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K.H. Klages

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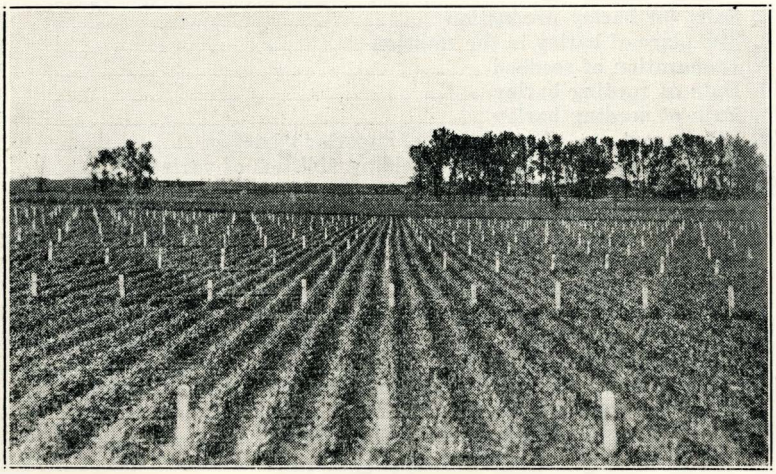

Barley nursery plats at Brookings, season of 1930

Agronomy Department
Agricultural Experiment Station
of the
South Dakota State College of
Agriculture and Mechanic Arts
Brookings

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The cereal crops produced in South Dakota may be listed in order of their importance from the standpoint of total value as wheat, oats, barley and rye. Corn is of greater value than any of the small grains while flax exceeds rye in value. Table I gives the acreage, total production, average yield per acre and total value of the most important field crops grown in South Dakota. It will be seen that corn, wheat and oats surpass barley in total value for the ten year period of 1920 to 1929.

A closer examination of Table 1 will show a decided increase in barley acreage and production in the last few years even up to the point where the acreage devoted to this crop and the value of it approaches that of oats. In view of the increasing interest in barley production it will be worth while to consider the relative value of barley as compared with other feed crops and especially with corn and oats. Barley has long been recognized as the most important feed crop in sections where climatic conditions are unfavorable to corn production. More and more interest in the production of barley as a feed crop is evident even in the best corn producing centers of the country and the state. This is apparent from Figs. 1 and 2 showing the distribution of barley acreage and production in South Dakota. The reasons for such increasing interest in barley production may be found in the recognition of its feeding value, the ease with which its production may be fitted into the prevailing systems of cropping, and the replacement of oats acreage by barley on soils where barley has shown itself more productive.

Distribution of Barley Production in South Dakota

Fig. 1 shows the distribution of barley acreage over the state with each dot representing 1000 acres. It will be seen that production is quite general

Acknowledgements

The author wishes to express his indebtedness to the following persons for parts of data used in this publication: Dr. A. N. Hume, agronomist and superintendent of substations; Mr. C. J. Franzke, assistant in agronomy; Mr. E. S. McFadden, now associate agronomist, Redfield Field Station, but during the early period covered by the investigations here reported, stationed at the Highmore substation; Mr. S. W. Sussex, foreman of the Highmore substation, and Mr. Walter Schonbrodt, foreman of the Eureka substation.

Dr. A. N. Hume directed the investigational work reported. It is due to his efforts that data extending over a long period of years are available at this time. Mr. C. J. Franzke supervised the experiments at Brookings and Highmore. The hybrids described and reported on were produced by Mr. E. S. McFadden while stationed at the Highmore substation. Through the period of the World war when assistance was limited, these hybrids were perpetuated in variety test plats at Highmore by Dr. A. N. Hume and Mr. S. W. Sussex. Segregations were noted and transfers made to Brookings and Eureka by Mr. C. J. Franzke. The author took charge of the varietal experiments in the summer of 1928.

Table 1.—Acreages, total production, yields, and relative values of important field crops in South Dakota for the ten year period, 1920-1929 inclusive.

