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Cultural Experiments with Wheat, Oats and Buckwheat

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Agricultural Experiment Station

College of Agriculture, West Virginia University

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Morgantown

Cultural Experiments with Wheat, Oats, and Buckwheat

Plots of Buckwheat Seeded at Different Rates on the Agronomy Farm,
Morgantown, West Virginia.

By

T. E. ODLAND

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Cultural Experiments with Wheat, Oats, and Buckwheat

The three most important small grain crops grown in West Virginia are wheat, oats, and buckwheat. The average annual acreage of wheat is about 240,000 acres and of oats about 200,000 acres. The acreage of buckwheat grown averages about 40,000 acres annually. Two important considerations in connection with growing these crops are time and rate of seeding.

Experiments with different rates of seeding buckwheat and also seeding at different dates have been conducted previously at this station.* No such experiments had, however, been conducted with wheat and oats. It was therefore thought advisable to start a series of such experiments with these two latter crops and also to repeat certain portions of the buckwheat experiments. The results of these tests are reported in this bulletin.

METHODS OF EXPERIMENTATION

The different crops were seeded in plots consisting of strips one drill-width wide by approximately eight rods in length. Each rate and date of seeding was repeated four times each year except where otherwise noted. The drill used was a fourteen-hole single disc drill with discs seven inches apart. This made each plot about eight feet wide with an area of approximately one-fourtieth (1-40) of an acre.

An unseeded alley one and a half feet wide was left between plots. At harvest time the two outside drill rows of each plot were cut and discarded before the remainder of the plot was harvested. This was done in order to eliminate border effect. The drill was carefully calibrated each year for the different rates of seeding for each crop.

In computing the yields per acre the probable errors of the yields were also calculated. The probable error is used to determine how large a difference in yield between two series of plots should be before it is considered significant. When results from such experiments as reported in this bulletin are considered, the consistency of a difference in yield as well as the relative amount of such difference, should be taken into consideration. Since the probable error takes these factors into consideration it helps to determine what de-

*W. Va. Exp. Sta. Bul. 171, 1919.

gree of confidence one can place in the differences in yields obtained from various treatments. The method of computing probable errors based on the yield of varieties under test as described by Hayes was used.*

Table I shows the probable error in per cent for the different tests for each year, both for single plots and for the mean or average yield of the plots seeded at the same rate or date.

TABLE I.—The Probable Errors in Percentages for Date and Rate of Seeding Experiments as Measured by the Deviation of Each Plot from the Mean Yield of Each Treatment.

Crop	Number of Plots	Probable Error in Per Cent							
		1921		1922		1923		1924	
		Single Plot	Mean	Single Plot	Mean	Single Plot	Mean	Single Plot	Mean
Wheat (date seeding)	20*			5.3	2.7	10.0	5.0	7.8	3.9
Wheat (rate seeding).....	20			11.3	5.7	6.6	3.0	6.3	2.8
Oats (rate seeding).....	16†	4.2	2.4	14.2	7.1	6.7	3.4	8.6	4.3
Buckwheat (date seeding)....	24	10.7	5.4	15.5	7.8	17.9	9.0	9.6	4.8
Buckwheat (rate seeding) ..	24‡	6.1	2.7	5.6	2.5	5.8	2.9	4.7	2.4

*25 plots in 1922 with 5 plots for each date.

†12 plots in 1921 with 3 plots in each rate.

‡25 plots in 1921-22 with 5 plots in each rate of seeding .

By applying the probable errors as shown in the table to the yield from different treatments, a figure is obtained showing the least difference in bushels that should be considered as a significant difference for each year of the experiment. It is interesting to note the variability shown in the probable errors for the different years and experiments. As an example the probable error for the buckwheat rate of seeding test is much smaller each year than for the date of seeding. This shows that the results from the rate of seeding experiment were much more uniform throughout than those from the date of seeding and, therefore, a much smaller difference in yield per acre could be considered significant.

Another method adopted to comparing average yields over a number of years was also used in determining the significance of the difference in average yields for the different treatments.† In this method the odds for or against a certain difference being significant are calculated.

