UNIVERSITY OF IDAHO
AGRICULTURAL EXPERIMENT STATION

GOODING SUB-STATION

Experiments with Small Grains Under Irrigation

The Station Cottage

By J. S. WELCH

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SUMMARY

The small grain crops are of great importance on the irrigated farms of Idaho.

Of the spring wheat varieties, the soft white ones are best adapted for growth under irrigation. Dicklow is the leading variety grown under irrigation at this time. For average irrigation conditions, the durum wheats are not recommended.

In the irrigation of spring wheat, water can be used most efficiently in the early stages of the plants' development. If but one irrigation can be given, that one should be applied just before the first jointing stage of growth. If water is withheld until the grain reaches the soft dough stage, it is of no value to the crop. The most satisfactory results on the station farm were secured by the application of one irrigation just before the first jointing, and another between the first jointing and the blooming stage. In the growth of spring wheat it is not advisable to apply a total of more than one and one-fourth acre-feet of water per acre.

Winter wheats can be grown to advantage on irrigated lands; perhaps to best advantage in those sections where irrigation water is not plentiful. On the station farm the best varieties have proved to be Jones' Fife and Turkey Red. In the irrigation of winter wheat, one irrigation of slightly less than three-fourths of an acre-foot of water per acre, given just before heading, was found to be sufficient.

Of the six-rowed spring barleys, Trebi, Beldi and Sandrel have proved to be the most satisfactory from the standpoint of yield. Of the two-rowed types, Bohemian and Horn have proved best. Eureka was the best of the hull-less barleys.

In the irrigation of spring barleys, the use of approximately one and one-half acre-feet of water per acre is recommended.

Winter barley proved to be less productive than the best spring varieties. For its growth, one irrigation of about one-half of an acre-foot of water per acre just before heading is recommended.

In the conduct of work with oat varieties, a large number have proved to be very productive. The best from the standpoint of yield per acre are Swedish Select and Wisconsin Pedigree No. 1. Oats require about one and three-fourths acre-feet of water per acre.

Results of experiments conducted on the station farm at Gooding are recommended for application only for those irrigation projects of the state which possess similar climatic and soil conditions.

EXPERIMENTS WITH SMALL GRAINS UNDER IRRIGATION*

INTRODUCTION

The Gooding Sub-Station was established in 1909 for the conduct of experimental work in the irrigation of farm crops. The station is a tract of forty acres located two miles south of the town of Gooding in Gooding County and, therefore, lies in the great Snake river plains at an elevation of approximately 3600 feet and somewhat closer to the western than the eastern boundary of the state. The Office of Irrigation Investigations of the United States Department of Agriculture and the Idaho Experiment Station have shared equally in the expense of its maintenance. This bulletin is based upon the results of experiments conducted on this station during the years 1909 to 1916 inclusive.

The soil of the farm in the main is a medium clay loam with a comparatively compact and heavy clay subsoil underlaid at a depth of from eight to twelve feet by the basaltic lava rock that is common to southern Idaho. The soil cannot be described as perfectly uniform because of the occurrence of "adobe" or "slick" spots. They, however, are gradually being worked out by cultivation and the addition of large amounts of organic matter. The tract is fairly representative of extensive areas of the great Snake river plains in southern Idaho that are now under irrigation. These sagebrush soils in their native condition are deficient in active organic matter and nitrogen but under intelligent management can be quickly brought to a state of high fertility and made productive of remarkable results in crop yields.

The station has devoted itself entirely to problems of irrigation agriculture. The work with small grains has occupied a prominent place in its activities and has included tests of varieties, experiments on cultural management, experiments to determine the proper time of irrigation, and experiments to determine the best methods and proper amounts in the use of irrigation water.

In the conduct of variety tests every effort has been made to elim-

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inate variations in soil conditions, cultural management, and irrigation so that variations in yield might be chargeable directly to variety characteristics. In the conduct of the irrigation experiments all variations that might be traceable to varieties and cultural methods were eliminated in so far as possible. All water used in the irrigation experiments was carefully measured over twelve-inch Cipolletti weirs. One weir was placed where the main supply ditch enters the farm. Five others were located at various points in the distributing laterals. These weirs permitted the measurement of the water close to the points of application and also provided for measurement in case the stream was divided below the head weir. One main waste weir was placed at the lowest corner of the farm and portable weirs were placed wherever needed for the measurement of waste water from plats which were a considerable distance from the main waste weir. In all measurements, both of on-flow and run-off, care was taken to take readings sufficiently often to enable the detection of fluctuations in the size of the stream. The amounts given in the following tables, therefore, represent that which was actually absorbed by the soil.

While the grain fields of the middle west produce by far the greater part of the country's total grain crop, the amounts grown on the irrigated lands of arid America are neither insignificant nor unimportant. Grain farming under irrigation is necessarily conducted on a smaller scale than is possible under conditions where the natural precipitation is sufficient for crop production. In the growing of small grains for the market, therefore, the irrigation farmer is not a strong competitor of the dry farmer nor of the man whose operations are conducted in humid sections. But if the irrigation farmer's fields are smaller, his yields per acre are greater and for many purposes he can with advantage produce the various small grains.

The most successful irrigation farmers are those who have made livestock production the most important feature of their farm practice and the most successful livestock farmers are those who realize the necessity of liberal grain rations in all of their feeding. The best system of irrigation farming is one which involves the growing of forage and grain crops and their utilization on the farm in the various kinds of livestock production.

From the standpoint of relative yields in pounds of feed on irrigated lands, barley usually ranks first, oats second, and wheat third, but since the irrigation experiments with wheat have been more extensive than those with barley and oats, they will be discussed first.

Climatological data introduced at this point will answer inquiries that are likely to arise with reference to climatological conditions under which the work of the station has been conducted. The summaries presented have been prepared from the records of cooperative observations made for the Weather Bureau Service of the United States Department of Agriculture.

CLIMATOLOGICAL DATA

Precipitation (in inches), 1910-1916 inclusive

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
1910	0.71	1.06	0.14	0.77	0.32	0.08	0.24	0.00	0.44	0.45	1.72	1.50	**7.43**
1911	3.21	0.43	0.47	1.13	1.77	1.06	0.00	0.00	0.00	1.10	2.15	0.09	**11.41**
1912	2.00	1.24	1.06	0.96	1.33	0.67	0.33	0.00	0.18	2.16	0.88	0.68	**11.49**
1913	0.63	0.05	0.55	0.47	0.15	0.91	0.73	0.08	0.05	0.94	2.36	1.64	**8.55**
1914	1.18	0.15	0.06	1.02	0.44	0.43	0.22	0.00	1.09	1.74	0.02	0.26	**6.61**
1915	0.58	1.62	0.23	0.75	1.91	0.33	1.01	0.10	1.04	0.00	1.04	0.93	**9.54**
1916	1.68	1.28	0.78	0.49	0.70	0.15	0.71	1.15	0.00	0.70	0.98	0.75	**9.37**
Aver. Mo.	1.43	0.83	0.47	0.80	0.95	0.52	0.46	0.19	0.40	1.01	1.31	0.83	

Mean Annual 9.20

Precipitation during growing season (April 1-Aug. 31), 7 year average, 2.91.

