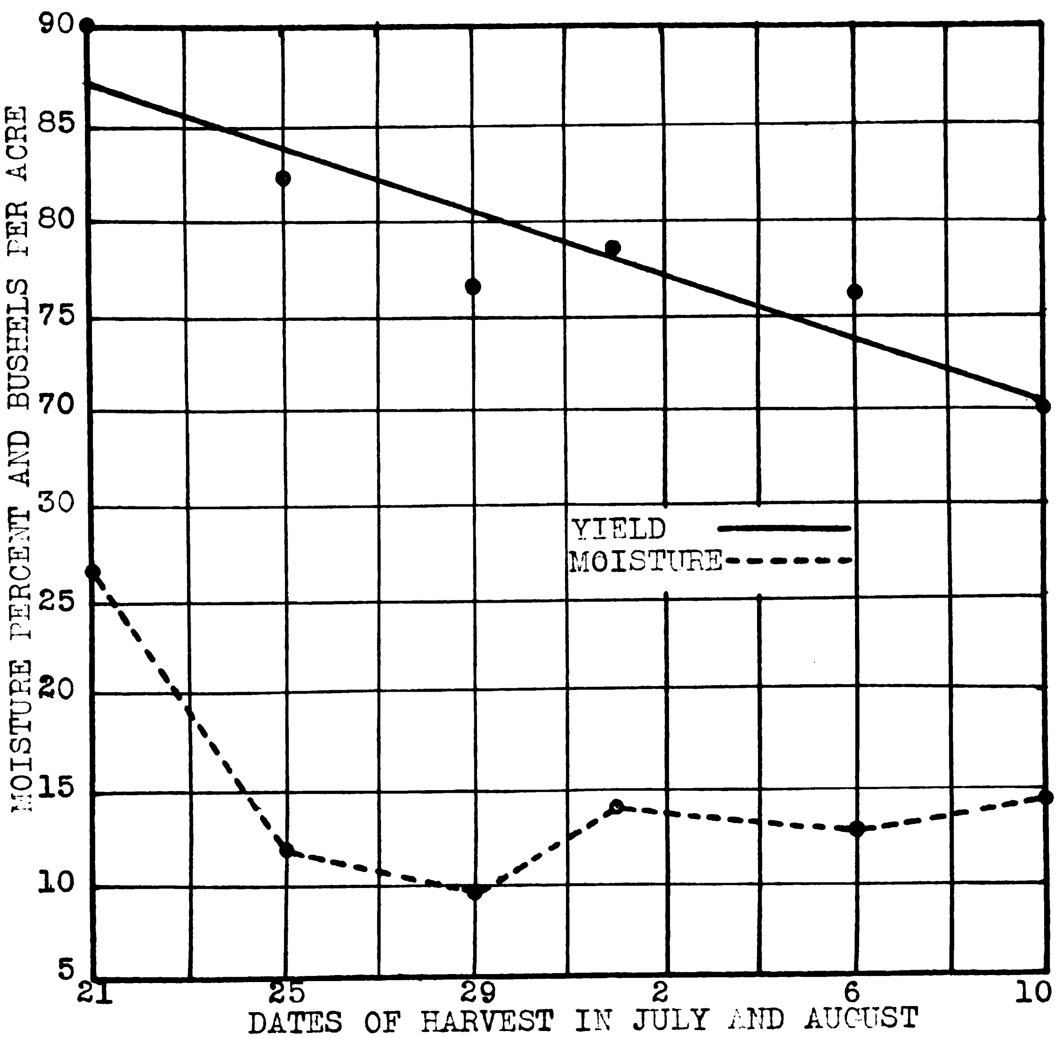


Chart 5. Showing the relationship between moisture and yield of Wolverine oats to date of harvest

Table 6. Moisture, yield and test weight of Worthy oats on different dates of harvest.

| Harvest Date | Moisture Percent | Bu. per Acre Yield P. E. | Test Weight |
|---|---|---|---|
| July 21, 1931 | 27.2 | 81.0 ± 2.17 | 31.9 lbs |
| 25 | 12.6 | 76.8 ± 1.46 | 31.5 " |
| 29 | 9.3 | 71.9 ± 1.72 | 32.5 " |
| Aug. 1 | 12.6 | 72.4 ± 2.20 | 32.4 " |
| 6 | 12.4 | 63.0 ± 1.51 | 30.6 " |
| 10 | 14.4 | 59.7 ± .63 | 30.6 " |