*Hayes, H. K. Controlling Experimental Error in Nursery Trials. Jour. Amer. Soc. Agron. 15:177-192. 1923.

†Student. Probable Error of a Mean. Biometrika 6:1-25. 1908.

EXPERIMENTS WITH WHEAT

In the fall of 1921 a test with different rates and dates of planting winter wheat was started. Portage wheat was chosen as being typical of much of the winter wheat grown in this state. This variety is a beardless wheat of the soft winter wheat type. It is a selection from Poole wheat and has given very satisfactory results at the Ohio Station.

Date of Seeding

The date of seeding test consisted of plots seeded at ten-day intervals from September 10 to October 20. A uniform rate of six pecks per acre was used. Table II shows the yield per acre obtained over the three-year period.

TABLE II.—Yield of Winter Wheat Obtained at Different Dates of Seeding on the Agronomy Farm 1922-23-24.

Date of Seeding	Average Date Harvested	Yield in Bushels per Acre			Average Yield per Acre 1922-23-24
		1922	1923	1924	
September 20	July 6	29.5	30.1	33.7	31.1
September 30	July 7	29.4	33.1	26.2	29.6
September 10	July 3	27.7	27.1	30.1	28.3
October 10	July 10	23.7	22.5	18.2	21.5
October 20	July 11	19.2	12.1	14.1	15.1

In all three years the yields for wheat seeded October 20 were decidedly lower than from any of the earlier plantings. The odds as calculated are approximately 63 to 1 that the average yield obtained from the September 20 seeding is significantly higher than the average yield obtained from the October 20 seeding. Similarly the odds are 21 to 1 that the difference in yield obtained from the October 10 and October 20 seedings is significant. The October 10 seeding also produced lower yield than any seeded before this date. Apparently this date also is too late for conditions prevailing in this locality. These late seedings resulted in a large amount of winter killing.

As an average for the three years there is little difference in yield in the three earlier plantings. In 1923 the September 30 seeding yielded more than the two seedings made prior to this date, but in 1924 it yielded less than these. The least difference in average yield that should be considered as significant as calculated from

Table I is approximately 3 bushels for 1922, 5.3 bushels for 1923, and 4 bushels for 1924.*

Winter wheat should not be sown too early on account of the danger of Hessian Fly infestation. The fall brood of this insect appears in August or the first part of September. If there is wheat growing at this time the eggs are deposited on the seedling plants where the young are hatched. These feed on the young wheat plants for a while in the fall and then go into the dormant stage. The chief injury is done when the spring brood appears.

If wheat is sown late enough to escape the fall brood there will be no flies to cause injury in the spring. The dates when wheat may safely be sown in a normal season so as to avoid the fall brood, have been fairly well worked out. The accompanying chart and table shows the fly free dates for West Virginia for a normal season and for various altitudes.

*Average yield of all plots multiplied by $3 \sqrt{2} \times$ RE. of mean.

Map of West Virginia Showing Safe Dates for Seeding Winter Wheat in a Normal Season at Different Altitudes. Seeding Before the Indicated Date Increases the Danger From Hessian Fly Infestation. (Courtesy U. S. Dept. of Agriculture.)

Dry weather may delay the emergence of the fly in the fall so that it might be necessary to seed later than the dates shown in the chart. It will be necessary to take the seasonal conditions into consideration each year in order to apply this chart properly. In looking at this chart we find that for the location of these experiments the dates recommended is from September 24 to October 4. The elevation of the Agronomy Farm is approximately 1200 feet. From the results obtained in the test it would seem that the fly free dates may be observed and still as high yields obtained as seeding at an earlier date. In 1924 a somewhat higher yield was obtained for the September 20 planting than the September 30, but in the other two years the September 30 seeding yielded as much or more than the earlier seedings. There was no fly infestation in any of the years of this experiment. It would not have been practical to conduct this test if fly infestation had been a common occurrence in this locality.

