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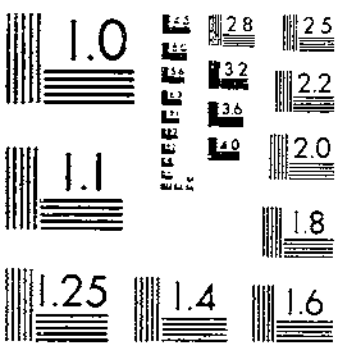

MICROCOPY RESOLUTION TEST CHART
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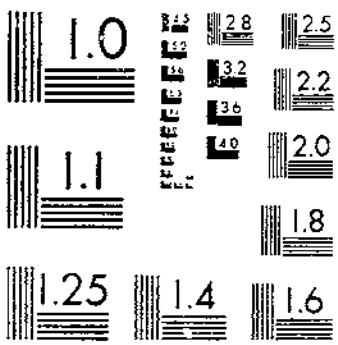

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

TECHNICAL BULLETIN No. 38 NOVEMBER, 1927

UNITED STATES DEPARTMENT OF AGRICULTURE
WASHINGTON, D. C.

RATE AND DATE OF SEEDING AND SEED-BED PREPARATION FOR WINTER WHEAT AT ARLINGTON EXPERIMENT FARM

By C. E. LEIGHTY, *Agronomist in Charge of Eastern Wheat Investigations*, and J. W. TAYLOR, *Associate Agronomist, Office of Cereal Crops and Diseases, Bureau of Plant Industry*

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INTRODUCTION

The rate for seeding winter wheat generally recommended in the eastern part of the United States is 6 pecks per acre. The date of seeding varies in different localities, depending on latitude, elevation, and to a considerable extent on the prevalence of the Hessian fly and the likelihood of winterkilling. The seed bed is prepared either by disking or plowing, depending largely on whether or not the preceding crop was cultivated. In many sections sufficient data have been accumulated to warrant definite recommendations in regard to these major cultural practices. In other sections experimental results on which definite recommendations can be based are not available, and further data are needed from stations representative of the prevailing climatic and soil conditions.

PLAN OF THE EXPERIMENTS

In the fall of 1918, experiments were begun at the Arlington Experiment Farm of the United States Department of Agriculture, located at Rosslyn, Va., involving the seeding of wheat at different rates per acre on different dates and on land prepared in different ways, as shown in Figure 1. Seedings were made at the rate of 2, 3, 4, 5, 6, 7, and 8 pecks per acre, on three dates, September 15, October 5, and

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October 30. Part of the land was prepared by disking and part by plowing, a cultivated crop having been grown on it in the preceding season.

The comparative seed-bed preparations were as follows:

Plowing: Land plowed 6 inches deep, Acme harrowed once, rolled once, double disked once, and Acme harrowed once.

Disking: Land double disked twice and Acme harrowed twice. When planting was delayed 20 to 45 days after the preliminary preparation, the disked and plowed plots both were fitted for seeding on the date sown, by double disking and Acme harrowing once over or occasionally twice over.

On September 15, 21 plots were prepared by disking and 21 by plowing. Seven of the disked plots and seven of the plowed plots were seeded on the day the seed bed was prepared and at the seven rates of seeding named. Seven of the remaining plots prepared September 15 by each of the two methods were seeded likewise at the

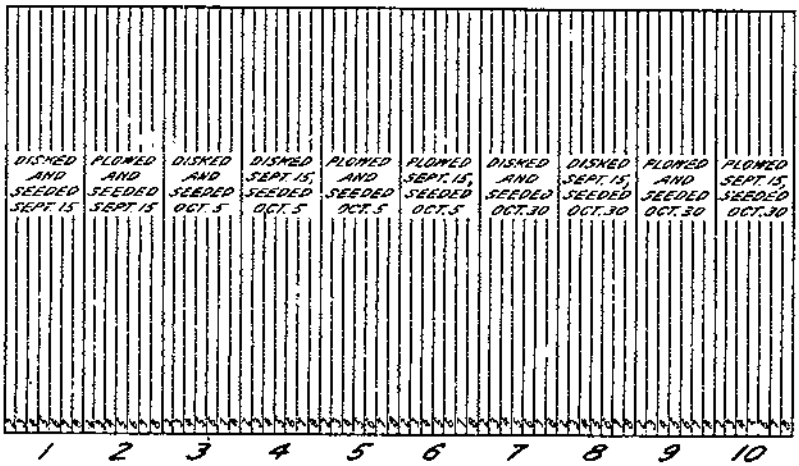

FIG. 1.—Layout of the experiments on wheat seeding conducted at the Arlington Experiment Farm for the six-year period 1919–1924

several rates October 5, and the last seven in each series were seeded October 30.[1] On the two October dates seven plots also were freshly prepared by each of the two methods, and these were seeded at once at the seven rates of seeding in each case.

There were then 70 plots in all, half of them prepared by disking and half by plowing. The seven different rates of seeding each occurred on 10 different plots. On the first date 14 plots were sown, and 28 were sown on both the second and third dates, 14 having been prepared September 15 and 14 on the date of seeding. All plots were 132 feet long and 8¼ feet wide, or a fortieth of an acre in size. Unseeded alleys 18 inches wide separated the plots.

The experiments were continued on this same plan for six years, crops being harvested each year from 1919 to 1924, inclusive. The soft red winter wheat Purplestraw (C. I. No. 1915) was used throughout the experiments.

[1] The date of seeding did not vary from the three chosen dates more than two days in any of the six years of the experiments, except that the last seeding in 1918 was made Oct. 25.

ENVIRONMENTAL CONDITIONS

SOIL

The soil on which the experiments were conducted has been classified as Keyport silt loam. The subsoil contains a large percentage of clay. Baking and clodding are common and are factors in determining the success of the seed-bed preparation. Summer and fall weeds, consisting principally of volunteer soy beans and crabgrass (*Digitaria sanguinalis* (L.) Scop.), always were present to a considerable extent on the land used.

ROTATION PRACTICED

The rotation practiced during the experiments consisted of wheat followed by a green-manure crop of cowpeas plowed under in September. Fall rye was then sown, and this was plowed under in April in preparation for soy beans grown for seed. Wheat in the experiments followed the soy-bean crop in all years except the first. The two green-manure crops have been used in a soil-improvement plan for bettering the physical condition and productivity of the soil. In 1918 land on which tomatoes had been grown was used. The tomato vines remained on the land prepared for wheat, but in the succeeding five years the soy beans, planted in rows and cultivated, were harvested, and only a short stubble remained. A different parcel of ground was used in each of the six years the experiments were conducted.

By using land on which soy beans had been grown as a cultivated crop in the preceding season, information was obtained on the preparation of such land for wheat. A rotation in which wheat follows soy beans is generally recognized as having many desirable features. With the rapid increase in acreage of soy beans that has taken place in the last few years, considerable soy-bean land is available for wheat. In 1917 there were fewer than a half million acres of soy beans in the United States, whereas in 1926 there were about 2,600,000 acres. Data on preparing soy-bean land for wheat are therefore of wide interest.

PRECIPITATION

The precipitation at the Arlington Experiment Farm is perhaps too great for the most satisfactory growing of winter wheat. A high yield of straw usually is obtained, and lodging of the crop frequently occurs. The monthly precipitation for the period of the experiment is shown in Table 1. The precipitation varied in the different crop years (July 1 to June 30) from 38.97 inches in 1918–19 to 45.75 inches in 1922–23, and averaged 41.91 inches for the six years of the experiments. The average rainfall for the month of October for the six year period (1918–1923) was 1.59 inches. This was unusually low, the average for October being 2.56 inches for the 15-year (1911–1925) period in which weather data have been recorded at Arlington Experiment Farm. In 4 or 5 of the 15 years it would have been impracticable to seed wheat October 30 owing to rains or wet land, but in all years but one a seeding could have been made during the first week of November.