Average monthly maximum and minimum temperature (in degrees F.) 1910-1916 inclusive

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	yearly
1910 Max.	30.0	34.7	61.2	71.0	75.0	85.0	93.5	88.0	79.0	68.0	49.5	40.0	
1910 Min.	14.0	15.9	32.2	35.5	40.0	45.6	55.0	46.5	39.8	34.0	29.4	25.0	
1910 Mean	22.0	25.3	46.7	53.2	57.5	65.3	74.2	67.2	59.4	51.0	39.5	32.5	**49.5**
1911 Max.	37.0	30.8	54.4	59.3	68.0	76.0	89.9	90.0	74.0	62.0	43.8	37.2	
1911 Min.	17.7	15.6	27.7	30.0	38.0	44.0	51.0	43.8	39.0	30.0	22.3	17.1	
1911 Mean	27.4	23.2	41.1	44.7	53.0	60.0	70.5	66.9	56.5	46.0	33.1	27.1	**45.8**
1912 Max.	34.5	40.9	49.5	60.2	69.8	88.0	85.3	85.7	71.9	57.8	50.1	36.5	
1912 Min.	17.6	23.9	29.8	32.5	38.0	47.3	49.1	48.1	35.9	32.6	27.8	12.5	
1912 Mean	26.0	32.4	39.7	46.4	53.9	67.9	67.2	66.9	53.9	45.2	38.9	24.5	**47.3**
1913 Max.	30.9	35.0	47.1	66.1	75.4	78.4	84.5	90.0	80.1	60.8	50.5	33.4	
1913 Min.	8.3	10.8	25.1	32.2	40.6	47.5	50.9	45.9	42.1	30.6	30.5	13.7	
1913 Mean	19.6	22.9	36.1	49.2	58.0	62.9	67.7	68.0	61.1	45.7	40.5	23.4	**46.2**
1914 Max.	35.7	37.3	54.0	63.8	76.5	77.9	91.6	88.7	75.8	64.5	55.1	33.5	
1914 Min.	20.6	19.7	27.4	31.6	39.7	44.3	53.4	47.9	38.9	37.1	22.7	7.3	
1914 Mean	28.1	28.5	40.7	47.7	58.2	61.1	72.5	68.3	57.3	50.8	38.9	20.4	**47.7**
1915 Max.	34.0	45.1	59.3	69.4	67.2	77.5	87.3	95.9	74.1	69.6	46.3	37.4	
1915 Min.	10.1	27.6	26.2	35.3	38.7	40.9	48.9	54.0	38.6	32.3	23.9	19.0	
1915 Mean	22.1	36.4	42.7	52.4	53.0	59.2	68.1	74.9	56.2	50.9	35.1	28.2	**48.3**
1916 Max.	30.0	38.2	51.9	65.3	67.0	78.2	89.2	88.0	78.5	61.9	46.4	34.3	
1916 Min.	9.5	18.9	27.2	32.1	34.0	41.1	51.3	46.2	40.7	29.8	19.2	14.7	
1916 Mean	19.8	28.6	39.6	48.7	50.5	59.6	70.2	67.1	59.6	45.8	32.8	24.5	**45.6**
Monthly Mean ...	23.6	28.2	40.9	48.9	54.9	62.3	70.1	68.5	58.4	47.9	36.9	25.8	

Average yearly mean **47.2**

Evaporation in inches from free water surface, April to September, incl.

Year	Max. per week	Min. per week	Aver. per week	Total per season
1910	2.44	1.34	1.89	49.36
1911	2.28	0.60	1.28	33.27
1912	2.15	0.63	1.37	35.70
1913	2.17	0.57	1.34	34.94
1914	2.14	0.87	1.60	37.18
1915	2.84	0.70	1.61	42.20
1916	2.33	0.79	1.60	41.54
Average..................................			1.53	39.16

* In securing data on evaporation a tank of galvanized iron three feet in diameter and eighteen inches in depth was used. This tank was set in the soil to a depth of fifteen inches. It was kept almost full of water. Readings were taken once each week.

Aspect of sky (days)

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
1910—													
Clear	10	7	19	20	21	24	23	31	15	18	6	11	205
Part Cloudy	12	12	10	6	10	6	6	0	12	8	5	10	97
Cloudy	9	9	2	4	0	0	2	0	3	5	19	10	63
1911—													
Clear	5	12	21	15	16	13	26	29	16	22	14	6	195
Part Cloudy	15	9	5	4	9	13	4	2	11	3	5	14	94
Cloudy	11	7	5	11	6	4	1	0	3	6	11	11	76
1912—													
Clear	15	5	11	12	15	20	18	19	16	15	16	12	174
Part Cloudy	5	12	14	8	11	7	10	10	11	4	5	11	108
Cloudy	11	12	6	10	5	3	3	2	3	12	9	8	84
1913—													
Clear	8	15	5	16	10	6	21	29	22	18	12	15	177
Part Cloudy	5	9	12	7	11	8	6	2	3	4	6	3	76
Cloudy	18	4	14	7	10	16	4	0	5	9	12	13	112
1914—													
Clear	12	15	20	9	17	16	19	27	14	13	20	12	194
Part Cloudy	5	4	8	17	11	10	9	3	11	10	8	11	107
Cloudy	14	9	3	4	3	4	3	1	5	8	2	8	64
1915—													
Clear	15	8	17	15	11	22	25	29	19	24	6	6	197
Part Cloudy	5	2	11	10	9	8	5	2	8	7	10	16	93
Cloudy	11	18	3	5	11	0	1	0	3	0	14	9	75
1916—													
Clear	8	8	13	22	23	25	26	27	21	20	21	10	224
Part Cloudy	11	12	13	7	5	4	2	3	7	7	6	12	89
Cloudy	12	9	5	1	3	1	3	1	2	4	3	9	53

Average number of clear days, 195. Average number partly clear days, 95. Average number of cloudy days, 75.

