Kansas State Agricultural College.

EXPERIMENT STATION.—Bulletin 166.

ED. H. WEBSTER, *Director.*

FARM BULLETIN.

Agronomy Department.

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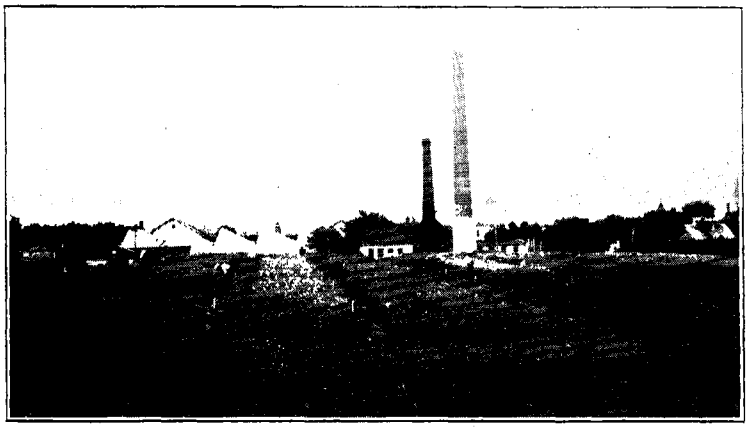

General View. Head-row Breeding Plots.

SPRING GRAINS.

BY

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MANHATTAN, KAN.
MARCH 24, 1910.

2059

SPRING GRAINS.

The first step in crop improvement is the testing of varieties. Different varieties of the same kind of grain when grown under similar conditions vary greatly in hardiness, yield and quality of product. Of the several hundred varieties of wheat, oats, barley and other small grains which have been grown in comparative trial plots at the Kansas Experiment Station during the last seven years, only a few varieties in each class have proven superior in all essential points so that they may be recommended for general planting in the state. Adaptation is the factor which finally determines whether a grain may be successfully grown in a given locality.

I.—Test of Varieties.

A TEST OF VARIETIES OF OATS.

Forty-four varieties of oats have been tested at this Station during the past seven years. Most of these were grown but two or three years and discarded because of their inferiority. A number have been grown continuously for five or seven years. The yields and other data for thirteen of the best varieties are given in table I.

The table shows that only four of the thirteen varieties proved of sufficient value to be generally recommended for planting in this state—the Red Texas, Sixty-day, Kherson, and Burt. Such varieties as the Minnesota No. 202, Silvermine, Early Champion, White Russian and Swedish Select may be grown with more or less success in the northeastern counties of the state, but even in these counties the Kherson should be the preferred variety, since it has also proven to be one of the best producing varieties at the Nebraska and Iowa experiment stations.

Description and Adaptation of Varieties.

IMPROVED RED TEXAS. This is the highest yielder, average for seven years being 44.03 bushels per acre. It is best adapted for growing in the central, south-central and southeastern portions of the state.

TABLE I. A comparison of varieties of oats tested at the State Experiment Station at Manhattan, Kan., arranged in order of average yield for five years.

Bulletin No.	VARIETY.	Type of seed.	Average for 1907–'08–'09			Yield per acre, 1909.	Yield per acre, 1908.	Yield per acre, 1907.	Av. yield per acre, 1908–'09, two years	Av. yield per acre, 1907–'08–'09, three years.	Av. yield per acre, 1905–'09, five years	Av. yield per acre, 1903–'09, seven years.
			Height of straw.	No. of days to mature.	Weight per bushel.							
			ins.		*lbs.*	*bus.*	*bus.*	*bus.*	*bus.*	*bus.*	*bus.*	*bus.*
36	Improved Red Texas	Large red	33.0	107	27.90	63.72	37.50	45.23	50.61	48.81	51.01	44.03
1	Sixty-day	Small yellow	36.3	104	24.25	69.67	23.60	41.33	46.63	44.86	45.82	43.93
8	Kherson	Small yellow	35.0	103	25.50	60.45	28.70	39.94	44.57	43.03	44.72	42.50
3	Minnesota 202	White	46.0	115	26.00	55.99	19.50	44.91	37.74	40.13	42.71	36.46
21	Burt	Medium red	33.0	103	*24.00	64.85	41.90	27.37	53.37	44.70	41.39	.....
15	Silvermine	Medium white	39.0	112	24.80	55.68	9.18	22.62	32.43	29.16	38.37	34.10
30	White Tartar	White	44.6	117	23.30	38.65	6.20	37.45	22.42	27.43	37.22	.....
35	Stavropol	White	45.6	114	27.00	55.83	13.31	28.60	34.57	32.58	36.81	.....
37	White Russian	White	42.6	114	26.10	50.74	11.40	30.82	31.07	30.99	34.89	(1)32.05
5	Tartarian	White	46.0	116	26.30	53.64	7.01	29.16	30.32	29.94	34.12	31.37
25	Swedish Select	White	37.6	111	25.60	52.82	12.49	8.14	32.65	24.48	32.75	.....
22	Irish Victor	Large white	40.6	110	24.30	45.53	8.10	22.64	26.81	25.42	32.72	29.67
14	Early Champion	White	*38.0	*105	*22 25	.....	15.50	20.81	.....	*18.15	*26.29	*26.69