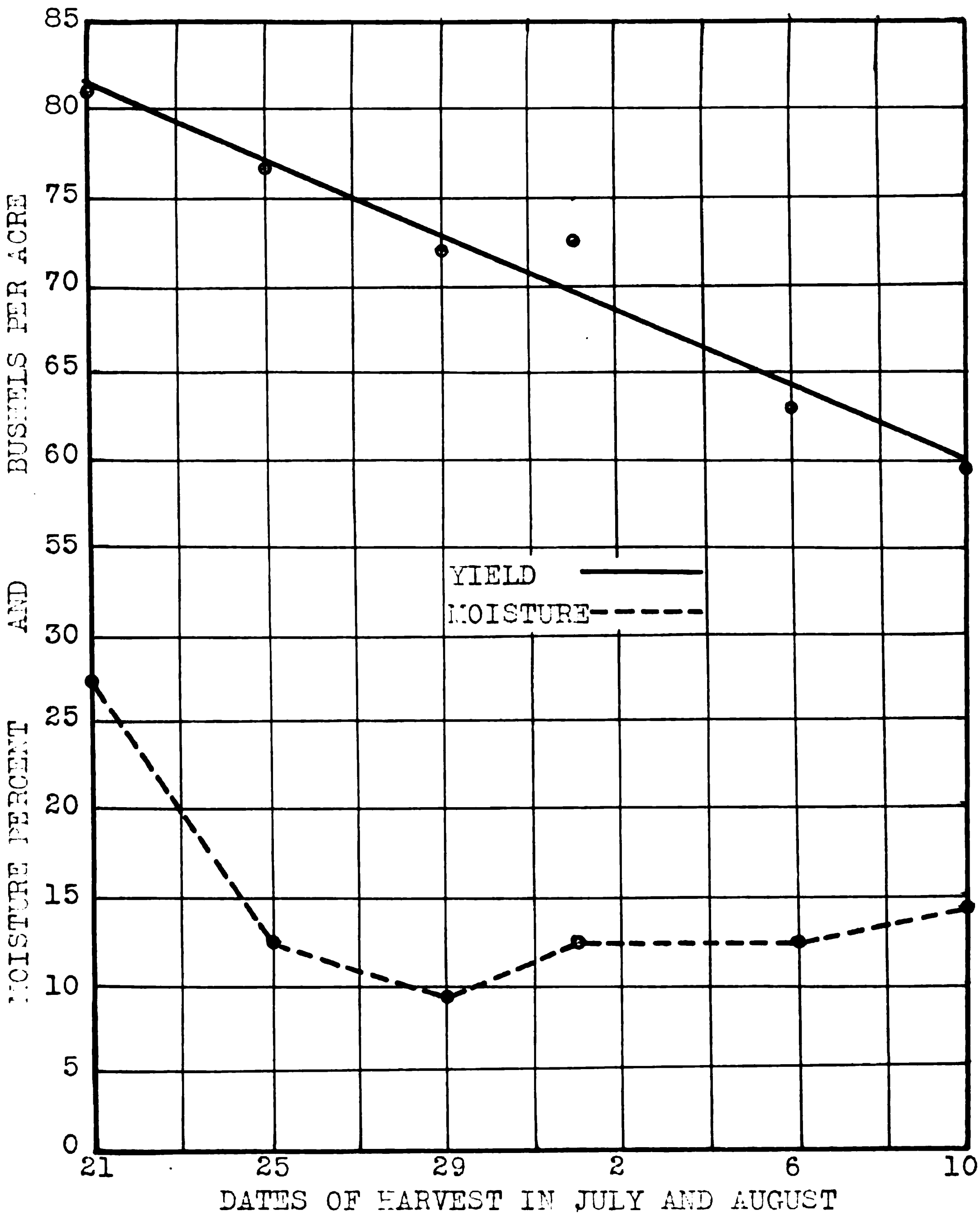


Chart 6. Showing the relationship between moisture and yield of Worthy oats to date of harvest.