TABLE 1.—*Monthly, annual, and average precipitation, in inches, at the Arlington Experiment Farm for the 12-month periods (July to June crop years) from July, 1918, to June, 1924, inclusive*

Month	1918	1919	1920	1921	1922	1923	Average, 1918–1923
July	3.98	7.42	4.97	4.96	7.84	4.08	5.54
August	2.33	3.71	4.91	1.67	4.09	2.21	3.15
September	3.15	1.68	2.85	3.89	7.65	3.57	3.80
October	.94	3.97	.43	.88	1.88	1.44	1.59
November	1.55	2.54	4.14	4.64	.60	1.90	2.58
December	4.44	3.27	3.58	1.50	3.80	3.27	3.31

Month	1919	1920	1921	1922	1923	1924	Average, 1919–1924
January	3.83	2.42	2.94	4.05	3.94	3.55	3.50
February	2.11	3.07	2.13	2.54	2.42	2.99	2.54
March	4.15	2.44	2.34	4.52	4.18	5.54	3.86
April	3.53	4.58	3.72	1.81	4.46	5.19	3.88
May	6.00	1.00	6.26	4.53	1.49	6.59	4.45
June	2.95	4.51	3.47	4.14	3.49	3.43	3.65
Annual total	38.97	41.21	41.94	39.73	45.75	43.85	41.91

WINTERKILLING

Winterkilling of wheat, even when sown as late as October 30, is not considered a factor of any importance in this section. Zero weather occasionally is experienced, but the actual killing of wheat, similar to that observed annually in winter oats and barley, seldom if ever occurs.

EXPERIMENTAL DATA

YIELDS FROM DISKED AND FROM PLOWED LAND

The yields of grain and straw and bushel weight of the grain, obtained in each of the six years, 1919 to 1924, inclusive, from each of seven rates of seeding, on land prepared by disking on different dates, are given in Table 2. Similar data obtained on land prepared by plowing are given in Table 3. The experiments were conducted on fortieth-acre plots, from the yields of which the acre yields were calculated. In order to facilitate consideration of the several factors involved in the experiments, other tables are presented in which the data are appropriately arranged.

In Table 4 are presented the average acre yields of grain and straw and bushel weight of grain, obtained on disked land and on plowed land, prepared both on the day of seeding and at an earlier date, arranged according to the date of seeding, but averaged for all rates of seeding. The data given, therefore, are those obtained on land prepared in each of two ways and on different dates, and sown on three different dates, but these data are averages for all the seven rates of seeding employed.

The average of the annual grain yields of all disked plots for the six-year period was 27.12 bushels per acre, and for all plowed plots 26.51 bushels per acre, or 0.61 bushel in favor of disking in comparison with plowing. The averages of the annual straw yields were 3,758 pounds per acre on the disked land and 3,882 pounds on the plowed land, or 124 pounds per acre more on the plowed land. The bushel weights—59.29 and 59.35 pounds, respectively—were practically the same for the grain grown on disked and on plowed land.

The average yields of grain were higher on the disked land than on the plowed land in 1920, 1921, 1922, and 1923 and lower in the other two years. The differences varied from 1.26 bushels per acre less on the disked land in 1919 to 2.46 bushels more in 1920. Average straw yields were higher on disked land only in 1920. Differences varied from 426 pounds less straw per acre on the disked land in 1924 to 156 pounds more in 1920.

DATE OF SEEDING

EFFECT ON YIELD AND BUSHEL WEIGHT

The effects of date of seeding on yield perhaps are best obtained from those plots seeded immediately following preparation by disking and plowing September 15, October 5, and October 30. These data are shown in Table 4. The September 15 seedings on both disked

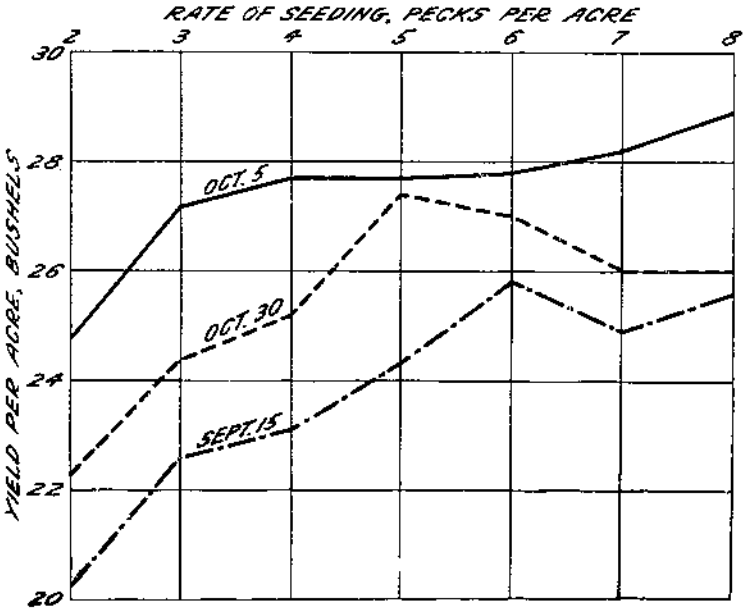

FIG. 2.—Average acre yields of winter wheat, in bushels, on all plots prepared and seeded on three successive dates, September 15, October 5, and October 30, at each of seven different rates of seeding at Arlington Experiment Farm, in the six-year period 1919–1924. The yields obtained on land prepared previous to the day of seeding are not included here. (See fig. 3)

and plowed land averaged 23.77 bushels of grain and 3,938 pounds of straw. The October 5 seedings averaged 27.48 bushels of grain and 3,902 pounds of straw, and the October 30 seedings 25.44 bushels of grain and 3,072 pounds of straw. The trend of the yields with respect to date of seeding is similar on both the disked and the plowed land. The comparative actual grain yields from each rate of seeding for each of the three different dates of seeding, on the land prepared and sown on the same day, are shown graphically in Figure 2. The yields shown are averages for the two methods of seed-bed preparation.

TABLE 2.—*Annual acre yields of grain and straw and bushel weight of winter wheat grown on individual fortieth-acre plots on land disked and seeded on varying dates and at seven different rates in the six-year period 1919–1924*