* 1909 crop not included.
(1). 1903 crop not included.

PLATE I. General view of experimental field plots, with College buildings in background.

SIXTY-DAY. Ranks second in yield, and for seven years averaged 43.93 bushels per acre; a hardy variety and good drouth resister. Recommended for western Kansas.

KHERSON. Ranks third in yield for seven years, averaging 42.5 bushels per acre; reported as the best producing variety in Nebraska and Iowa, and well adapted for northern and northeastern Kansas.

BURT. One of the earliest maturing varieties, average yield for five years being 41.39 bushels per acre; very hardy and a drouth resister. Recommended for western Kansas.

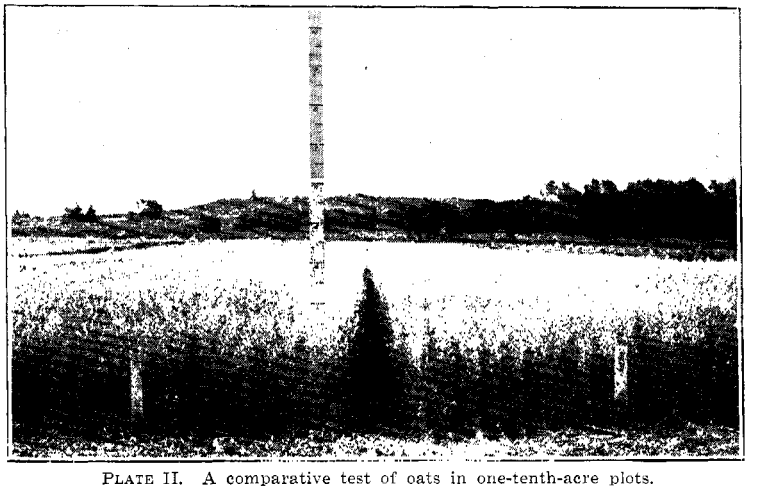

PLATE II. A comparative test of oats in one-tenth-acre plots.

Relative Value of Different Varieties of Oats for Feeding.

The value of oats for feeding is determined by the relative percentage of hulls and kernel. (See table 11.)

In this comparative test the White Russian variety contained the lowest percentage of hulls and highest percentage of kernels. However, the four best producing varieties—Red Texas, Kherson, Sixty-day, and Burt—also contained a relatively high percentage of kernels, which indicates relatively high feeding value. The hardiness and productiveness of these varieties make them the more profitable ones for growing in this state.

A TEST OF VARIETIES OF BARLEY.

Thirty-two varieties of spring barley have been tested in trial plots at this Station during the past seven years. The yields and other data for ten of the best producing varieties is given in table III. For comparison the yields of spring wheat, spring and winter emmer, winter rye, winter wheat and winter barley are also given in table III.

The Mansury six-row bearded barley ranks above all other varieties in yield. The Hulless barley has been an inferior yielder, while the Beardless variety has not produced as high a yield or as good a quality of grain as the better producing bearded varieties. Comparing the yields of the highest producing varieties of oats and barley, it is seen that the barley has outyielded the oats. The average annual yields for seven years, in pounds, compare as follows: Oats, 1409 pounds per acre: barley, 1666 pounds per acre.