Table 7. Moisture, yield and test weight of Iogold oats at different dates of harvest.

| Harvest Date | Moisture Percent | Bu. per Acre Yield P.E. | Test Weight |
|---|---|---|---|
| July 15, 1931 | 24.7 | 100.4 ± 2.08 | 31.5 lbs |
| 18 | 18.2 | 100.2 ± 1.19 | 31.0 " |
| 23 | 11.9 | 90.4 ± 1.31 | 31.1 " |
| 27 | 12.2 | 92.1 ± 1.16 | 31.7 " |
| 31 | 10.0 | 84.7 ± 1.50 | 30.8 " |
| Aug. 4 | 14.2 | 83.6 ± 1.38 | 30.0 " |

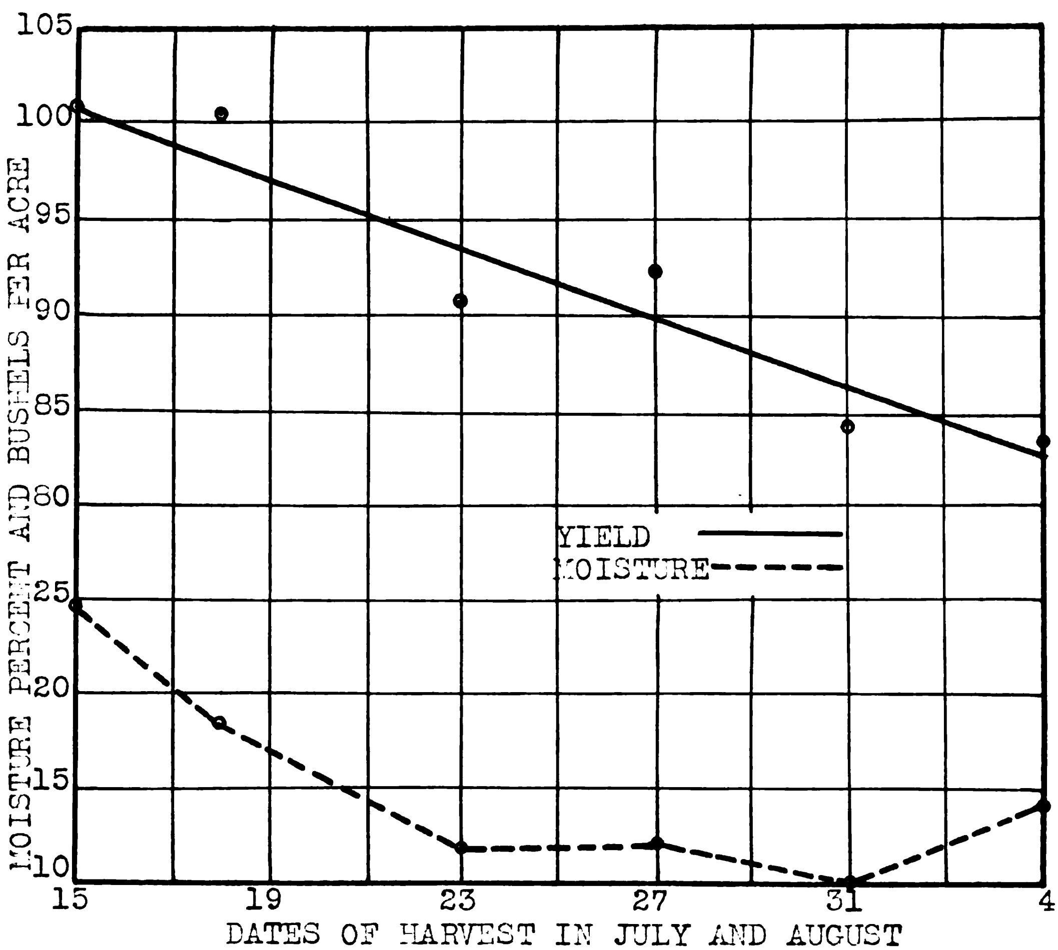


Chart 7. Showing the relationship between moisture and yield of Iogold oats to date of harvest.