Year	Treatment		Rates of seeding per acre																					
			2 pecks			3 pecks			4 pecks			5 pecks			6 pecks			7 pecks			8 pecks		
	Disked on—	Sown on—	Grain	Straw	Bushel weight	Grain	Straw	Bushel weight	Grain	Straw	Bushel weight	Grain	Straw	Bushel weight	Grain	Straw	Bushel weight	Grain	Straw	Bushel weight	Grain	Straw	Bushel weight
			Bush.	*Cwt.*	*Lbs.*	*Bush.*	*Cwt.*	*Lbs.*	*Bush.*	*Cwt.*	*Lbs.*	*Bush.*	*Cwt.*	*Lbs.*	*Bush.*	*Cwt.*	*Lbs.*	*Bush.*	*Cwt.*	*Lbs.*	*Bush.*	*Cwt.*	*Lbs.*
1919	Sept. 15	Sept. 15	12.7	23.4	55.8	15.0	28.4	55.8	15.9	26.5	57.3	18.5	28.5	56.5	16.0	28.2	53.3	17.2	31.3	54.0	21.2	33.3	58.0
	do	Oct. 5	18.0	33.2	53.5	23.2	41.7	57.5	23.0	48.0	54.8	21.0	44.4	54.0	25.7	45.4	51.3	23.0	43.4	54.0	24.0	45.0	52.0
	Oct. 5	do	23.2	49.3	53.5	20.2	36.7	54.8	24.0	44.6	56.0	22.3	38.0	55.3	18.7	39.0	56.0	18.3	64.2	47.5	20.2	71.5	45.0
	Sept. 15	Oct. 30	17.3	27.6	53.0	21.9	39.1	53.3	24.3	48.4	54.5	23.7	48.0	50.5	24.0	53.8	52.5	22.2	55.3	49.3	26.3	51.8	51.5
	Oct. 30	do	17.9	24.9	53.5	18.7	29.4	54.5	21.7	33.8	55.3	22.3	36.4	54.0	23.0	35.2	51.0	24.0	37.4	53.5	25.3	41.4	52.0
Average			17.8	31.7	53.9	19.8	35.1	55.2	21.8	40.3	55.6	21.6	39.1	54.1	21.5	40.3	52.8	20.9	46.3	51.7	23.4	48.6	51.7
1920	Sept. 15	Sept. 15	16.2	24.7	61.8	14.6	27.2	61.0	22.7	35.6	61.0	25.6	38.2	61.5	27.3	38.8	63.1	25.3	40.8	61.5	26.8	42.7	61.5
	do	Oct. 5	22.7	33.6	61.0	25.6	35.8	60.0	39.1	37.6	60.5	31.0	32.2	61.5	31.0	31.8	60.5	29.9	30.1	60.8	30.0	30.0	61.0
	Oct. 5	do	31.7	29.8	60.5	32.3	29.4	60.5	31.9	26.1	61.5	27.7	24.6	62.0	34.0	32.4	62.0	34.0	33.2	61.8	33.7	38.2	61.0
	Sept. 15	Oct. 30	26.9	23.9	63.3	28.7	25.6	61.5	29.6	26.2	62.5	28.3	23.8	63.0	28.2	22.7	62.0	26.4	21.4	61.5	27.5	22.3	61.5
	Oct. 30	do	30.7	26.8	60.0	27.7	22.6	61.3	28.5	22.9	62.0	29.7	23.8	60.0	31.2	28.1	63.0	34.0	28.8	61.5	37.3	33.2	60.5
Average			25.6	27.8	61.3	25.8	28.1	60.9	28.6	29.7	61.5	28.5	28.5	61.6	30.3	30.8	62.1	29.9	30.9	61.4	31.1	33.3	61.1
1921	Sept. 15	Sept. 15	10.4	18.4	60.5	18.1	34.8	60.5	16.1	27.6	61.0	14.7	29.6	60.0	17.9	30.4	60.5	16.6	24.4	60.5	17.8	30.8	61.0
	do	Oct. 5	23.0	40.4	60.0	25.7	36.4	62.0	27.1	36.4	61.5	26.5	35.6	61.0	23.3	33.6	61.5	28.3	38.0	60.5	27.7	36.4	61.0
	Oct. 5	do	13.8	18.4	60.5	18.1	25.6	59.5	18.1	22.4	60.0	19.1	25.2	60.0	18.7	26.8	62.0	19.5	30.4	60.0	19.3	26.0	61.5
	Sept. 15	Oct. 30	22.5	34.8	60.0	22.6	36.0	60.0	27.7	40.8	60.0	26.7	41.2	59.5	28.3	40.4	60.5	28.4	40.0	60.0	31.7	41.2	60.0
	Oct. 30	do	10.7	15.6	55.5	14.1	22.0	55.0	17.8	28.4	56.5	21.1	34.0	54.5	20.3	36.0	56.5	19.5	34.0	55.0	20.7	36.8	55.0
Average			16.1	25.5	59.3	19.7	31.0	59.4	21.4	31.1	59.8	21.6	33.1	59.0	21.7	33.4	60.2	22.5	33.4	59.2	23.4	34.2	59.7
1922	Sept. 15	Sept. 15	25.3	34.4	60.5	28.5	48.8	59.5	22.1	35.1	58.5	29.5	49.0	60.0	25.2	41.7	60.0	27.3	45.5	60.0	27.3	44.8	60.5
	do	Oct. 5	29.0	38.6	59.5	25.3	39.4	59.5	29.3	43.6	59.5	29.0	44.2	58.5	30.7	45.6	58.5	30.8	40.7	59.5	33.3	49.2	60.0
	Oct. 5	do	32.9	41.0	61.0	35.1	44.3	60.5	34.5	41.7	61.0	35.5	42.7	60.5	35.3	43.2	59.5	35.6	45.3	60.0	37.8	48.7	61.0
	Sept. 15	Oct. 30	30.5	34.3	60.5	34.3	39.2	59.5	35.7	41.8	59.5	36.1	44.0	60.0	37.0	44.0	60.5	37.7	47.4	60.0	38.7	47.0	60.0
	Oct. 30	do	30.5	39.8	57.0	29.7	37.8	58.0	30.9	39.0	58.5	31.7	37.8	59.5	33.3	40.8	59.5	35.3	44.8	60.0	34.8	38.7	59.0
Average			29.6	37.6	59.7	30.6	41.9	59.4	30.5	40.2	59.4	32.4	43.5	59.7	32.3	43.1	59.6	33.3	44.7	59.9	34.4	45.7	60.1

1923	Sept. 15	Sept. 15	26.7	40.2	61.3	25.1	39.6	61.0	29.4	49.6	60.5	37.0	46.2	60.5	34.0	55.6	61.0	32.3	48.0	60.8	27.3	54.6	60.5
	do	Oct. 5	14.7	15.8	61.5	18.0	20.0	61.5	23.0	25.2	61.0	25.3	32.6	61.5	32.5	44.9	61.0	30.0	42.6	61.5	33.3	46.2	61.0
	Oct. 5	do	19.6	24.0	61.3	25.2	32.5	61.0	28.2	37.9	61.5	30.1	41.9	61.5	28.3	38.0	62.0	32.2	45.5	62.0	34.1	48.4	61.0
	Sept. 15	Oct. 30	43.2	44.1	61.5	46.0	51.2	61.8	44.5	53.5	62.0	45.3	47.6	62.0	42.2	46.3	61.5	42.0	43.8	62.0	39.0	41.4	62.0
	Oct. 30	do	23.7	23.6	61.8	26.3	25.8	62.5	26.9	25.9	62.5	24.9	24.3	61.5	31.1	21.4	62.5	23.2	23.3	62.0	24.7	22.6	62.0
Average			25.6	29.5	61.5	28.1	33.8	61.6	30.4	38.4	61.5	32.5	38.5	61.4	33.6	41.2	61.6	31.9	40.6	61.7	31.7	42.6	61.3
1924	Sept. 15	Sept. 15	31.2	50.1	61.0	31.2	48.5	61.0	31.7	50.4	59.5	30.7	57.4	60.0	30.7	52.8	61.0	30.3	50.8	60.5	28.2	45.5	60.0
	do	Oct. 5	31.9	50.9	58.0	33.9	57.1	59.0	30.1	57.1	57.5	29.4	53.6	58.0	29.5	59.5	57.5	30.7	59.6	56.0	30.2	59.5	58.0
	Oct. 5	do	30.6	36.8	61.0	31.2	41.7	61.0	30.9	39.5	61.5	31.4	43.6	61.5	30.3	43.0	61.5	33.3	48.2	61.5	34.3	55.4	60.5
	Sept. 15	Oct. 30	29.8	39.9	59.5	33.7	44.4	59.0	35.5	48.9	59.0	35.9	47.6	60.0	36.4	47.2	59.0	37.0	49.2	60.0	34.1	46.6	60.5
	Oct. 30	do	22.7	22.8	61.0	23.1	20.5	61.0	22.8	20.5	61.9	19.4	15.4	61.5	19.5	16.5	62.0	23.1	19.3	61.5	24.7	24.6	61.5
Average			29.2	40.1	60.1	30.6	42.4	60.2	30.2	43.3	59.7	29.4	43.5	60.2	29.3	43.8	60.2	30.9	45.4	59.0	30.3	46.3	60.1