TABLE II. Comparison of husk and kernel in oats and emmer, crop of 1909.

Bulletin No.	VARIETY.	Weight of grains in grams.	Per cent of meat or kernel.	Per cent hulls.
36	Red Texas	1.979	74.27	25.73
1	Sixty-day	1.093	73.28	26.72
8	Kherson	1.272	73.89	26.11
3	Minnesota	1.319	73.54	26.46
21	Burt	1.406	75.24	24.76
15	Silvermine	1.462	69.90	30.10
30	White Tartar	1.348	71.73	28.27
35	Stavropol	1.315	74.14	25.86
37	White Russian	1.482	78.94	21.06
5	Tartarian	1.285	72.76	27.24
25	Swedish Select	1.703	71.05	28.95
22	Irish Victor	1.277	73.21	26.79
.....	Emmer	2.466	75.22	24.78
.....	Emmer	1.555	66.17	33.83

TABLE III. A comparison of varieties of barley, emmer, speltz and rye tested at the State Experiment Station, Manhattan, Kan. Spring barley arranged in order of average yield for five years.

Bulletin No.	VARIETY.	Type of head.	Average 1907-'08-'09. No. of days to mature.	Average 1907-'08-'09. Height in inches.	Average 1907-'08-'09. Weight per bushel.	Yield, 1909.	Yield, 1908.	Yield, 1907.	Average yield, 1908-'09.	Average yield, 1907-'09.	Average yield, 1905-'09.	Average yield, 1903-'09.
					lbs.	*bus*	*bus.*	*bus.*	*bus.*	*bus.*	*bus.*	*bus.*
20	Select Mansury	Six-row bearded	101	35.3	44.60	50.21	45.38	32.13	47.79	45.27	36.59	34.70
17	Stavropol	" "	100	30.6	46.60	39.79	46.89	31.87	43.34	39.52	34.95	.....
21	Select Mandscheuri	" "	101	35.6	47.00	45.67	45.78	30.31	45.72	40.59	34.64	32.99
19	Selected Bonanza	" "	100	35.6	47.80	42.43	39.10	30.06	40.76	37.20	33.40	32.49
5	Common	" "	101	33.6	45.60	37.50	42.90	14.83	40.20	31.74	31.75	31.37
13	Six-row Ellis	" "	100	30.3	41.10	32.46	44.50	9.27	38.48	28.74	28.58	.....
8	Success Beardless	Six-row beardless	99	36.6	42.25	35.44	36.23	20.57	35.83	30.75	28.32	28.69
7	Bearded Hulless	Six-row bearded	100	29.3	59.10	32.43	37.04	21.08	34.37	30.18	27.54	25.65
15	U. S. 195	.....	98	23.0	43.75	32.28	20.48	11.51	29.38	23.42	25.03	.....
18	Select two-row Mandscheuri	Two-row bearded	103	36.6	46.41	17.03	12.54	19.09	14.78	16.22	*17.86	18.88
3	Tennessee winter barley	Six-row bearded	250	25.5	49.00	65.64	32.69	14.20	49.16	37.51	52.12	.....
	Spring emmer	.....	109	35.0	28.00	23.23	34.60	21.45	28.45	26.42	26.53	30.49
	Black winter emmer	.....	271	41.0	29.00	.....	57.00	25.00	.....	.....	.....	.....
	Winter speltz	.....	262	38.0	28.00	.....	53.23	64.27	.....	.....	.....	.....
11	Spring wheat	Durum	108	40.0	.....	13.16	11.74	4.10	12.45	9.67	12.07	11.74
	Spring wheat	Fife or beardless	106	35.0	.....	6.68	3.05	3.17	4.87	4.30	7.56	7.52
19	Winter wheat	Turkey	.....	.....	.....	52.81	39.73	49.63	46.27	47.39	44.11	.....
	Winter rye	Ivanhoff	254	49.6	.....	†41.91	38.74	.....	40.32	.....	‡41.01	.....

*Used yields of original seed for the years 1905-'06 to get average yields in this column.
†41.01, 1907 yield, not included.

PLATE III. Testing varieties of barley in one-tenth-acre plots.