Table 8. Moisture, yield and test weight of Markton oats at different dates of harvest.

| Date of Harvest | Moisture Percent | Bu. per Acre Yield P. E. | Test Weight |
|---|---|---|---|
| July 19 ,1931 | 24.6 | 83.3 ± 1.22 | 31.4 lbs |
| 23 | 10.6 | 81.6 ± 1.59 | 31.2 " |
| 27 | 10.6 | 80.9 ± 2.22 | 31.0 " |
| 31 | 8.8 | 85.1 ± 1.82 | 31.8 " |
| Aug. 4 | 14.0 | 82.4 ± .95 | 29.2 " |
| 7 | 14.0 | 82.2 ± 1.51 | 29.2 " |

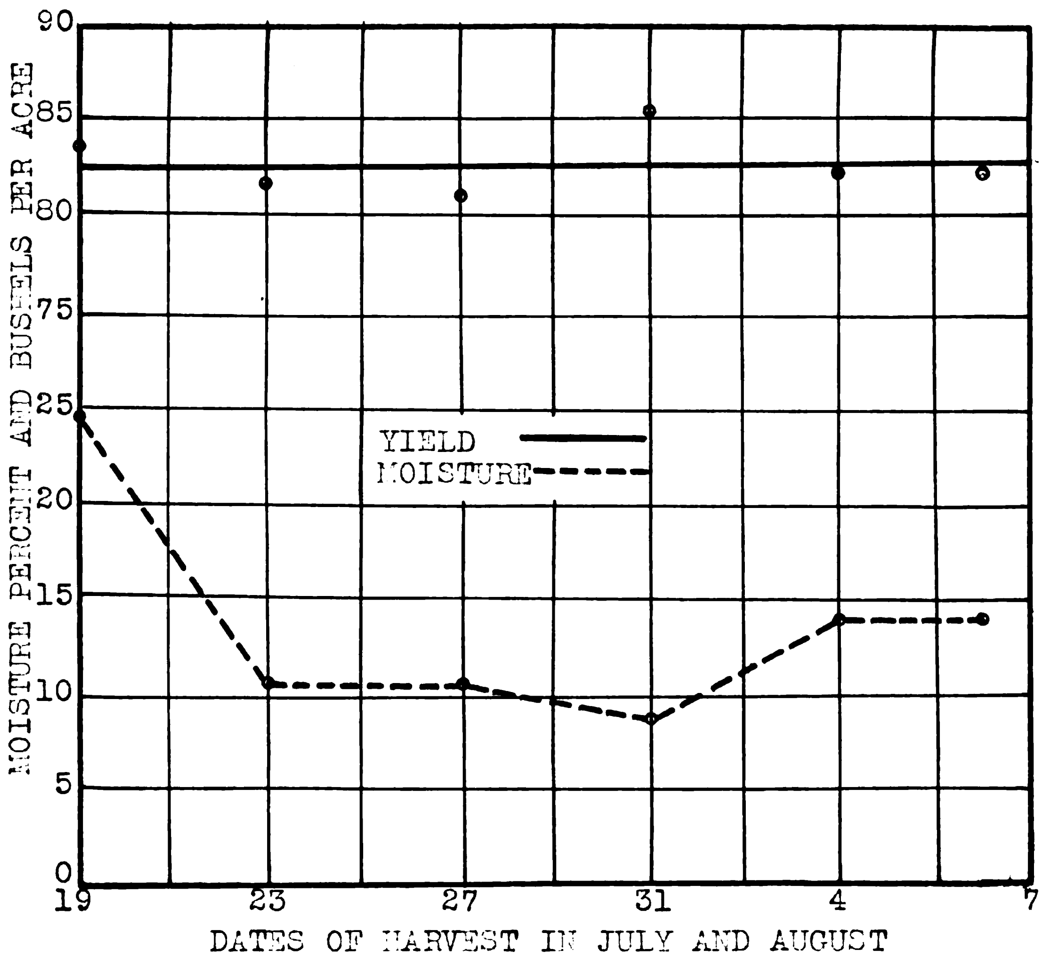


Chart 8. Showing the relationship between moisture and yield of Markton oats to date of harvest.

## DISCUSSION

The following discussion gives the relative merits of the varieties in regard to shattering, crinkling and lodging, and the increase or decrease in yield during the various harvesting periods.