Killing frosts

Season	1910	1911	1912	1913*	1914	1915	1916
Last in spring	May 17	May 20	May 5	May 2	June 22	May 7	May 15
First in fall	Sept. 11	Sept. 14	Sept. 5	Sept. 11	Sept. 9	Sept. 12	Sept. 19
Frost-free period (days)	117	117	123	131	79	128	96

* A light frost occurred July 14. Average length of frost-free period, 113 days.

WHEAT

Wheat is usually considered the most important of all cereal crops. From the standpoint of the irrigation farmer, however, barley and oats are of greater importance because they will produce more pounds of feed per acre and because wheat grown under irrigation is usually somewhat inferior for flour and bread making purposes. Nevertheless, wheat is an important crop and a valuable one for the irrigation farmer. In spite of the somewhat inferior product obtained from wheat grown with irrigation, the milling trade annually takes off large quantities. Enormous amounts of it too are fed to livestock with excellent results; in fact, wheat is one of the best of the grains for feeding purposes.

SPRING VARIETIES

Spring-sown varieties of wheat are more commonly grown on irrigated lands than fall-sown varieties. For that reason experimental work with wheats on the Gooding station has been conducted with the spring-sown types. Prominence has been given to the testing of varieties inasmuch as in the production of grain crops one of the most important considerations is the selection of varieties capable of a satisfactory performance in the matter of yield.

Fig. I.—Showing arrangement of plats in variety tests

Fifteen varieties of spring wheat have been tested. Five of them were discarded in the course of the work because of failure to show desirable characteristics. The three durum or macaroni varieties which have been tested will be discussed separately. The following tables give the average results for the year they were under test of all varieties retained for further work.

Performance record of spring wheat varieties

Name	No. of years under test	Time from seeding to maturity in days	Average height of plants in inches	Yield		Weight of grain in pounds per bushel
				Grain in bushels per acre	Straw in tons per acre	
Marquis	4	114	45	53.2	1.96	60
Dicklow	6	117	47	46.1	1.86	59
College Hybrid No. 143	3	114	43	43.8	1.74	62
Saskatchewan Fife	3	114	43	41.6	1.86	59
Defiance	5	117	46	39.4	1.89	60
Palouse Bluestem	4	114	45	37.6	1.97	58
Galgalos	4	111	38	35.3	1.55	62

Marquis is a red wheat and when first introduced is a comparatively hard one. When grown for a number of years under irrigation, however, it does not completely retain these characteristics for the grains become lighter in color and less glutinous in character. From the standpoint of the miller this tendency to become more starchy is an objectionable one. On the station farm, however, it has out-yielded all other varieties of spring wheat.

The Dicklow has given very satisfactory results from the standpoint of yield and should be considered a very desirable variety of spring wheat for irrigated lands. It is a large soft white wheat and, therefore, not considered the best for milling purposes; nevertheless it is being extensively used in the manufacture of certain grades of flour. It is commonly believed that the soft wheats are best adapted for growth under irrigation since they will continue to produce year after year grain of uniform quality, whereas the hard wheats tend to lose their glutinous characteristics and, therefore, gradually come to lack uniformity in color and hardness. Some experience, however, gained during the course of these investigations does not support the belief that hard wheats *necessarily* become soft when grown under irrigation.

College Hybrid No. 143 has made a good average yield. It is a club wheat and was originated by the Washington Experiment Station.

Saskatchewan Fife and Defiance are fairly satisfactory varieties from the standpoint of yield but both are very easily shattered in harvesting operations.

Since a great many inquiries have been received relative to durum or macaroni varieties of wheat, three of them have been included in the variety tests. Our records of performance are indicated below for the year 1911, the only season they were under test.

Performance record, spring wheat varieties, durum type

Name	Time from seeding to maturity in days	Average height of plants in inches	Yield		Weight of grain in pounds per bushel
			Grain in bushels per acre	Straw in tons per acre	
Pelissier	109	46	39.8	1.91	63
Kubanka	109	47	38.3	1.91	63
Purple Durum	109	45	32.2	1.98	64

These grains have returned smaller yields per acre than the best common varieties previously mentioned. They are, however, more resistant to drouth and, therefore, in sections where the water supply is deficient they might be grown to very good advantage. On most irrigated lands, however, drouth-resistance is not as important a characteristic as high-yielding power and the durums, therefore, are not to be generally recommended for production under irrigation.

Seeding

The amount and kind of labor necessary for the preparation of a good seed bed varies greatly with different kinds of soil. The labor necessary to secure that condition, however, is always a good investment. Drilling will give better results than broadcasting. The *time of seeding* necessarily varies with weather conditions in different localities. On the station farm the seeding has usually been made during the first half of April. Wheat is usually the first of the small grains to be sown. If sown early, less seed per acre is required because the grain will stool extensively. Fertile land with adequate moisture such as can be supplied by irrigation will support a much heavier stand than would be advisable on less productive land or where adequate irrigation water is not available. Generally speaking, six pecks per acre is a satisfactory rate of seeding for spring wheat. All seed wheat should be carefully cleaned and graded with a good fanning mill and treated with formalin solution for the prevention of smut.

Irrigation

In the production of many farm crops with irrigation, the proper time at which to apply water is a most important consideration in irrigation practice. It is believed that there are certain stages in the development of some plants when a greater moisture supply is needed than at other stages. The irrigator can apply water at any time, but, if his work is to be most efficient, the water must be given at such times as the crop can make best use of it. It is clearly a serious waste of time and water to irrigate when water is not needed or might even prove to be harmful to the crop irrigated. The work at the station has included a series of experiments conducted for the purpose of determining the stage or stages in the growth of small grains at which irrigation water can be most advantageously applied.

In the production of ripened grain, wheat, barley and oats go thru the same stages of development as first jointing, booting, heading, soft dough and maturity, and in practically the same manner. The limited area of the farm prevented the conduct of *time-of-irrigation* experiments on each of these three grains. It was confined entirely to spring wheat but it is believed that the results secured are applicable to both spring barley and oats.

During the first three years of this time-of-irrigation work, all of the stages of growth just mentioned were taken into consideration. They were irrigated singly and in various combinations. The results are recorded on pages 13 to 17 of bulletin No. 78* of the Idaho Experiment Station. The plan followed during these three years proved to be a cumbersome one and the results could not be readily understood and applied to ordinary farm practice. In order to simplify the procedure and to insure the general application of results secured, the growing period of the grain was divided into three stages, early, medium and late, and they are designated as follows: first stage, planting to first jointing; second stage, first jointing to blooming; third stage, blooming to maturity. Eight sub-plats were used and they were irrigated as indicated in the following: (1) no irrigation; (2) one irrigation in the first stage; (3) one irrigation in the second stage; (4) one irrigation in the third stage; (5) one irrigation in the first stage and one in the second; (6) one irrigation in the first stage and one in the third stage; (7) one irrigation in the second stage and one in the third; (8) one irrigation in the first stage, one in the second stage, and one in the third stage. This plan of procedure has worked out very satisfactorily. Moreover, in the assembling of results of this latter work, it became apparent that the various irrigations applied under the earlier plan of procedure could be grouped very satisfactorily under the subdivisions of the latter plan. The following table, therefore, includes the average results of all *time-of-irrigation* experiments with spring wheat during the years 1911 to 1916 inclusive.