TABLE 3.—*Annual acre yields of grain and straw and bushel weight of winter wheat grown on individual fortieth-acre plots on land plowed and seeded on varying dates and at seven different rates in the six-year period 1919–1924*

Year	Treatment		Rates of seeding per acre																					
			2 pecks			3 pecks			4 pecks			5 pecks			6 pecks			7 pecks			8 pecks		
	Plowed on—	Sown on—	Grain	Straw	Bushel weight	Grain	Straw	Bushel weight	Grain	Straw	Bushel weight	Grain	Straw	Bushel weight	Grain	Straw	Bushel weight	Grain	Straw	Bushel weight	Grain	Straw	Bushel weight
			Bush.	*Cwt.*	*Lbs.*	*Bush.*	*Cwt.*	*Lbs.*	*Bush.*	*Cwt.*	*Lbs.*	*Bush.*	*Cwt.*	*Lbs.*	*Bush.*	*Cwt.*	*Lbs.*	*Bush.*	*Cwt.*	*Lbs.*	*Bush.*	*Cwt.*	*Lbs.*
1919	Sept. 15	Sept. 15	9.9	17.1	55.0	16.2	27.9	54.5	17.7	30.2	56.5	16.2	30.5	56.0	21.9	32.9	55.5	19.0	25.6	54.0	20.9	26.7	54.0
	do	Oct. 5	19.2	33.1	51.5	23.3	42.0	55.0	25.0	41.8	56.3	22.5	47.5	54.8	23.3	36.2	55.0	23.2	42.9	56.8	24.7	46.4	55.3
	Oct. 5	do	22.3	39.0	53.0	22.2	46.3	46.8	24.9	46.7	54.5	23.3	47.0	52.3	26.7	44.0	56.3	23.3	44.4	56.0	26.3	41.0	56.5
	Sept. 15	Oct. 30	21.3	44.4	50.3	22.0	48.2	54.3	26.0	46.6	52.3	21.0	52.2	52.5	20.0	47.0	50.5	23.7	53.0	52.5	25.0	49.4	54.5
	Oct. 30	do	19.7	34.6	54.0	22.3	38.6	54.8	21.7	36.6	57.5	21.3	42.0	55.8	23.3	41.2	54.8	24.3	45.4	58.0	28.0	44.8	56.5
Average			18.5	33.6	52.8	21.2	40.6	53.1	23.1	40.4	55.4	21.5	43.8	54.3	23.0	40.3	54.4	23.3	42.3	55.5	25.0	41.7	55.4
1920	Sept. 15	Sept. 15	14.2	39.0	60.0	20.2	39.1	60.5	19.2	33.3	60.5	16.5	23.7	61.0	24.4	34.6	61.3	26.3	36.6	60.5	27.6	30.2	62.3
	do	Oct. 5	19.5	21.9	60.8	19.8	19.8	60.0	13.6	12.0	62.3	23.8	22.6	61.3	23.1	24.2	61.0	26.5	30.1	60.0	28.2	25.9	61.0
	Oct. 5	do	33.1	38.2	62.0	35.5	29.1	61.5	31.3	38.0	63.0	27.3	28.8	61.4	35.7	41.4	62.8	34.2	37.9	62.0	32.4	35.0	62.4
	Sept. 15	Oct. 30	26.9	22.3	61.5	28.0	25.2	61.5	28.5	26.1	62.3	24.2	21.5	61.5	28.2	25.1	60.0	27.2	24.1	61.5	28.0	25.6	60.5
	Oct. 30	do	26.8	33.5	61.0	31.6	27.4	60.5	27.6	25.4	62.0	32.6	28.4	62.0	29.2	25.3	61.5	22.0	18.0	60.5	18.6	19.6	61.0
Average			24.1	31.0	61.1	27.0	28.1	60.8	24.0	27.0	62.0	24.9	25.0	61.4	28.1	30.1	61.3	27.2	29.3	60.9	27.0	27.3	61.4
1921	Sept. 15	Sept. 15	14.3	29.6	60.0	13.6	27.6	60.0	14.1	32.0	60.0	15.6	35.2	60.5	19.1	34.0	60.5	19.5	33 2	61.5	19.6	27.6	60.5
	do	Oct. 5	25.5	36.4	61.0	27.9	39.2	60.0	25.9	40.4	60.0	19.9	43.2	61.0	25.9	41.6	61.5	24.7	43.2	61.0	24.5	30.8	62.5
	Oct. 5	do	15.7	21.2	60.5	18.5	23.0	59.5	18.1	23.4	61.5	18.3	30.0	60.0	17.0	23.6	61.0	16.8	23.2	60.5	18.7	26.4	60.5
	Sept. 15	Oct. 30	23.2	34.0	60.5	23.1	37.2	61.0	27.7	40.8	61.0	30.1	45.2	61.0	27.1	36.8	61.0	23.9	38.8	61.5	25.5	30.0	61.0
	Oct. 30	do	10.9	24.8	55.0	15.5	32.8	51.0	18.1	40.8	55.5	18.8	38.8	55.5	18.1	40.4	55.5	19.8	40.4	55.5	20.0	39.2	56.0
Average			17.9	29.2	59.4	19.7	33.0	58.3	20.8	36.5	59.6	20.5	38.5	59.6	21.4	35.3	59.9	21.9	35.8	60.0	21.7	30.8	60.1
1922	Sept. 15	Sept. 15	23.1	42.8	60.5	26.5	42.3	60.0	28.3	40.9	59.5	25.5	38.3	61.0	30.0	47.2	60.0	25.0	48.4	60.0	30.7	52.4	60.5
	do	Oct. 5	23.0	45.8	59.5	31.4	52.7	58.5	28.5	47.3	58.5	32.1	56.7	59.0	32.5	55.0	59.5	33.6	53.8	59.0	34.9	56.6	59.0
	Oct. 5	do	29.1	33.0	60.5	33.4	42.2	60.0	35.7	44.6	60.0	35.0	45.2	60.0	33.8	44.9	60.0	34.8	45.5	60.0	33.3	50.8	60.0
	Sept. 15	Oct. 30	27.3	39.6	59.5	28.3	43.0	57.5	26.0	44.2	57.5	24.7	40.4	57.0	29.9	44.8	57.5	31.3	44.0	59.0	33.5	38.9	60.5
	Oct. 30	do	22.9	28.8	57.5	29.5	35.1	58.5	27.3	32.8	60.0	30.7	37.2	58.5	31.0	33.6	58.5	30.1	35.5	59.5	27.7	30.8	60.5
Average			27.3	38.0	59.5	29.8	43.1	58.9	29.2	42.0	59.1	29.6	43.6	59.1	30.8	45.1	59.1	31.0	45.4	59.5	32.0	45.9	60.1