Plots of Winter Wheat Sown at Different Dates on the Agronomy Farm. The Thin Stands in the Center of the Picture Are of Plots Seeded October 10 and 20. On the Extreme Left the Plot Seeded September 10 is Shown.

Rate of Seeding

The rate of seeding wheat varied from four to eight pecks per acre. These plots were all seeded and harvested at the same time. The yields obtained are shown in Table III.

TABLE III.—Yields of Winter Wheat Obtained at Different Rates of Seeding on the Agronomy Farm 1922-23-24.

Rate of Seeding Pecks per Acre	Average Date of Seeding	Average Date of Harvest	Yield in Bushels per Acre			Average Yield per Acre 1922-23-24
			1922	1923	1924	
8	Sept. 28	July 7	20.0	34.3	40.0	31.4
7	Sept. 28	July 7	16.0	34.7	37.7	29.5
6	Sept. 28	July 7	15.2	35.0	36.0	28.7
5	Sept. 28	July 7	13.9	33.5	34.1	27.2
4	Sept. 28	July 7	13.4	30.8	28.9	24.4

In 1922 the yields varied from 13.4 bushels per acre from the four-peck seeding to 20.0 bushels for the eight-peck rate with the other plots ranging between these in the order of the rate of seeding. Evidently for the conditions prevailing during that year a seeding of four or five pecks per acre was not enough. The yield from the six-peck seeding was 15.2 bushels per acre and from the seven-peck it was 16 bushels. The difference in yield between these two is not large enough to be considered significant.

In comparing rates of seeding yields the net yields should be used as the basis. The net yield of a plot is obtained by subtracting the amount of seed sown from the total yield. Thus the net yield from the six-peck seeding is 13.7 bushels, and from the eight-peck seeding it is 18 bushels. Considered in this way it can be stated with a fair degree of certainty that for this year seedings of seven and eight pecks per acre yielded better than the lighter seedings of four, five, and six pecks.

In the 1923 yields there is a lesser range between the different rates of seeding. The plots were located on better soil than in 1922 and the yields are all considerably higher. In this year the four-peck seeding again averaged the lowest yield with 30.8 bushels per acre. The six-peck seeding produced the highest average yield with 35.0 bushels. The seven and eight-peck seedings yielded 34.7 and 34.3 bushels per acre, respectively. The net yield per acre for all seedings were 29.8, 32.2, 33.5, 32.9, 32.3 bushels per acre for the four, five, six, seven, and eight-peck seedings, respectively. Under the more favorable soil and weather conditions prevailing this year there was little difference in yield between the different rates from five to eight pecks. The four-peck seeding was not enough to give the best results.

Plots in Rate of Seeding Wheat in Shocks With Cock Covers to Protect Against Birds and the Weather.

The season of 1924 was again favorable for wheat and the yields correspondingly high. The yields ranged from 28.9 bushels for the four-peck seeding to 40.0 bushels for the eight pecks. The net yields were 27.9, 32.8, 34.5, 35.9, and 38.0 bushels per acre for the four, five, six, seven, and eight-peck seedings, respectively. In this year as in 1922 the seven and eight-peck seedings yielded better than the lighter seedings. Four pecks again yielded considerably lower than the five or six-peck seeding.

The average net yields per acre for the three years were 23.4, 25.9, 27.2, 27.7, and 29.4 bushels per acre for the four, five, six, seven, and eight-peck seedings, respectively. From this it is seen that the eight-peck seeding averaged only 1.7 bushels more per acre than the seven-peck and the latter only .5 bushels more than the six-peck. Considering the short period over which the experiment extended these differences are probably not large enough to be of any significance. The odds are only 5 to 1 that the net yield obtained from the seeding of eight pecks per acre is significantly higher than that obtained from the seeding of six pecks per acre.