* Out of print.

Results of time-of-irrigation experiments with spring wheat

Time of irrigation	Water absorbed, acre-feet per acre	Average height of plants in inches	Yield: Grain in bushels per acre	Yield: Straw in tons per acre	Weight of grain in pounds per bushel
No irrigation	.000	25	23.0	.80	57
One irrigation in first stage.	.492	33	33.6	1.22	55
One irrigation in second stage.	.367	32	28.5	1.05	56
One irrigation in third stage	.484	25	22.7	.74	56
One irrigation in first stage and one in second	.978	40	43.5	1.48	56
One irrigation in first stage and one in third	.979	36	39.1	1.61	58
One irrigation in second stage and one in third	.808	35	41.6	1.20	58
One irrigation in first stage, one in second and one in third	1.137	40	43.9	1.36	58

In all of this time-of-irrigation work the water was applied by flooding between borders. Ordinary irrigations were given in each case, the soil being allowed to absorb what water it would without appreciable waste. Where waste occurred it was measured and deducted from the amount of water applied. There was an average precipitation of 2.72 inches of rain or .227 feet during the time represented by the three stages.

Fig. II.—Spring wheat properly irrigated

About 80 per cent of this precipitation occurred during the first two stages. The experiments were conducted with Dicklow spring wheat.

The yield of grain per acre is the principal criterion by which these results are to be judged. It will be noted from a study of the preceding table that practically the same amount of water applied at different stages produced widely different yields of grain. The one irrigation applied during the first stage of growth produced considerably more grain than did the one irrigation applied during the second stage of growth; the one irrigation applied in the second stage of growth gave better results than the one applied during the third stage. From these results it would appear that if only one irrigation can be given to spring wheat, it should be applied during this first stage of growth or just before first jointing takes place. Irrigation had better be withheld entirely than applied only during the third stage of growth for less grain was produced from water applied at that time than was produced on the plat to which no water at all was applied.

It will be noted that the later irrigation produced heavier grain than the earlier irrigation, but early irrigation resulted in a greater height of plant and a heavier yield of straw.

If two irrigations can be given to spring wheat, it appears that they should be applied during the first and second stages of growth, for in these experiments more grain was produced from irrigations applied during the first and second stages of growth than was produced from the

Fig. III.—Spring wheat over-irrigated. The variety is the same as that shown in Fig. II. The plats were photographed on the same day.

two irrigations applied during the first and third stages, or from the two irrigations applied during the second and third stages of growth. Irrigations applied during the first and third stages of growth gave less satisfactory results from the standpoint of yield than those applied during the second and third. This is probably due to the fact that the interval between the first and third stages was too long. Any two irrigations, however, gave more satisfactory results than any one.

The applications of three irrigations, one in each stage, produced slightly more grain than the application of one irrigation in each of the first two stages.

Harris at the Utah Experiment Station* divided the growing period of the wheat plant into four stages and found that an irrigation during

* Harris, F. S. *The Irrigation of Wheat,* Utah Experiment Station Bulletin No. 146.

the first stage of growth produced more grain than one applied during the second. One applied during the second stage of growth produced more grain than one applied during the third stage, and one during the third stage produced more than one applied during the fourth stage of growth. Moreover, he found that irrigation applied during the last stage of growth seemed to be of practically no benefit. He also found that where but two irrigations could be given, they should be applied during the first two stages of growth. The early application of water increased the height of the plants and later irrigations produced a heavier grain. It will be noted that results secured at the Gooding station agree with those secured at the Utah station. A great many irrigators hold to the idea that the most advantageous time to irrigate grain is when the kernels are in the dough stage. Results secured from this time-of-irrigation work indicate that this view is not the correct one. In the growing of spring wheat irrigation water can be used most efficiently and economically in the early stages of the plant's development.

The *method* of applying water is of less importance in the irrigation of spring wheat than is the case in the irrigation of some other crops

Fig. IV.—Border method of irrigation

as potatoes and corn. Experiments were started in the spring of 1916 to determine the relative value of the flooding and the corrugation methods in the irrigation of spring wheat. They have not extended over a sufficient period of time to permit the drawing of definite conclusions. The first year's work indicates, however, that where the slope of the land is such that either method may be used, there is little choice between the two insofar as the crop itself is concerned. On lands that have an uneven slope, the corrugations may be of enough value to justify their use in the even distribution of water but on land that has a uniform and regular slope, flooding between borders will prove to be entirely satisfactory.

In the conduct of experiments to determine the *duty of water* for spring wheat, the station has cooperated with the Department of Chemistry of the central station. The work included a study of the effect of varying amounts of irrigation water upon the protein content of the wheat kernel and upon the production and movement of nitric nitrogen in the soil. In this connection only that part of the work which had to do with the determination of duty of water will be presented.

The duty-of-water experiments were conducted during the seasons of 1910 to 1916 inclusive, a total of seven years. During the progress of the work, five varieties of wheat were grown and one hundred and twenty-one plats averaging one-fifth of an acre each were used. The average results are presented here in tabulated form.

Duty of water—Spring wheat

Number of irrigations	Total water absorbed in acre-feet per acre	Yield		Increase over no irrigation per acre-foot of water applied	Weight of grain in pounds per bushel
		Grain in bushels per acre	Straw in tons per acre		
	.000	13.3	.52		59
1	.361	23.3	1.03	27.9	59
3	.748	28.7	1.27	20.6	58
4	1.228	31.8	1.31	15.1	61
6	1.759	33.1	1.29	11.3	60
8	2.269	36.0	1.55	10.0	61
9	2.935	27.5	1.40	4.8	60

There was an average precipitation of .247 feet during the growing seasons in which this work was conducted. All water was applied by flooding between borders. Each season all plats were given their first irrigation at the same time, usually at about the first jointing stage. Every attempt was made to eliminate the time-of-irrigation factor. Some variation in the time of irrigation necessarily occurred, however, and has unquestionably influenced the results. In future work on the irrigation of wheat these two lines of investigation, time of irrigation and duty of water, should be taken into account in the same experiment.