1923	Sept. 15	Sept. 15	24.2	41.9	61.0	32.9	48.7	61.3	28.7	52.8	60.5	32.9	58.2	61.0	34.0	53.2	61.3	32.[illegible]	49.6	60.3	30.2	49.9	60.5
	...do...	Oct. 5	24.1	41.7	59.5	28.0	45.2	60.0	27.3	43.2	60.5	10.3	43.4	61.0	18.1	21.6	59.0	18.[illegible]	20.9	61.8	19.3	22.8	61.5
	Oct. 5	...do...	13.0	16.6	61.0	19.4	24.4	60.5	21.9	23.9	60.0	29.4	35.6	61.0	24.3	26.2	60.3	25.7	35.0	61.3	28.3	35.4	60.0
	Sept. 15	Oct. 30	29.5	34.7	62.0	40.9	47.8	61.5	45.7	53.4	62.3	48.3	55.8	62.3	45.5	50.7	62.5	48.4	55.8	62.5	47.3	52.2	62.0
	Oct. 30	...do...	25.5	21.9	62.0	28.0	26.0	61.8	31.0	31.4	62.5	40.5	45.7	61.5	36.0	45.2	62.0	29.3	29.2	62.5	27.4	25.6	62.0
Average			22.9	31.4	61.1	29.8	38.4	61.0	30.9	40.9	61.2	34.1	47.7	61.4	31.6	39.4	61.0	30.8	38.1	61.7	30.5	37.2	61.2
1924	Sept. 15	Sept. 15	30.0	50.8	61.5	28.7	56.0	59.0	30.9	55.3	61.0	28.7	54.0	60.5	28.6	51.4	61.5	28.2	43.1	61.0	29.2	51.3	61.5
	...do...	Oct. 5	28.0	47.2	60.0	30.0	55.0	60.0	32.7	54.4	60.0	32.7	61.6	59.0	31.3	57.2	59.0	30.5	58.7	58.5	26.7	59.0	58.0
	Oct. 5	...do...	32.4	59.8	60.0	35.0	64.6	60.0	33.1	62.1	60.3	32.9	60.3	60.0	31.3	55.8	60.0	31.0	60.4	60.0	28.7	59.2	60.0
	Sept. 15	Oct. 30	24.4	34.2	59.0	30.7	42.8	58.5	32.5	42.7	59.5	30.8	47.3	60.0	33.7	42.0	61.0	35.2	47.1	60.5	36.0	52.3	60.0
	Oct. 30	...do...	27.2	27.9	61.5	25.8	26.9	61.0	27.6	27.4	61.0	32.3	33.0	61.5	27.5	25.7	61.5	28.0	24.4	61.5	23.1	22.0	61.5
Average			28.4	44.0	60.4	30.0	49.1	59.7	31.4	48.4	60.3	31.5	51.2	60.2	30.5	46.4	60.6	30.6	46.7	60.3	28.9	48.8	60.2

TABLE 4.—*Average annual acre yields of grain and straw and average bushel weights of winter wheat, for all rates of seeding from 2 to 8 pecks per acre, inclusive, when grown on plots with different seed-bed preparations and different dates of seeding, in the six-year period 1919–1924*

Year	Acre yield and bushel weight	Land disked—						Land plowed—					
		Sept. 15; seeded same date	Sept. 15; seeded Oct. 5	Oct. 5; seeded same date	Sept. 15; seeded Oct. 30	Oct. 30; seeded same date	Average of all five plots	Sept. 15; seeded same date	Sept. 15; seeded Oct. 5	Oct. 5; seeded same date	Sept. 15; seeded Oct. 30	Oct. 30; seeded same date	Average of all five plots
1919	Grain, bushels	16.6	22.6	21.0	22.8	21.8	20.96	17.4	23.5	24.1	22.7	23.4	22.22
	Straw, hundredweight	28.5	43.0	49.0	46.3	34.1	40.18	27.3	41.4	44.1	48.7	40.5	40.40
	Bushel weight, pounds	55.8	53.9	52.6	52.1	53.4	53.56	55.1	55.0	53.6	52.4	55.9	54.40
1920	Grain, bushels	22.6	28.6	32.2	27.9	31.3	28.52	21.2	22.1	32.8	27.3	26.9	26.06
	Straw, hundredweight	35.4	33.0	30.5	23.7	26.6	29.84	33.8	22.4	36.5	24.3	25.4	28.28
	Bushel weight, pounds	61.6	60.8	61.3	62.2	61.2	61.42	60.9	60.9	62.2	61.3	61.2	61.30
1921	Grain, bushels	15.9	25.0	18.1	26.8	17.7	20.88	16.5	24.9	17.6	26.5	17.3	20.56
	Straw, hundredweight	28.0	36.7	25.0	39.2	29.5	31.68	31.3	39.3	25.8	37.5	36.7	34.12
	Bushel weight, pounds	60.6	61.1	60.5	60.0	55.4	59.52	60.4	61.0	60.5	61.0	54.9	59.56
1922	Grain, bushels	26.5	29.6	35.2	35.7	32.3	31.86	27.7	31.7	33.6	28.3	28.5	29.96
	Straw, hundredweight	42.8	43.0	43.8	42.5	39.8	42.38	44.6	52.6	43.7	42.1	33.4	43.28
	Bushel weight, pounds	59.9	59.3	60.5	60.0	58.8	59.70	60.2	59.0	60.1	58.4	59.0	59.34
1923	Grain, bushels	30.3	25.3	28.2	43.2	25.8	30.56	30.7	22.1	23.1	43.7	30.8	30.08
	Straw, hundredweight	47.7	32.5	38.3	46.8	23.8	37.82	50.6	34.1	28.2	50.1	32.1	39.02
	Bushel weight, pounds	60.8	61.3	61.5	61.8	62.1	61.50	60.8	60.5	60.6	62.2	62.0	61.22
1924	Grain, bushels	30.6	30.8	31.7	34.6	22.2	29.98	29.2	30.3	32.1	32.0	27.3	30.18
	Straw, hundredweight	50.8	56.8	44.0	46.3	19.9	43.56	51.7	56.2	60.3	44.1	26.8	47.82
	Bushel weight, pounds	60.4	57.7	61.2	59.6	61.4	60.06	60.9	59.2	60.1	59.8	61.4	60.28
Average, 1919–1924	Grain, bushels	23.75	27.13	27.73	31.83	25.18	27.12	23.78	25.77	27.22	30.08	25.70	26.51
	Straw, hundredweight	38.87	40.83	38.43	40.80	28.95	37.58	39.88	41.00	39.60	41.13	32.48	38.82
	Bushel weight, pounds	59.85	59.02	59.60	59.28	58.72	59.29	59.72	59.27	59.52	59.18	59.07	59.35

When the yields obtained on land prepared September 15 and seeded October 5 and October 30, respectively, are combined with the yields, reported above, obtained on land both prepared and seeded on these dates, it is found that the highest average yields were obtained from seedings made October 30, as shown in Figure 3. The average acre yield of all plots seeded October 5 was 26.96 bushels, whereas the average yield of all plots seeded October 30 was 28.20 bushels, a difference of 1.24 bushels in favor of the later seeding. The average acre yield of all plots seeded September 15 on land prepared on this date only, earlier preparation not being included in this case, was 23.77 bushels, or 4.43 bushels less than the average of all plots seeded October 30.