The five-peck seeding averaged 1.3 bushels less than the six-peck and the four-peck 2.5 bushels per acre less than the five-peck. The four-peck rate is too small while under favorable conditions the five-peck may give nearly as good results as six pecks or more. The odds are 18 to 1 that the net yield obtained from the eight-peck seeding is significantly higher than that obtained from the four-peck seeding. It seems that it is wiser to seed six pecks in order to be better insured against an adverse season. The increase in average yield for a seven or eight-peck seeding is not large enough, how-

ever, to warrant recommending a heavier seeding than six pecks per acre.

EXPERIMENTS WITH OATS

It is generally recognized that oats should be sown just as early in the spring as the ground can be put in shape. A date of seeding test was therefore not considered necessary for this crop. The rate of seeding test was started in the spring of 1921. The variety used the first year was Sweedish Select. This is a representative of the medium to late maturing oats. Iowa 103, an early maturing variety, was used in 1922, and Gopher oats, another early type, the following years. The results obtained over the four-year period are shown in Table IV.

TABLE IV.—Yields of Oats Obtained at Different Rates of Seeding on the Agronomy Farm 1921-24.

Rate of Seeding Pecks per Acre	Average Date of Seeding	Average Date of Harvest	Yield in Bushels per Acre				Average Yield per Acre 1921-24
			1921	1922	1923	1924	
12	April 10	July 18	26.8	15.3	40.3	42.3	31.2
10	April 10	July 18	29.7	15.2	36.5	40.9	30.6
8	April 10	July 18	30.9	13.9	35.1	39.0	29.7
6	April 10	July 18	24.5	14.5	33.9	35.1	27.0

In 1921 when Swedish Select oats were grown the eight and ten-peck rates of seeding yielded most. Six pecks were evidently not enough and the twelve-peck seeding did not yield as much as the intermediate rates. In 1922 the plots were located on rather thin soil and the season was not favorable for oats. As a result the yields were very low and fluctuated considerably. In this year the six-peck seeding yielded fully as well as any of the heavier seedings.

For the 1923 season there was a gradual increase in average yield from six-peck to twelve-peck seeding. The net yields per acre were 32.4, 33.1, 34.0, and 37.3 bushels for the six, eight, ten, and twelve-peck seedings, respectively. Here also the increase for the heavier seedings as compared with six pecks show only small increases in yield. The differences between six, eight, and ten pecks certainly are not large enough to be significant and it is doubtful whether even the net increase of the twelve-peck over the ten-peck seeding is large enough to be considered a real difference.

The net yields for 1924 were 33.6, 37.0, 38.4, and 39.3 bushels per acre for the six, eight, ten, and twelve-peck seedings, respectively.

In this year there was little difference in net yields between the eight, ten, and twelve-peck seedings. These, however, yielded better than the six-peck rate.

Considering the average yields for the different rates of seeding oats over the four year period, there is no appreciable difference in net yield for the eight, ten, and twelve-peck seedings. The six-peck seeding averaged approximately two bushels per acre less than the eight-peck seeding, and two and a half bushels less than the ten and twelve-peck seedings. Over the period under test, therefore, it would seem that eight pecks was a full seeding especially of early oats. There was no significant increase in yield from heavier seeding than this. A heavier seeding will do no harm and ordinarily a ten-peck seeding should probably be used in order to insure against adverse growing conditions.

EXPERIMENTS WITH BUCKWHEAT

Tests with different rates and dates of planting buckwheat were started in 1921. Japanese buckwheat was used in all these experiments. This variety is the one most commonly grown in West Virginia and has also consistently given the highest yields in the varietal experiments conducted at this station.

Date of Seeding

Buckwheat was planted at ten-day intervals from June 10 to July 30 each year. The field used in this experiment was plowed at the same time for all the plots, about May 15 to June 1. The ground was worked down to a good seedbed before the first planting was made. The plots seeded June 20 and later were given a double discing immediately before seeding in order to eradicate the weeds which usually appeared before that time. The plots were all seeded at the uniform rate of four pecks per acre.

TABLE V.—Yields of Buckwheat Obtained at Different Dates of Seeding on the Agronomy Farm 1921-24.