No variation resulted in the date of heading but the maximum irrigation delayed the ripening from six to eight days. In general plants which received the most water attained a greater height than those which received the small amounts of water. In many cases the tall grain lodged badly. Best results from the standpoint of yield were secured from the application of about one and one-fourth acre-feet per acre. The application of larger amounts did not sufficiently increase the yield to justify it. The yield from the application of approximately three feet of water was actually less than that from the one and one-fourth feet. These results indicate that on lands similar to those of the Gooding station spring wheat should be given about one and one-fourth acre-feet of water per acre. This amount can be applied in three or four irrigations.

Results of the work on the time of irrigating spring wheat show somewhat higher yields and a considerably higher duty of water than do the results from these duty-of-water experiments. An explanation lies in the fact that the time-of-irrigation tests were conducted on land which had previously been in alfalfa or clover or had been given applications of barnyard manure, while the greater part of the duty-of-water work was conducted on raw sage brush soil. The duty of water is markedly increased thru soil improvement accomplished by the turning under of large amounts of organic matter.

WINTER VARIETIES

There are a number of reasons why winter wheat can be grown to advantage on irrigated lands. The best varieties produce very satisfactory yields of grain and when grown they help to equalize the farm work and to distribute it more evenly thruout the year; they are sown in the fall after the rush of harvest work is over and require practically no attention in the spring when there is so much work to be done with other crops. Because of their early development they are able to make use of a greater proportion than the spring varieties of the winter and spring precipitation. Their irrigation requirement is, therefore, light and their irrigation season is over before the rush of general farm irrigation begins. The winter varieties are particularly adapted to lands in sections where the supply of water is likely to be somewhat deficient. It is believed that irrigation farmers could with profit to themselves give more attention in the future than they have in the past to the production of winter varieties of wheat.

The variety tests with winter wheats were conducted during the years 1911 and 1912. The average results are shown below in tabulated form.

Performance record of winter wheat varieties

Name	Time from seeding to maturity in days	Average height of plants in inches	Yield		Weight of grain in pounds per bushel
			Grain in bushels per acre	Straw in tons per acre	
Jones' Fife...	272	45	53.6	1.78	62
Turkey Red...	275	45	52.4	1.88	64
Koffoid	276	49	42.8	1.57	61
Missouri Red Fultz	272	55	40.5	2.06	61

The Jones' Fife is a beardless variety with white velvet chaff and red kernels. It has a coarse stiff straw that prevents lodging. It has proven to be winter hardy in this section but has one characteristic weakness, a tendency to shatter easily in harvesting operations.

Turkey Red is a well known bearded variety with smooth red-colored chaff and hard red kernels. Its straw is not as stiff as that of some other varieties, a characteristic which often results in lodging under conditions which induce rank growth. For localities where there is a shortage of water, Turkey Red should be given first consideration.

Koffoid and Missouri Red Fultz have not proved to be as desirable from the standpoint of yields as the first two mentioned. Missouri Red Fultz is the least hardy of these four varieties.

Seeding

Satisfactory results may be expected by sowing about October 1. Five pecks per acre is a satisfactory rate of seeding, and as in the case of spring-sown varieties, the seed should be recleaned and treated for smut.

Irrigation

If the season is a normal one with a fair amount of winter and spring precipitation, winter wheat should not be given irrigation before the booting stage. Most varieties reach that stage late in May. The method of applying water should be the same as that adopted for irrigating the spring-sown varieties.

Experiments on the duty of water for winter wheat were conducted during the years 1910, 1911, and 1912. Three plats averaging two-thirds of an acre in size were used each season. Turkey Red was the variety grown. The following table shows the results of the three years' work.

Duty of water—Winter wheat

Number of irrigations	Length of irrigation season in days	Total water absorbed acre-feet per acre	Yield		Bushels grain per acre-foot of water	Weight of grain in pounds per bushel
			Grain in bushels per acre	Straw in tons per acre		
1		.635	30.4	1.08	47.8	62
2	27	1.066	27.8	.96	25.0	62
4	38	1.464	30.6	1.04	20.9	63

There was an average precipitation of .240 feet during the growing seasons in which this work was conducted. All irrigation water was applied by flooding between borders. Each season all plats were given their first irrigation at the same time, the booting stage, and that stage occurred during the last week in May. No variation resulted in the date of heading but the time of ripening was delayed an average of three days by the maximum irrigation. The plants receiving the most water attained an average height three inches greater than those which received the least. The variation in yield of grain is not very great but a safe conclusion appears to be that one good irrigation of slightly less than three-fourths of an acre-foot per acre is productive of the most economical results in the irrigation of winter wheat under conditions similar to those which prevail at Gooding.

BARLEY

Barley is a very valuable grain for feeding all classes of livestock. The crop is particularly well adapted to conditions which prevail on most of the irrigated farms in southern Idaho. The area devoted to its culture is rapidly increasing. On the Gooding station it has produced more pounds of grain per acre than any of the other small grains.

SPRING VARIETIES

The varieties of barley show great differences in their productive capacity. Tests of varieties conducted on the station farm have shown a variation in yielding capacity of as much as sixty bushels per acre. When the work at Gooding was commenced practically none but low-yielding varieties were known in the irrigated sections of the state. The station has, therefore, given a great deal of attention to the introduction of new varieties for the purpose of securing high-yielding ones. Sixty-seven varieties in all have been tried out. Of this number forty-seven were secured from the Office of Cereal Investigations of the Bureau of Plant Industry, United States Department of Agriculture. The other varieties were secured wherever possible, mostly from various state experiment stations. Newly introduced varieties were grown first in nursery rows. Those which showed desirable characteristics there after two years were grown in field tests. A comparatively small area of land only was available for this work of testing for which reason all varieties which failed to show desirable characteristics were discarded. Of the sixty-seven varieties tested, thirty-six have been discarded. The thirty-one remaining will have their performance record reported.

There is a greater variation in type in the different kinds of barley than is the case with other small grains. For purposes of discussion in this connection, the spring-sown varieties will be classed in one of the following groups:

(1) The first consists of those varieties whose kernels are arranged on the spike or head in four or six rows and are not separated from the hulls in threshing.

(2) The second group is made up of varieties whose kernels are not separated from the hulls in threshing and are arranged on the head in two rows.

(3) In the third group fall those varieties whose kernels separate from the hulls in threshing.

Varieties belonging to the first group are more commonly grown than any other. Technically they are all six-rowed, but in many of them the kernels in the alternate rows overlap to such an extent as to give the head the appearance of having four rows only. In tabulated form below is given the average performance record of the varieties of this first group. They appear in the table in the order of their yield of grain expressed in bushels per acre.