### The effect of delayed harvest on the yield of the barley varieties tested.

#### Spartan Barley.

Spartan barley held its yield fairly well over the entire harvest period of twenty days and gave promise of being a variety adapted to combine harvesting. An increase of three bushels in yield was secured from the time the grain was in the hard dough or binder stage to the time when the grain contained about fourteen per cent moisture. At this point it is considered that grain may be safely combined and stored. A loss of five bushels occurred from the fourteen per cent moisture stage to the end of the delayed harvest period.

The straw of Spartan barley withstood lodging better than any other variety. (Figs. 5 and 6) Eight days after the first date of harvest the straw began to crinkle at a point twelve to fifteen inches below the head. The heads, however, did not break off, but remained supported by the other plants. The heads remained in this position during the remainder of the harvest period and could be combined with very little loss twenty days after the hard dough or binder harvest period.

Fig. 5. — The straw of Spartan barley (left) is stronger and more resistant to lodging than that of Wisconsin Pedigreed No. 38 barley (right).

Fig. 6. — Wisconsin Pedigreed No. 9 barley (left) compared to Spartan barley (right) shows a very decided tendency to lodge and crinkle at the head.

Wisconsin Pedigreed No. 9 barley.

The maximum yield of Wisconsin Pedigreed No. 9 barley was obtained when it was cut at the start of the binder harvest period, and a loss of seventeen and one-half bushels occurred from then until the end of the delayed harvest period. At the fourteen per cent moisture stage the yield had decreased about five bushels from that of the first cutting. The loss from the fourteen per cent moisture stage to the end of the delayed harvest period was about twelve bushels.

The straw of Wisconsin No. 9 barley was the weakest of the varieties tested. (Fig. 6) The straw crinkled badly at a point just below the head, and shortly after the binder stage the heads began to drop off resulting in a material decrease in yield.

Wisconsin Pedigreed No. 38 barley.

The variation in yield during the entire harvest period of Wisconsin No. 38 barley was quite similar to that of Spartan. An increase of three and one-half bushels was secured from the binder harvest period to the fourteen per cent moisture stage. A loss of about seven bushels occurred from the fourteen per cent moisture stage to the end of the delayed harvest period.

In strength of straw Wisconsin No. 38, as shown in Fig. 5, is slightly weaker than Spartan. The straw has somewhat of a tendency to crinkle at the head in a fashion similar to Wisconsin No. 9. The crinkling, however, was not as pronounced and the heads did not break off and fall to the ground as in Wisconsin No. 9. If cut with a binder under very dry conditions the chances are that there would be quite a loss in shocking and handling preparatory to threshing. The combining loss would, under the same circumstances, be decidedly less.

## Glabron Barley.

Glabron barley decreased about thirteen bushels in yield during the entire harvest period with a decrease of about four bushels from the binder to the fourteen per cent moisture stage. The loss that took place from the fourteen per cent moisture stage to the last date of cutting was about nine bushels, and can only be traced to shattering in the head.

In strength of straw Glabron is quite similar to Spartan, possessing a fair amount of stiffness and lacking the characteristic head crinkling of the Wisconsin barleys. (Fig. 7) If it would be possible to combine a grain as soon as it reached fourteen per cent moisture, Glabron would be a very commendable variety for the combine user. It is necessary at times, with weather conditions we cannot control, to postpone combining for quite a number of days after this point has been reached. It is during this period that the yield of Glabron would decrease.

Fig. 7. — Glabron barley (left) compared to Wisconsin Pedigreed No. 9 barley (right) is fairly stiff strawed and shows little tendency to lodge under normal conditions. The loss in yield of Glabron barley after maturity is attributed to shattering.

## The effect of delayed harvest on the yield of the oat varieties tested.

### Wolverine Oats.

The decrease in yield of Wolverine oats after the binder harvest stage was quite rapid. At the fourteen per cent moisture period a loss of three bushels had occurred over the maximum yield secured at the binder harvest stage, and on the final date of cutting a loss of about seventeen bushels was recorded. The loss occurring from the fourteen per cent moisture period to the end of the delayed harvest period was fourteen bushels. The rapid decrease in yield is considered to be due primarily to shattering.

In strength of straw, Wolverine is slightly inferior to Worthy. (Figs. 8 and 9) The difference in lodging, however, was quite small this season.