Date of Seeding	Average Date of Harvest	Yield in Bushels per Acre				Average Yield per Acre 1921-24
		1921	1922	1923	1924	
July 10	Sept. 20	21.7	16.7	14.9	19.3	18.2
July 20	Sept. 29	20.7	19.8	19.6	10.6	17.7
July 30	Oct. 5	8.1	14.5	23.0	15.0	15.2
June 10	Aug. 27	14.1	17.8	12.8	15.0	14.9
June 20	Sept. 5	16.6	14.1	10.2	18.1	14.8
June 30	Sept. 11	20.3	9.2	7.9	17.1	13.6

In 1921 the late seeding made July 30 produced the lowest yield with only 8.1 bushels per acre. The early plantings on June 10 and June 20 also produced relatively low yields. The intermediate dates of seeding June 30, July 10, and July 20 produced the highest yields with 20.3, 21.7, and 20.7 bushels per acre, respectively.

In 1922 the July 20 seeding made the best yield with 19.8 bushels and the June 30 seeding the lowest with 9.2 bushels per acre. The July 30 seeding made the highest yield in 1923 and the July 10 seeding in 1924. As an average of the four years the July 10 and 20 seedings, with 18.2 and 17.7 bushels respectively, yielded the most. The odds are 30 to 1 that the difference in average yield between the July 10 and the June 30 seedings is large enough to be considered a significant difference. The yields fluctuated considerably with the different dates of seeding for the different years. As an average for the conditions where this test was conducted, seeding some time from July 10 to 20 will probably give the most uniformly good results.

Rate of Seeding

The different rates of seeding buckwheat varied from two pecks to six pecks per acre in the first two years. A seeding of eight pecks per acre was also included in the last two years of this experiment. The plots were all seeded at the same time. Table VI shows the results obtained.

TABLE VI.—Yield of Buckwheat Obtained at Different Rates of Seeding on the Agronomy Farm 1921-24.

Rate of Seeding Pecks per Acre	Average Date of Seeding	Average Date of Harvest	Yield in Bushels per Acre				Average Yield per Acre 1921-24
			1921	1922	1923	1924	
2	July 9	Sept. 17	24.1	22.0	20.3	22.9	22.3
3	July 9	Sept. 17	22.7	21.6	21.3	23.7	22.3
4	July 9	Sept. 17	23.8	20.0	21.7	23.3	22.2
5	July 9	Sept. 17	23.6	18.9	23.1	23.2	22.2
8*	July 9	Sept. 17			22.3	21.5	21.9*
6	July 9	Sept. 17	22.1	17.0	24.5	22.5	21.5

*Two-year average.

It may be seen from Table VI that for the years under test there was not a very large difference in yield as a result of the different rates of seeding. As an average of the four years there was no significant difference in yield between any of the plots. The thin seeding of only two pecks per acre produced as high average yields as any of the heavier seedings. Where the net yields are considered

Plots of Buckwheat Sown at Different Dates on the Agronomy Farm.

the average yield from the two-peck seeding is 21.8 bushels per acre and for the six-peck 20 bushels.

Although in this test the two-peck seeding has proved as good as the heavier seedings, a seeding of three or four pecks probably should be recommended in order to insure a good stand under more adverse conditions. The heavy seedings of six and eight pecks per acre resulted in thin stemmed plants which did not stand up as well as the plants from the thinner seedings. This made these plots more difficult to harvest.

SUMMARY AND CONCLUSIONS

1.—Rate and date of seeding tests were conducted with wheat and buckwheat and a rate of seeding test was made with oats on the Agronomy Farm near Morgantown.

2.—Wheat seeded September 10 to 30 produced the highest yields. Wheat should not be seeded earlier than about September 25 in order to escape Hessian fly infestation.

3.—Seeding six pecks per acre is recommended for winter wheat.

4.—Eight or ten pecks per acre is recommended for early oats.

5.—Although two pecks per acre of buckwheat produced as high a yield as heavier seedings, a seeding of three or four pecks is recommended in order to insure against adverse conditions.

6.—Buckwheat seeded July 10 and 20 produced the best results.

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