The Tennessee winter barley has yielded 15½ bushels more grain per acre for five years than the best producing variety of spring barley, while the spring emmer has yielded an average of ten bushels per acre less than the Mansury barley. Spring wheat has been an inferior producer compared with barley, oats and emmer. The Durum has yielded fifty per cent better than the ordinary spring wheat.

Winter wheat and winter rye have produced more bushels and more pounds of grain per acre than any of the other grains. The average yields for five years of the highest producing varieties in each class compare as follows: Winter wheat, 2647 pounds; winter rye, 2460 pounds; winter barley, 2461 pounds; spring barley, 1756 pounds; oats, 1632 pounds; emmer, 1189 pounds; Durum spring wheat, 724.2 pounds, per acre, respectively.

The winter varieties of emmer and speltz have outyielded the spring varieties during the years in which comparative trials have been made, as shown in table III.

Description and Adaptation of Varieties.

IMPROVED MANSURY. Six-rowed bearded type, medium early; best producing variety in seven years, trial; average yield, 34.7 bushels per acre. Best adapted for eastern and central Kansas.

IMPROVED BONANZA. Similar to Mansury in type and yield-

ing qualities and adaptation for growing; average yield for seven years, 32.49 bushels per acre.

SIX-ROWED ELLIS. Bearded type, good yielder; average for five years, 28.58 bushels. Seed from Fort Hays Branch Station, Hays, Kan. Adapted for growing in western Kansas.

STAVROPOL. Six-rowed bearded type; one of the earliest maturing varieties and a good producer. Recommended for western and south-central Kansas. Average yield for five years, 34.95 bushels per acre.

SUCCESS BEARDLESS. Six-rowed barley, without beards. Adapted to all parts of the state; not so hardy and a little less productive than the best bearded varieties. Average yield for seven years, 28.69 bushels per acre.

EMMER. Spring emmer may take the place of barley or oats as stock feed, and may be somewhat more hardy and more drouth resistant in central and western Kansas. Emmer matures later than barley or oats, hence it is more likely to be injured by hot weather. Sow about three bushels of emmer per acre.

SPRING WHEAT. The tests of spring wheat indicate that it is not a profitable crop to grow at this Station. It is better adapted to the northern and northwestern portions of the state. The Durum should be preferred above other varieties of spring wheat for western Kansas, while for the northeastern part of the state the hard red spring wheat of the Fife or beardless type may succeed about as well as the Durum, and is preferred as a milling wheat.

II.-Improvement of Small Grains by Selection and Breeding.

The testing of varieties is necessarily an important factor in crop improvement, in order to learn which are best for planting under certain climate and soil conditions. The Agronomy Department is breeding by the "head-row" method eight varieties of winter wheat, five varieties of oats, four of barley, and one or more varieties each of spring wheat, emmer and winter rye. Thirteen hundred and forty separate head rows were planted in 1909. The work with most of these varieties has not progressed far enough to produce pedigreed seed in quantity for distribution.

PLATE IV. Breeding head rows of Crimean wheat.

The yield secured from "head rows" indicates that certain individuals have much greater productive capacity than others of the same variety. For example, in a head-row test of Kharkof wheat in 1907-'08 the highest producing "head row" out of fifty yielded 349 per cent more grain than the lowest producing "head row," and 46 per cent more than the average yield from the fifty "head rows" in the test.

The head-row breeding work with oats and barley has given similar results. In a test of fifty heads of Red Texas oats, in 1909, the highest yielding row, No. 3, yielded 298.25 grams of grain, while the lowest yielding row, No. 44, produced 80.5 grams. The average yield of the fifty rows was 210.6 grams. The highest yielding row produced 270 per cent more grain than the lowest yielding row, and 42 per cent more grain than the average yield of all the head-test rows.

The 1909 head-row test of Mansury barley gave a variation in yields ranging from 62 grams per row to 299 grams per row. The average yield for the thirty rows in the test was 208.2 grams, or the highest yielding row produced 382 per cent more grain than the lowest producing row, and 44 per cent more grain than the average of the head test. The range in yield, height at maturity and the number of plants harvested for each of these rows is shown in table IV. It should be observed also that there was a marked variation in the quality of the grain produced by different "head rows." The quality and hardiness of the plants are considered as well as the yield in making breeding selections for further propagation.