Performance record--Spring barleys, six-rowed type

Name	No. of years under test	Time from seeding to maturity in days	Average height of plants in inches	Yield		Weight of grain in pounds per bushel
				Grain in bushels per acre	Straw in tons per acre	
Trebi	1	110	34	95.5	1.61	48
Beldi No. 1209 *	5	109	31	87.3	1.46	47
Sandrel	1	110	34	82.9	1.46	50
Han River	3	108	31	78.7	1.49	51
Beldi No. 1404 *	5	108	31	77.9	1.41	48
California Feed	6	113	35	74.2	1.56	47
Odessa	2	108	32	74.1	1.40	48
Calif. Feed No. 3318 *	2	109	29	69.6	1.24	48
Gaitami	1	95	35	44.8	1.38	53
Oderbrucher	2	108	36	42.3	1.16	51
Minnesota No. 105	2	102	36	39.5	1.30	51

* Centgener numbers of the California Experiment Station where these three varieties were originated.

These varieties are characterized by an upright growth and a comparatively coarse and stiff straw which prevents serious lodging. Comparatively speaking, the grain is light in weight per bushel, for the proportion of hull to kernel is greater than is the case in the two-rowed types. The best of these varieties are unusually heavy yielders. Trebi stands at the head of the list but Beldi, Sandrel and Han River are also exceptionally good yielders and on the station farm have produced enormous quantities of excellent feed grain. Sandrel and Han River are high in weight per bushel for feed barleys. The grower may select any of the above mentioned varieties with an assurance of satisfactory returns.

The two-rowed varieties are not very commonly grown in southern Idaho. In other states they are extensively grown for malting purposes. Because of the relatively small proportion of hull to kernel and their heavy weight per bushel, they are exceptionally good for feeding purposes. Some high-yielding varieties have been introduced on the Gooding farm as the following table shows.

Performance record—Spring barleys, two-rowed type

Name	No. of years under test	Time from seeding to maturity in days	Average height of plants in inches	Yield		Weight of grain in pounds per bushel
				Grain in bushels per acre	Straw in tons per acre	
Bohemian	3	110	32	84.21	1.69	51
Horn	3	110	36	81.65	1.94	53
Holland	3	110	32	76.15	1.81	52
Italian	3	110	32	73.79	2.02	52
Gold Foil	3	110	33	73.25	1.64	53
Scholeys	3	110	32	70.77	1.72	51
Proskowetz	2	110	34	70.13	1.64	51
Frankish	2	110	37	69.09	1.71	52
Servian	2	110	37	66.34	1.48	51
Manchuria	3	110	39	66.15	1.82	52
Svanhals	4	109	37	63.92	1.82	51
Hanna	2	110	34	63.82	1.16	52
Mahrische	2	110	35	61.04	1.75	52
White Moravian	4	107	24	57.79	2.03	52
White Smyrna	4	106	32	56.93	1.31	50
Minnesota No. 137	3	105	31	48.91	1.42	53

Trebi, Sandrel and Odessa of the six-rowed varieties and all of the two-rowed varieties excepting Svanhals, White Moravian and Minnesota No. 137 were secured from Mr. Harry V. Harlan of the Office of Cereal Investigations, Bureau of Plant Industry, United States Department of Agriculture. They are pedigreed selections made by Mr. Harlan from various importations. The Trebi comes from an importation from the southern shore of the Black Sea. The Bohemian and Horn come from seed secured at the Paris Exposition. Gold Foil comes from an importation from Bohemia. Italian and Holland come from Germany.

These varieties are characterized by straw that is softer than that of the six-rowed types, by a growth that is not quite so erect, and by some tendency to lodge. In the course of this work with varieties, more two-rowed barleys were discarded than of any other type; their tendency to lodge was the principal reason for discarding them. The varieties mentioned in the preceding table have shown the least tendency toward this undesirable characteristic.

The grain of the two-rowed varieties is heavier than that of the six-rowed ones, a characteristic that is explained in part at least by the smaller proportion of hull to kernel. The first five mentioned varieties have shown very desirable characteristics thus far, and at least the first three can be strongly recommended to irrigation farmers.

The hulless type of barley, often called "bald" barley, is widely known. Of the hulless varieties, some have six and some have two rows. Some are beardless and some bearded, and the color of the grain may be white, purple or black. The proximate composition of hulless barley is similar to that of wheat. While pound for pound, the bald barleys may be worth more for feed than varieties bearing hulls, their low yield per acre more than offsets this advantage. The tests of varieties have included four of this type, the average results of which are shown in the following table:

Performance record—Spring barleys, hulless type

Name	No. of years under test	Time from seeding to maturity in days	Average height of plants in inches	Yield		Weight of grain in pounds per bushel
				Grain in bushels per acre	Straw in tons per acre	
Eureka	4	107	33	63.4	1.48	63
Abyssinnian	3	107	31	44.4	1.55	57
S. P. I. No. 28624....	4	107	26	44.1	1.55	60
White Hulless	2	99	31	40.0	1.30	64

Of these varieties the Eureka is the only one to be recommended. It was originated by the Washington Experiment Station. It is a beardless, six-rowed type with white grain. Its one undesirable characteristic is the marked tendency of its heads to break off if they are allowed to become over-ripe. Unless the grain is harvested early, a great deal of it is lost in the harvesting operations. The ripe grain of the Abyssinnian variety is black and that of the S. P. I. No. 28624 is white. Both are two-rowed and bearded and both are very easily shattered in harvesting.

Seeding

Thoro preparation of the seed bed is essential to the successful production of spring barley. No definite rules of procedure can be given for the preparation of the seed bed as the amount of work necessarily varies with different types of soil. This alone may be said. The seed bed should be fine and comparatively firm and should contain sufficient moisture to insure vigorous germination.

The time of seeding on the station farm has varied widely with different seasons but usually seeding was accomplished some time during the first three weeks of April. In the irrigated sections, barley is usually sown after wheat. The proper depth of seeding varies with the character of the soil and with the supply of moisture. On the station farm sowing at a depth of two and one-half inches has given satisfactory results. Spring barley does not stool as extensively as wheat or oats; therefore, greater care should be taken to insure the sowing of sufficient seed to secure a good stand. A productive soil with irrigation will support a thicker stand than a poor soil or even a good one inadequately supplied with moisture. Eight pecks per acre has been found a satisfactory rate of seeding. It is advisable to carefully clean and grade seed barley and to treat it with formalin solution for the prevention of losses which might result from the growth of smut.