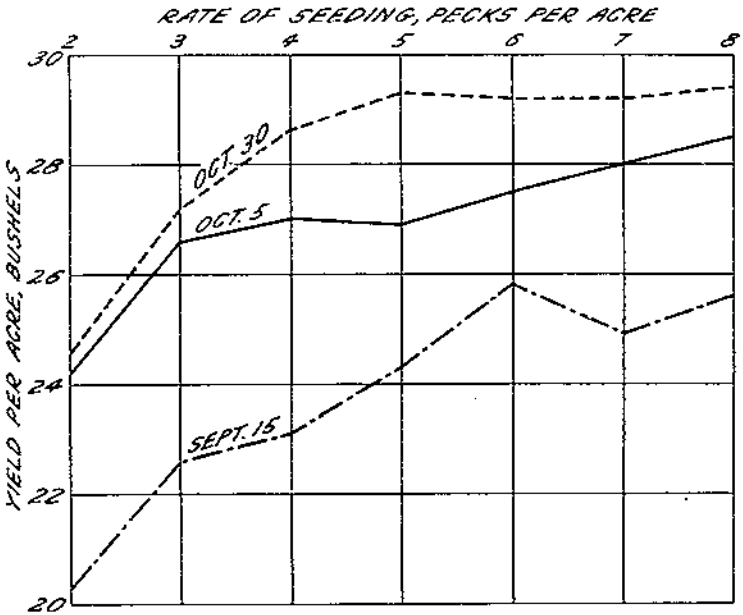

FIG. 3.—Average acre yields of winter wheat, in bushels, on all plots seeded on three successive dates, September 15, October 5, and October 30, at each of seven different rates of seeding, at Arlington Experiment Farm in the six-year period 1919–1924

The average bushel weight of the grain produced was highest from the September 15 seedings and lowest from the October 30 seedings on land prepared on this date. The average differences were 1.13 pounds on the disked land and 0.65 pound on the plowed land for these two seeding dates. Both yield and bushel weight of the grain show seasonal fluctuations at the different dates of seeding.

EFFECT ON MATURITY

The plots seeded September 15 were fully headed, on the average, May 19 and ripe June 16. The plots sown October 5 were fully headed and ripe two days later, respectively, while those sown October 30 were fully headed and ripe six days later, respectively, than those from the September 15 seeding. In certain years the hot,

dry weather near the time of maturity hastened the ripening of the later sown plots and consequently there was little difference in the date of maturity of all three seedings.

Figure 4 shows the comparative stage of maturity of the plots sown September 15 and October 5, 1923, and Figure 5 of the plots sown October 5 and October 30, 1923, both photographs being taken on the same day in May 1924.

EFFECT OF TIME OF PREPARATION OF THE SEED BED

In these experiments wheat was seeded at three different dates on both disked and plowed land. Seedings September 15 were made only on seed beds prepared on the date of seeding. On October 5 and October 30 seedings were made on seed beds prepared on these dates, and also on seed beds prepared September 15. Comparison can thus be made of the effect of preparation of the seed bed on the date of seeding with the effect of preparation 20 days and 45 days previous to seeding. The data are given in Table 4.

Highest average yields of grain were obtained in the six-year period from seedings made October 30 on land prepared September

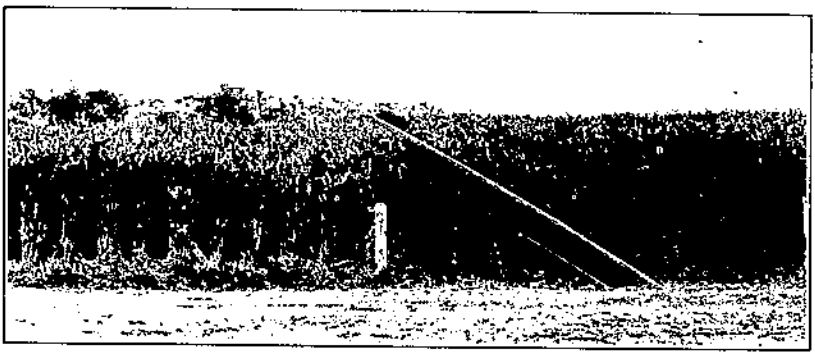

FIG. 4.—Wheat plots at Arlington Experiment Farm in 1924. On left, plots sown September 15; on right, plots sown October 5

15. The disked land produced 31.83 bushels of grain and 4,080 pounds of straw, whereas the plowed land produced 30.08 bushels of grain and 4,113 pounds of straw. In comparison with these yields the land both disked and seeded October 30 produced 25.18 bushels of grain and 2,895 pounds of straw, and land plowed and seeded on this date produced 25.70 bushels of grain and 3,248 pounds of straw.

The land disked September 15 and seeded October 5 averaged 27.13 bushels of grain and 4,083 pounds of straw, and the land plowed September 15 and seeded October 5 averaged 25.77 bushels of grain and 4,100 pounds of straw. The land prepared and sown October 5 produced average yields of 27.73 bushels of grain and 3,843 pounds of straw when disked, and 27.22 bushels of grain and 3,960 pounds of straw when plowed. The lowest grain yields—23.75 and 23.78 bushels on disked and plowed land, respectively—were obtained on land prepared and seeded September 15.

It appears, then, that seeding September 15 is too early under the conditions obtaining at Arlington Experiment Farm. It was observed that the wheat sown on this date made too much fall

growth and was subject to considerable injury by leaf rust, both in the fall and in the spring. Leaf rust was found to develop on this early-sown wheat before it developed on wheat sown later in the fall.

It appears also that when seeding is late, early disking or plowing of the land is advantageous. When wheat is seeded October 30 on plowed land the difference in favor of preparation September 15 in comparison with preparation on the day of late seeding was 4.38 bushels of grain and 865 pounds of straw. On the disked land the difference in favor of preparation September 15 in comparison with preparation on the day of late seeding was 6.65 bushels of grain and 1,185 pounds of straw.

When seeding was done October 5, however, no advantage is apparent from preparing land 20 days before in comparison with such preparation on the day of seeding. The land prepared by disking on September 15 and seeded October 5 produced 0.6 bushel less grain and 240 pounds more straw than the land both disked and seeded October 5. The land plowed September 15 and seeded October 5 produced 1.45 bushels less grain but 140 pounds more straw than the land both plowed and seeded October 5.

FIG. 5.—Wheat plots at Arlington Experiment Farm in 1924. On left, plots sown October 5; on right, plots sown October 30

Straw yields on plowed land were higher than on disked land for all of the three different dates of seeding. In most years the seed bed prepared by plowing was less compact and more cloddy than the seed bed prepared by disking, and it probably absorbed more rain than the disked land. More available moisture undoubtedly would increase the vegetative growth of the wheat plants.

The land plowed September 15 and seeded October 30 returned the highest yield from all seedings in only two of the six years, and the unusually high yield of these plots in 1923 possibly is due to the higher native fertility of the particular soil used and to the seasonal conditions which favored late seeding. The high yield of the plots disked September 15 and sown October 30 for the crop of the year 1923 perhaps is due in part to the same cause, but this treatment outyielded all others in all years except 1920; and it appears that disking September 15 and seeding October 30 results in high yields of grain. In addition to the firm seed bed obtained by this method, practically all weeds were controlled. By delaying seeding until October 30, however, there is risk of encountering cold, wet, weather which may make seeding impossible. For this reason it is questionable whether the practice of delaying seeding until this date can be

recommended for this locality without qualification, at least in cases where the Hessian fly is not a factor, as was the case in these experiments.