### Worthy Oats.

The loss in the yield of Worthy oats over the entire harvest period was greater than Wolverine, the total decrease amounting to twenty-one bushels. The decrease from the binder harvest period to the fourteen per cent moisture stage was also slightly greater, amounting to about four bushels. The loss from the fourteen per cent moisture period to the end of the period was seventeen bushels.

The straw of Worthy oats was the most resistant to

Fig. 8. — Worthy oats (left) possessed the strongest straw of the varieties under test. Iogold oats (right) proved also a very commendable variety in stiffness of straw.

Fig. 9. — Markton oats (right) shows a very decided tendency to lodge. Wolverine (left) is comparable to Iogold in strength of straw.

lodging of all varieties tested, and would be a desirable variety for combining in this respect. (Fig. 8) The rapid decrease in yield, as in the case of Wolverine oats, was due primarily to shattering.

## Iogold Oats.

Iogold oats decreased five bushels in yield from the binder harvest period to the fourteen per cent moisture stage. The total loss for the entire period was nearly seventeen bushels. The period was, however, about two days longer for Iogold than for Wolverine or Worthy. The decrease from the fourteen per cent moisture stage to the end of the delayed harvest period was twelve bushels, the loss being attributed to shattering.

In lodging resistance, Iogold (Fig. 8) is about mid-way between Wolverine and Worthy.

## Markton Oats.

Markton oats gave surprising results, in that practically the same yield as obtained at the binder harvest period was maintained throughout the combine stage and through the remainder of the delayed harvest period.

From the standpoint of maintaining a maximum yield over a delayed harvest period, Markton is a very promising variety. However, when stiffness of straw is considered, Markton literally fell by the way-side, as it lodged severely. Fig. 9 clearly demonstrated the one drawback of Markton oats as a combine variety. It is realized, however, that the experimental plats were located on a very productive soil favorable to lodging, and that Markton oats grown on different soils and under different conditions might not lodge as badly as it did in this experiment.

Being somewhat in the nature of a variety test, the problem has raised a very pertinent question in regard to plat technique used in variety testing work at the present time. It is a common plat practice to harvest a variety test usually when the latest varieties in the test are mature. Let us then assume that we are conducting a test on the relative merits of Wolverine and Iogold oats in regard to yield. We harvest the plats when Wolverine, which is about six days later in length of growing season than Iogold, is mature. By a survey of the charts on pages 24 and 26, we see that the yield of Wolverine at maturity is approximately ninety bushels and the yield of Iogold on the same date, as shown by the trend line, is about ninety-five bushels. However, if we look back to the time when Iogold was in a mature state we find the maximum yield to be one hundred bushels. By this method of harvesting the ten per cent advantage that Iogold had over Wolverine was decreased to five per cent. This discrepancy in variety testing work seems worthy of further study.

## SUMMARY AND CONCLUSIONS

1. In the study of the effect of delayed harvest, a variation was noted among the oat and barley varieties in their ability to maintain a maximum yield over the delayed harvest period.

2. This variation is associated with the amount of crinkling and shattering of each variety.

3. The straw of Spartan and Glabron was most resistant to lodging of the barley varieties.

4. Wisconsin Pedigreed barley No. 9 crinkled very badly at a point just below the head; these broke off and resulted in a decided reduction in yield during the delayed harvest period.

5. The yield of Spartan and Wisconsin No. 38 barleys decreased least of all varieties over the delayed harvest period.

6. The quite rapid decrease in the yield of Glabron barley during the delayed harvest period is attributed to shattering in the head.

7. Of the oat varieties tested Worthy was the most resistant to lodging. Its variation from Wolverine and Iogold, in this respect, was small.

8. Though Markton oats lodged very badly in this experiment, this characteristic may vary under different soil and seasonal conditions.

9. The yields of Wolverine, Worthy and Iogold oats decreased rapidly during the delayed harvest period. The decrease amounted to approximately twenty-two per cent for Wolverine, twenty-six per cent for Worthy and seventeen per cent for Iogold.

10. Markton oats maintained practically the same yield through the delayed harvest period. In view of its decided tendency to lodge the results were surprising.

11. Before final recommendations can be made in regard to the proper oat and barley varieties for combine harvesting under Michigan conditions, the experiment should be conducted over a period of years, and under varying climatic and environmental conditions.

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