Irrigation

On the station farm the practice has been in the production of spring barley to irrigate as for spring wheat insofar as the time of irrigation is concerned. The practice has been entirely satisfactory.

Experiments to determine the comparative value of the flooding and the corrugation methods in the irrigation of spring barley were commenced in 1916. The work up to this time has extended over too short a period to permit the drawing of definite conclusions but the indications are that there is but little choice between the two methods insofar as the crop itself is concerned. Which one the grower should choose would seem at this time to depend entirely upon the character of his soil and the slope of his land.

An experiment was conducted during the years 1915 and 1916 to determine what should be the *size of stream* and the *depth of application* in the irrigation of spring barley. The work was conducted in duplicate. One set of plats was irrigated by allowing as large a stream as could be obtained to flush over the surface, taking care to shut it off in time to prevent appreciable waste, a procedure which resulted in a shallow application of water. Another set of plats was irrigated by using a stream one-half the size of the first until the surface was wet, a procedure which gave a somewhat deeper application of water. A third set of plats was irrigated by allowing a stream one-fourth the size of the first to run as long as was necessary to cover the ground, a procedure which resulted in the application of a heavy irrigation. All of the plats in the experiment were irrigated on the same dates and were given the same number (two) of irrigations. Results secured are indicated below.

Influence of size of stream on the irrigation of barley

Size of stream in cubic feet per second	Average time used	Average depth of application in acre-feet per acre	Total water absorbed in acre-feet per acre	Yield		Bushels of grain per acre-foot of water
				Grain in bushels per acre	Straw in tons per acre	
1.20	28 min.	.323	.646	54.7	1.00	84.1
.65	1 hr., 23 min.	.468	.934	55.9	1.02	60.5
.30	2 hrs., 57 min.	.544	1.086	49.2	.89	45.2

There resulted from this procedure in the irrigation of these plats small variations only in the yield of grain per acre but the work indicates that a great advantage is secured by the use of a good sized stream for a short time, a procedure which gives a comparatively light irrigation.

Experiments on the *duty of water* for spring barley have extended over five years, 1910 to 1914 inclusive. Each year three plats averaging two-thirds of an acre in size were used. One was given minimum, one medium and one maximum irrigation. In 1910 White Moravian barley was grown. In all other years California Feed was the variety grown. The average results of this duty-of-water work are shown in the following table:

Duty of water—Spring barley

Number of irrigations	Length of irrigation season in days	Total water absorbed in acre-feet per acre	Yield		Grain in bushels per acre-foot of water	Weight of grain in pounds per bushel
			Grain in bushels per acre	Straw in tons per acre		
2	16	.783	35.1	.75	44.8	46
3	42	1.497	45.5	.87	30.4	48
5	48	2.003	47.5	.95	23.7	49

During the growing seasons an average of .218 feet of rainfall occurred. All water was applied by flooding between borders. All plats were given their first irrigation at the same time and that usually was about the first jointing stage.

No variation resulted in the date of heading but the time of ripening was delayed three days by the maximum irrigation. The plants grown on plats given the most water attained a greater length by three inches than those grown on the plats given the least water.

This work which sought to establish the duty of water for spring barley should have involved the use of a greater number of subdivisions so that the variation of water applied could have extended from none to all that could be given. The variation of water applied to the three plats used each year was not sufficiently great to permit of a maximum that would prove to be actually injurious to the crop. As actually conducted, however, the most economic result was secured by the application of three irrigations aggregating about one and one-half acre-feet of water per acre.*

WINTER VARIETIES

Very little winter barley is being grown at the present time on the irrigated lands of southern Idaho. On the station farm the varieties grown have suffered very little from winter killing. Winter barley like winter wheat matures early in the season and its irrigation requirement, therefore, is also light. Under normal irrigation the winter varieties are not nearly as productive as the spring-sown ones. They can be most profitably grown in localities characterized by short seasons or inadequate supplies of irrigation water. Two varieties only have been grown in variety tests. In the table below their average performance records may be noted for the years 1911 and 1912.

Performance record—Winter barleys

Name	Time from seeding to maturity in days	Average height of plants in inches	Yield		Weight of grain in pounds per bushel
			Grain in bushels per acre	Straw in tons per acre	
Utah	280	37	69.7	1.43	48
Tennessee ...	275	36	60.8	1.16	53

The Utah is characterized by a coarse, stiff straw, and a short, thick six-rowed head. It is sometimes called White Winter Club. The Tennessee has a much shorter straw and under conditions which induce rank growth is more likely to lodge. It has a six-rowed head that shatters easily in harvesting operations. On the station these varieties have been sown about October 1st at the rate of seven pecks per acre.

Irrigation

Winter barley like winter wheat can make use of a large proportion

* In the conduct of the strictly irrigation experiments of the station and those which had to do with the testing of varieties, there has been an important difference which must not be lost sight of for it will account in a large measure for the differences in yields secured from the two lines of work. The major portion of the farm has been devoted to experiments in irrigation, and they of necessity have been conducted on comparatively raw sagebrush land. The testing of varieties has been practiced on land which has been improved by the growth of alfalfa, clover, or the application of barnyard manure.

of the winter and spring precipitation because of its very early development. In a normal season it will not require irrigation until it reaches the booting stage. What has already been said in reference to method of application in the irrigation of other grains is equally applicable to winter barley.

Experiments to determine the duty of water for winter barley have extended over three seasons, 1913 to 1915 inclusive. Three plats averaging one-third of an acre in size were used each season. The Utah was grown each year. The following table gives the average results secured in this duty-of-water work for winter barley.

Duty of water—Winter barley

Number of irrigations	Length of irrigation season in days	Total water absorbed in acre-feet per acre	Yield		Grain in bushels per acre-foot of water	Weight of grain in pounds per bushel
			Grain in bushels per acre	Straw in tons per acre		
1		.427	35.2	1.03	82.4	47
2	33	.826	33.4	1.11	40.4	48
3	38	1.372	35.0	1.20	25.6	48

There was an average precipitation of .238 feet during the growing seasons included in this experiment.

All water was applied by flooding between borders. The several plats were always given their first irrigation at the same time, the booting stage. No variation resulted in the date of heading, but the time of ripening was delayed from three to six days by the maximum irrigation. The plants grown with the most water averaged three inches greater in length than those grown with the least water. On June 7, 1914, when the barley was in full bloom, a heavy frost occurred. It killed about seventy-five percent of the crop on all of the plats used in the experiment and is responsible for the low average yields shown in the above table. The damage from frost, however, was the same on all of the plats so that the comparative yields were not affected.