RATE OF SEEDING

The results of rate-of-seeding experiments may be influenced by size of seed, germination of seed, date of seeding, winterkilling, or other factors, some of which in turn may be unequally influenced by differences in stand resulting from differences in the rate of seeding. A drill set at the 6-peck rate of seeding will sow approximately 30 per cent fewer kernels of Mammoth Red wheat, a large-kerneled variety, than of Purplestraw, a small-kerneled variety. Calibration of the drill to the variety is necessary each year.

The variety Purplestraw was used in all six years of the present experiments. The seed sown each year was obtained from the previous crop. It was recleaned in an ordinary fanning mill before being sown but received no other treatment. Field germination was close to 80 per cent. The field counts taken in 1924 showed germination to be almost 10 per cent higher on the disked ground than on the plowed. The better germination of the seed on the disked land occurred at all rates of seeding. Fall and spring stands were determined in all years, but no differences in germination or winterkilling due to seed or season were recorded in any of the six years of the experiments. Winterkilling is not considered a limiting factor in wheat yields in any of the adapted varieties at Arlington Experiment Farm.

Data taken on disked plots sown September 15 at the rates of 6 and 8 pecks per acre showed that the percentage of spring survival for the 6-peck rate was 97.3 per cent and for the 8-peck rate 96 per cent, an insignificant difference. The average number of heads per plant was slightly greater in the plots seeded at the 6-peck rate than in plots seeded at the 8-peck rate. The data are given in Table 5.

TABLE 5.—*Fall and spring stands, percentage of spring survival, and average number of heads per plant at the 6-peck and 8-peck rates of seeding of winter wheat for the crop year 1923–24*

Rate of seeding	Number of plants in 3-foot lengths of drill rows		Percentage of spring survival	Average number of heads per plant
	Fall stand	Spring stand		
6 pecks per acre	73	71	97.3	2.18
8 pecks per acre	101	97	96.0	2.06

In Table 6 are shown the average actual and net grain yields for all plots sown at each rate of seeding as given in Tables 2 and 3. The actual grain yields increase progressively from the lowest to the highest rate of seeding, the yields from the 6-peck and 7-peck rates being identical. The straw yields increase progressively, the 6-peck rate excepted, from the lowest to the highest seeding rates. The actual grain and straw yields obtained on all plots sown at the different seeding rates are shown graphically in Figure 6. The net grain yields increase progressively from the 2-peck to the 6-peck rates, inclusive, but the 7-peck and 8-peck rates show a loss in net yield as compared with the 6-peck rate.

The significance of the difference between actual grain yield obtained from the 6-peck seeding rate and from each of the other six rates has been calculated by Student's method and is shown in Table 6. In comparison with the yield from the 6-peck rate of seeding, the yields from the 2-peck and 3-peck rates were significantly lower, and the yield from the 4-peck rate of seeding was slightly lower. The gains or losses in yield from 5-peck, 7-peck, and 8-peck rates in comparison with the 6-peck rate of seedings were smaller and fluctuated so greatly that they are not significant mathematically. The 2-peck rate was decidedly too low for seeding wheat. The plots sown at this rate pro-

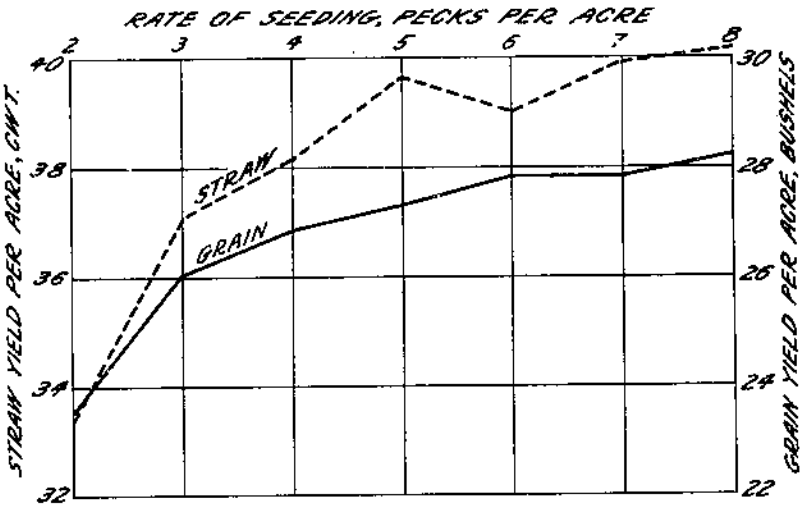

Fig. 6.—Average acre yields of grain and straw of winter wheat obtained from all plots sown at different rates at Arlington Experiment Farm for the six-year period 1919–1924

duced an average of 2.4 bushels less grain than was obtained from those seeded at the 3-peck rate. The odds are 4,999 to 1 that this difference is significant. No other comparison of seeding rates differing by only 1 peck shows any significant difference.

TABLE 6.—*Average actual and net grain yields of all plots at each rate of seeding during the six-year period 1919–1924 and the mathematical significance of the gain or loss*

Rate of seeding	Acre yield (bushels)		Gain or loss in actual acre yields	
	Actual	Net	Compared with the 6-peck rate	Odds as to significance [1]
2 pecks per acre	23.6	23.1	−4.3	9,999 : 1
3 pecks per acre	26.0	25.3	−1.9	400 : 1
4 pecks per acre	26.8	25.8	−1.1	49 : 1
5 pecks per acre	27.3	26.1	−.6	8 : 1
6 pecks per acre	27.9	26.4		
7 pecks per acre	27.9	26.2	0	
8 pecks per acre	28.3	26.3	+.4	5 : 1

[1] Odds calculated from pairing the average annual yields from the different seeding rates on the disked and plowed seed beds. The 2-peck rate exceeds the 3-peck rate by 2.4 bushels per acre, with odds of 4,999 to 1.

The date of heading and ripening of the crop was slightly affected by the seeding rate. This is shown graphically in Figure 7. The plots sown at the 8-peck rate were fully headed and ripe approximately three days earlier than those sown at the 2-peck rate. At the lower rates of seeding the tillers per plant are increased and the later tillers delay the heading or maturity of the plants.

The bushel weight of the grain apparently was unaffected by the seeding rate. Data taken for two years also showed no effect of the rate of seeding on the size of kernel. The data on size of kernel were obtained on grain produced on the plots shown at the 2-peck, 6-peck, and 8-peck rates by means of fanning-mill screens and also by counting the kernels contained in vials of grain produced from each of the three rates of seeding.