PLATE V. Breeding head rows of Kherson oats.

Some forty of the best head-row selections of winter wheat were planted last fall (1909), in one-tenth-acre plots, for propagation and comparative testing, and a number of one-tenth-acre plots from the head-row selections of barley, oats

TABLE IV. Data from head test. No. 721 Mansury barley.

Row.	No. plants harvested.	Height at maturity.	Stooling, or number of heads.	Actual yield, grams.	Row.	No. plants harvested.	Height at maturity.	Stooling, or number of heads.	Actual yield, grams.
		ins.					*ins.*		
1	18	38	157	134.50	16	23	39	169	233.52
2	17	39	224	293.02	17	22	38	182	229.85
3	11	38	101	62.00	18	20	39	154	205.35
4	20	38	177	224.52	19	20	38	200	196.35
5	18	39	128	183.88	20	18	37	160	149.35
6	21	39	188	299.00	21	20	37	137	251.35
7	15	37	108	100.50	22	26	39	262	256.35
8	18	38	176	243.02	23	20	38	202	180.85
9	19	38	172	162.35	24	24	36	268	290.35
10	23	37	192	150.85	25	20	40	187	159.85
11	22	39	196	230.85	26	17	40	204	238.02
12	21	38	183	186.35	27	21	38	207	250.02
13	17	38	169	142.50	28	20	38	187	288.52
14	25	39	278	310.52	29	24	38	250	299.02
15	26	39	210	192.02	30	16	38	186	101.00

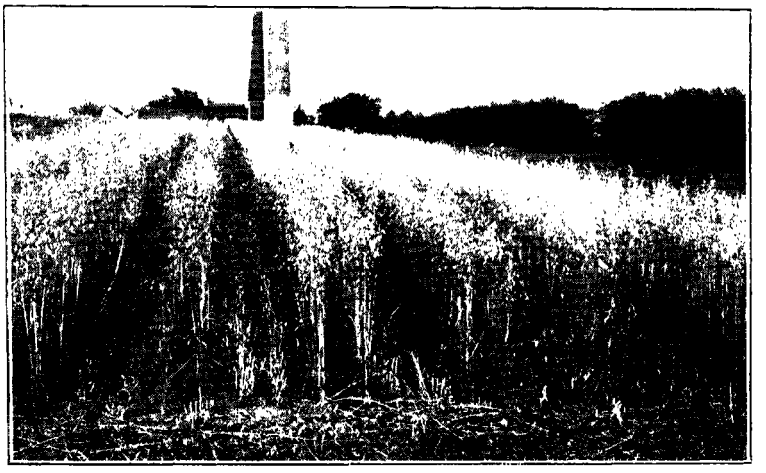

PLATE VI. Propagation rows of pedigreed oats. First year after head test.

and other grains will be planted this spring (1910). In two or three years sufficient seed of these improved strains should be produced to supply a limited demand throughout the state.

The seed grain distributed by the Agronomy Department up to the present time has been largely purified samples of the better producing varieties. The seed of Improved Red Texas oats, Selected Mansury and Selected Bonanza barley was secured by selecting a large number of good heads from the field, threshing the grain of these selected heads separately and planting in separate plots, from which seed was secured for further propagation. This general selection has produced some improvement over the original seed, as shown by the experiments with barley.

These selected strains of barley have been planted in test plots for three successive seasons in comparison with the original variety from which the selection was made. The yields and other data for the three selected strains of barley, compared with the original and average samples, are given in table V.

In each case the selected or improved strain has given a larger yield than the original seed, the Selected Mansury having produced a total of fourteen bushels more barley per acre in the three years than the original Mansury. Similar figures may be given for oats and for corn. No similar comparative tests with winter wheat have yet been made, but selections are now planted as stated above.

TABLE V. Selected and improved strains of barley compared with original variety.