It will be noted that the maximum yield was secured with the minimum irrigation, from which it would appear that under conditions which prevail in the vicinity of Gooding, at least winter barley should be given one irrigation only of about one-half acre-foot of water per acre.

OATS

The oat crop is one of the most valuable of the cereal crops grown extensively in Idaho. When fed it furnishes a nearly balanced ration and since the grain is comparatively soft, it is capable of wide adaptation in feeding operations. Most of the State's irrigation projects are located at comparatively high altitudes and are exceptionally well adapted to the production of the oat crop. The grain produced on these high elevation irrigation projects is uniformly of high quality. Up to this time no winter variety has been developed that is sufficiently hardy to be grown successfully under normal conditions in Idaho. The oat crop in this state is entirely spring sown. At the Gooding station an effort has been made to introduce, study and improve as many varieties of oats as could be conveniently gotten together and handled in the comparatively limited space that could be devoted to this particular crop. The varieties thus far found to be most satisfactory are listed in the following table in the order of their performance record in the matter of production for the years they were under test.

Performance record of spring-sown oats

Name	No. of years under test	Time from seeding to maturity in days	Average height of plants in inches	Yield		Weight of grain in pounds per bushel
				Grain in bushels per acre	Straw in tons per acre	
Swedish Select	5	114	46	96.6	1.63	39
Wisc'n Pedigree No. 1	4	114	47	96.5	1.69	37
Silvermine	2	111	45	96.0	1.65	39
Victor	4	113	50	88.6	1.86	38
Colorado No. 37	6	113	42	88.2	1.34	39
Big Four	6	110	43	87.4	1.67	40
Garton's No. 5	4	113	45	86.9	1.76	38
Victory	6	111	43	86.6	1.69	40
Danish Island	6	111	43	86.6	1.66	39
Lincoln	6	111	45	86.2	1.61	39
C. I. No. 724	2	106	41	85.5	1.72	36
Wisc'n Pedigree No. 5	4	112	43	85.3	1.52	39
Minnesota	6	111	43	83.6	1.59	39
Golden Rain	6	110	45	83.4	1.79	40
Wisconsin No. 4	1	110	43	83.2	1.51	40
President	4	113	44	83.1	1.51	39
Schoenen	2	111	45	83.0	1.55	37
White Russian	5	115	45	82.4	1.74	39
Abundance	5	112	42	81.6	1.11	40
White Bonanza	2	111	45	78.8	1.62	39
Canadian	2	105	45	78.7	1.78	43
Early Mountain	4	108	40	76.2	1.27	40
Minnesota No. 295	2	106	41	73.2	1.14	41
Kherson	1	96	32	71.1	1.68	39
Minnesota No. 26	1	104	40	67.8	1.42	39
Shadeland Wonder	2	108	39	67.2	1.34	40
Minnesota No. 261	1	99	36	63.1	1.52	40
Sixty-Day	1	94	37	61.0	1.50	37
Shadeland Triumph	1	104	40	46.5	1.70	41

The yields reported in the above table were all calculated on a basis of thirty-six pounds to the bushel. It will be noted that there are listed in the table a number of high-yielding strains and varieties whose performance record is about the same. In fact, the first ten varieties listed show a variation in yield of only about ten bushels per acre.

The variety listed as Swedish Select was secured by Professor W. H. Olin from the Swedish Oat Breeders Association of Stockholm, Sweden. The Swedish Select is a very important and valuable variety. It has furnished the foundation stock for a large number of the strains and sorts developed by various breeders the country over. Colorado No. 37, Wisconsin Pedigree No. 5, Wisconsin No. 4, and Minnesota No. 281 are all strains developed from this famous variety.

Wisconsin Pedigree No. 1 was developed from White Bonanza by the Wisconsin Experiment Station.

To the Kherson group belong Kherson, Minnesota No. 261, and Sixty-Day. They are early strains but have not produced satisfactory yields.

The Victor is a black oat. It is characterized by a rank growth and a yield of straw that is heavier than that produced by any other variety tested on the station farm.

Seeding

No specific directions can be given for the preparation of the seed bed in which oats are to be sown. Practice must vary with the different locations and types of soils. It is sufficient to state that thoro preparation of the seed bed is no less essential for the successful growing of oats under irrigation than it is for the production of wheat and barley. Oats, like spring wheat, should be sown early. On the station farm, seeding during the first half of April has given excellent results. It has been found that ten pecks per acre is a satisfactory rate of seeding. The seed grain, as in the case of wheat and barley, should be recleaned, graded, and treated with formalin solution to prevent the growth of smut.

Irrigation

In the production of the oat crop, insofar as *time of irrigation* is concerned, the plan of procedure recommended for spring wheat has proved satisfactory. Experiments planned to determine the best method to pursue in the application of irrigation water to the oat crop have been conducted in the same manner as those which had to do with the irrigation of spring barley, and from them practically the same conclusions have been reached. Experiments to determine the *duty of water* for oats have been conducted during the seasons 1910 to 1914 inclusive. In 1912 five plats were devoted to this work. In each of the other seasons, three plats only were used. Lincoln oats were grown in 1910 and Big Four in all of the other years. In the following table are given the average results from this duty-of-water work with oats.

Duty of water—Oats

Number of irrigations	Length of irrigation season in days	Total water absorbed in acre-feet per acre	Yield		Grain in bushels per acre-foot of water	Weight of grain in pounds per bushel
			Grain in bushels per acre	Straw in per acre tons		
1		.434	44.5	.69	102.6	35
3	37	1.087	60.7	1.06	55.9	38
6	56	1.828	70.3	1.18	38.5	41

The average precipitation for the growing seasons during which this work was conducted was .218 feet.

All water was applied by flooding between borders. All plats were given their first irrigations at the same time, usually about the first jointing stage. As was the case with wheat and barley, no variation resulted in the date of heading but the time of ripening was delayed from four to six days by the maximum irrigation. The plants grown on plats which were given the maximum irrigation averaged eight inches greater in length than those grown on plats which were given the minimum irrigation. As was the case in the duty-of-water work with barley, this work with oats did not involve the use of a sufficiently large number of plats. Variations in the amounts of water applied were not sufficiently great and a point was not reached at which the application of water proved to be injurious to the crop. From this work one can not say that water applied in excess of one and three-quarters acre-feet per acre would result in an increased yield of grain. Excessive water is probably not as injurious to oats as it is to some other grain crops, but there is reason to believe that the application of more water than one and three-fourths acre-feet per acre, under conditions similar to those which prevail on the station farm, would not be productive of profitable returns.

The yields of grain produced in this duty-of-water work are much lower than those recorded from the results of variety tests for reasons similar to those already mentioned under the discussion of the work with spring barley.

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