The average yields of grain obtained in the six-year period from the seven different rates of seeding made on the three different dates of

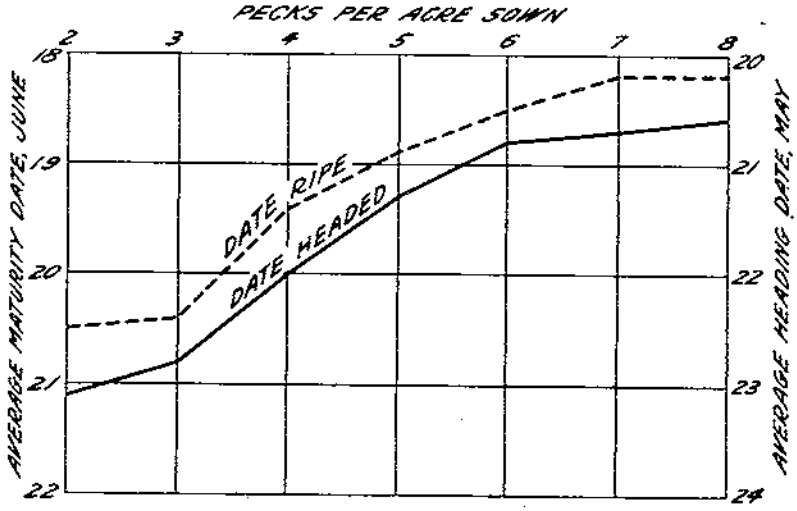

FIG. 7.—Effect of the rate of seeding on the average date of heading and of ripening of winter wheat at Arlington Experiment Farm for the five-year period 1920–1924

seeding are shown graphically in Figure 3. The actual yields are shown in Table 7. In this table the average yields obtained from each rate of seeding also are given in percentages of the yield obtained from the 2-peck rate of seeding, the lowest rate employed. These percentages show the relative increases in yield obtained from sowing larger quantities of seed on the different dates. For the September 15 seedings a maximum increase of 27.1 per cent was obtained at the 6-peck rate of seeding over that obtained from the 2-peck rate. For the October 5 seedings a maximum increase of 17.8 per cent was obtained from the 8-peck rate, and for the October 30 seedings a maximum increase of 19.5 per cent was obtained from the 8-peck rate, in comparison with the yield from the 2-peck rate in each case. The increased yield from the 5-peck rate in seedings made October 30, 19.1 per cent, was practically the same as that obtained from the 8-peck rate.

TABLE 7.—*Average yields of grain obtained from seedings made on three different dates and at seven different rates per acre, in bushels per acre and in percentages of the yields from the 2-peck rate, for the six-year period 1919–1924*

Rate of seeding	Acre yields from seedings on—					
	Sept. 15		Oct. 5		Oct. 30	
	Actual (bushels)	Percentage of the yield from 2-peck rate	Actual (bushels)	Percentage of the yield from 2-peck rate	Actual (bushels)	Percentage of the yield from 2-peck rate
2 pecks per acre	20.3	100.0	24.2	100.0	24.6	100.0
3 pecks per acre	22.6	111.3	26.6	109.9	27.2	110.6
4 pecks per acre	23.1	113.8	27.0	111.6	25.6	116.3
5 pecks per acre	24.3	119.7	26.9	111.2	29.3	119.1
6 pecks per acre	25.8	127.1	27.5	113.6	29.2	118.7
7 pecks per acre	24.9	122.7	28.0	115.7	29.2	118.7
8 pecks per acre	25.6	126.1	28.5	117.8	29.4	119.5

It appears, then, that greater increase is obtained from sowing larger quantities of seed when the seeding is early than when seeding is late. The late seeding, however, October 30, was perhaps not so late as it should have been for a critical determination of this point.

The lower relative yields obtained from the September 15 seedings at all rates, and the larger relative increases obtained at the higher rates of seeding on this date, appear to be due chiefly to the greater prevalence of and injury from leaf rust on grain sown on this date. Many plants of the early seedings were severely injured by rust developing in the fall. Many of the first leaves died in the fall or during the winter. Rust also began to develop in these early-sown plots earlier in the spring than in later sown plots. As a result of this the vigor of the plants was affected. One result was the production of smaller kernels from the earlier seedings. In 1923 the kernels* in equal volumes of seed were counted. Those from the September 15 seedings contained 138 kernels, and those from October 5 and October 30 seedings contained 124 and 121 kernels, respectively.

COMPARATIVE COSTS OF DIFFERENT SEED-BED PREPARATIONS

While there is but little difference in the average yields obtained on land prepared by disking in contrast with those obtained on land prepared by plowing, there is a considerable advantage in the labor requirements in favor of preparation by disking. In preparing the seed bed for use in these experiments the operations involved were kept at a minimum. The object in view was to prepare a reasonably good seed bed, or one in which the grain could be sown and covered reasonably well. It was found that such a seed bed could be prepared by disking and harrowing. The land was gone over twice with a double disk behind which an Acme harrow was attached. When the land was plowed it was found necessary to follow the plow with a roller in order to break up the large clods turned up by the plow. After rolling, it was necessary to go over the plowed land twice with the double disk to which the Acme harrow was attached. In the first three years of the experiments the Acme harrow also was used

following plowing and preceding rolling. This operation appeared unnecessary and was discontinued.

The time required to prepare a plot of land 63 by 132 feet, or approximately seven-fortieths of an acre, by the disking method used, in which the land was gone over twice with a double disk with Acme harrow attached, was found to be 25 minutes, one man and four horses being employed in the operation. The time required to plow a plot of land 63 by 132 feet was 90 minutes, one man and two horses being employed. Rolling, following plowing, required 20 minutes for one man and two horses. Going over the plowed land twice with double disk with Acme harrow attached required one man and four horses for 32 minutes. The man labor required in preparing the seed bed without plowing, therefore, was 25 minutes for a seven-fortieths-acre plot, in contrast with 142 minutes, or 5.68 times as much, when the land was plowed. The horse-labor requirement for the two methods was 100 minutes when the land was prepared by disking, and 348 minutes, or 3.48 times as much, when the land was prepared by plowing. These requirements are for land prepared and seeded on the same day. Land given preliminary preparation September 15, but not seeded until later, was gone over once or occasionally twice with double disk and Acme harrow just before seeding. As this treatment was given to both disked and plowed land, it is not considered in comparing the labor requirements of the two methods of seed-bed preparation. This extra labor required at the time of seeding affects the cost of preparation in both cases. The higher yields obtained on land prepared several weeks before seeding therefore are obtained at a slightly higher cost, namely, the cost of going over the land twice with double disk and Acme harrow.

SUMMARY AND CONCLUSIONS

Following a cultivated crop of soy beans, disked land produced 2.3 per cent more wheat than plowed land, and the expense of preparing the seed bed was much less. Straw yields, however, were greater on the plowed land.

Land prepared by disking or plowing September 15 and seeded October 30 produced the highest average grain yields. Owing to the possibility of wet and cold weather, the delaying of seeding until October 30 is attended with some risk. In some years earlier seedings gave larger yields.

Preparation of the land by disking or plowing 45 days before seeding October 30 resulted in considerably higher average yields than were obtained from land both prepared and seeded October 30, but preparation of the land 20 days before seeding October 5 did not result in increased yields in comparison with those obtained from land both prepared and seeded October 5.

When the land was prepared by disking or plowing and sown on the same day, the highest grain yields were obtained from seeding October 5, followed by those from October 30 and September 15, in order.

The 6-peck rate per acre returned the highest net grain yield. Seeding at the rates of 2 and 3 pecks per acre produced significantly less grain than the 6-peck rate, and the yield from the 4-peck rate of seeding was slightly lower. Seedings at the rates of 5, 7, or 8 pecks per acre produced slightly less net yields of grain than the 6-peck rate.

Slightly greater increases in yield were obtained from sowing larger quantities of seed per acre when the seeding was early than when it was late.

No significant difference in bushel weight of grain resulted from the different rates of seeding or from the different seed-bed preparations.

A small-kerneled variety of wheat, Purplestraw, was used in these experiments. With large-kerneled varieties a somewhat higher rate of seeding might be required.

ORGANIZATION OF THE UNITED STATES DEPARTMENT OF AGRICULTURE

November 11, 1927

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U. S. GOVERNMENT PRINTING OFFICE: 1927

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