Bulletin No.	Variety.	Type of head.	Average 1907–'08–'09. No. of days to mature.	Average 1907–'08–'09. Height at maturity.	Average 1907–'08–'09. Weight per bushel.	Yield, 1909.	Yield, 1908.	Yield, 1907.	Average three years, 1907–'08–'09.	Average increased yield per acre, three years.	Total increased yield per acre, three years.
				ins.	*lbs.*	*bu.*	*bu.*	*bu.*	*bu.*	*bu.*	*bu.*
1	Mansury	Six-row bearded	100.6	34.0	37.75	36.46	44.06	32.94	37.82	.....	.....
20	Selected Mansury	" "	100.6	35.3	44.60	50.21	45.38	32.13	42.57	4.75	14.25
6	Bonanza	Six-row bearded	100.0	35.9	44.25	36.42	44.10	29.23	36.58	.....	.....
19	Selected Bonanza	" "	100.0	35.6	47.80	42.43	39.10	30.06	37.20	0.62	1.86
4	Two-row Mandscheuri	Two-row bearded	104.5	32.5	48.00	.....	8.83	17.99	*13.41	.....	.....
18	Selected two-row Mandscheuri	" "	103.0	36.6	46.40	17.03	12.54	19.09	*15.82	*2.41	*7.23

*Average for two years, 1907–'08.

III.-Distribution of Improved Seed Grain.

The seed of the better producing varieties which the Agronomy Department has distributed is superior to the average seed which the farmers are growing, and the selected or improved strains are superior even to the original seed of the best producing varieties, as indicated by the comparative tests which have already been made. The seed which the Experiment Station will distribute in the future will be largely from the selected and pedigreed strains.

The seed distribution work was begun in 1904, but only a small quantity of seed was distributed in 1904 and 1905. The following is a brief summary of the number of bushels of seed distributed of each of the standard crops:

KIND OF CROP.	Bushels of seed distributed yearly.						
	1904.	1905.	1906.	1907.	1908.	1909.	Total.
Winter wheat	32.0	174.9	1,288.2	1,726.6	768.5	1,258.1	5,224.0
Winter barley	.....	5.0	253.4	162.0	183.4	70.3	674.0
Winter rye	.....	.....	.....	.....	5.0	28.2	33.2
Oats	22.0	0.8	276.7	389.5	75.8	266.5	1,031.2
Spring barley	5.5	24.0	46.0	49.3	6.0	12.0	142.8
Emmer	2.0	12.0	.....	.....	13.0	15.8	42.8
Cane	.....	.....	.....	69.0	78.0	110.0	257.6
Corn	40.2	294.5	422.7	561.7	344.8	714.7	2,378.0
Kafir	.....	.....	29.0	217.0	168.0	262.0	676.0
Milo maize	.....	.....	.....	.....	15.3	36.5	51.8
Broom corn	.....	.....	0.5	.....	24.8	28.3	53.6
Soy beans	28.0	.....	58.6	23.5	12.0	9.7	131.2
Cowpeas	.....	.....	8.9	12.7	.....	14.5	36.1
Flax	.....	.....	15.0	28.6	10.5	1.5	55.6
Millet	.....	.....	.....	1.0	5.8	0.5	7.3
Bromus inermis	.....	.....	0.5	.....	4.2	.....	4.7
Totals	125.5	511.0	2,350.0	3,241.0	1,715.0	2,845.7	10,795.0

These seeds were sold at a good price, and have been in great demand. The work has been well appreciated by the farmers, very few unfavorable reports having been received from the growers of the "College-bred" seed. Often farmers report yields of 25 to 30 per cent above that secured from unimproved home-grown seed planted in the same field or in adjacent fields. There is little question but that the sale and distribution of well-bred seed of these better producing varieties will have a marked influence in increasing the yield and improving the quality of our several standard grain crops, especially wheat and corn.

In the judgment of the writer this work is of vast impor-

PLATE VII. A field of Tennessee winter barley on Experiment Station farm in 1906. Yield, 65 bushels per acre.

tance to the state. The improvement of crops by breeding and selection is primarily the work of the Experiment Station, and the Experiment Station should be the source or first distributer of well-bred seed. The general farmer cannot well undertake the improvement of crops by these expensive breeding methods, although he may grow the high-bred seed, and thus become a further distributer of improved seed grain.

PLATE VIII. A field of pure-bred Ghirk wheat on Agricultural College farm. Crop of 1909. Yield, 52 bushels per acre.