Year	CORN				WHEAT				OATS			
	Acreage 1000 acres	Prod'tion 1000 bu.	Av. yield per acre	Value 1000 dollars	Acreage 1000 acres	Prod'tion 1000 bu.	Av. yield per acre	Value 1000 dollars	Acreage 1000 acres	Prod'tion 1000 bu.	Av. yield per acre	Value 1000 dollars
1920	3,650	109,500	30.0	45,990	2,930	26,920	9.2	30,958	2,219	75,446	34.0	24,897
1921	3,926	125,632	32.0	32,664	2,845	25,980	9.1	22,603	2,650	58,300	22.0	11,660
1922	3,861	110,038	28.5	55,019	2,989	40,012	13.4	36,811	2,400	74,400	31.0	23,808
1923	4,208	145,176	34.5	75,492	2,870	27,515	9.6	22,287	2,304	78,336	34.0	24,284
1924	4,814	102,538	21.3	82,030	2,408	36,120	14.6	45,150	2,889	106,893	37.0	42,757
1925	4,478	78,365	17.5	47,019	2,701	31,835	11.8	40,749	2,834	96,356	34.0	26,980
1926	4,630	83,340	18.0	48,337	1,917	11,611	6.1	13,701	1,984	23,213	11.7	8,357
1927	4,655	134,995	29.0	76,947	3,037	45,386	14.9	48,109	2,550	74,715	29.3	26,897
1928	4,469	93,849	21.0	58,186	3,360	34,928	10.4	29,689	2,193	59,211	27.0	19,540
1929	4,916	112,085	22.8	69,493	3,114	30,247	9.7	28,130	2,259	64,882	28.5	21,890
Av.	4,361	109,552	25.5	59,118	2,817	31,055	10.8	31,819	2,428	71,125	28.9	23,107

Year	BARLEY				FLAX				RYE			
	Acreage 1000 acres	Prod'tion 1000 bu.	Av. yield per acre	Value 1000 dollars	Acreage 1000 acres	Prod'tion 1000 bu.	Av. yield per acre	Value 1000 dollars	Acreage 1000 acres	Prod'tion 1000 bu.	Av. yield per acre	Value 1000 dollars
1920	1,028	25,700	25.0	13,364	220	2,200	10.0	3,630	205	2,768	13.5	3,017
1921	1,120	19,040	17.0	5,522	216	1,404	6.5	1,952	191	3,056	16.0	1,772
1922	881	20,268	23.0	8,510	162	1,539	9.5	3,093	506	9,108	18.0	5,283
1923	890	20,025	22.5	8,010	284	2,414	8.5	5,021	304	3,496	11.5	1,713
1924	790	21,330	28.0	13,651	548	4,877	8.6	10,876	245	3,430	14.0	3,499
1925	915	23,790	26.0	11,181	559	3,801	6.8	8,552	177	1,682	9.5	1,127
1926	778	7,858	10.1	4,086	475	2,755	5.8	5,235	103	639	6.2	466
1927	1,200	36,000	30.0	20,880	594	5,940	10.0	10,989	154	2,772	18.0	2,190
1928	1,680	36,456	21.7	17,499	554	3,601	6.5	7,238	162	1,458	9.0	1,152
1929	2,016	37,296	18.5	16,783	637	3,758	5.9	10,522	186	2,046	11.0	1,555
Av.	1,130	24,776	22.2	11,949	425	3,229	7.8	6.711	223	3,046	12.7	2,177

over the eastern half of the state, with the greatest acreage in the east central portion. Tripp county has the largest acreage of any county west of the Missouri river.

Fig. 2 shows the distribution of barley production with each dot representing 20,000 bushels harvested in 1929. Due to drought, yields in the central and northern portions of the state were low. This had a tendency to move the center of production south of the region of greatest concentration of acreage. Since less rainfall in the central part of the state is of common occurrence, yields per acre there are not so high as can be expected in the eastern counties with greater amounts of precipitation and generally more favorable temperatures. This is shown in Table 10 giving average yields of two and six-rowed barleys at Brookings, Highmore and Eureka for a period of 21 years, 1909 to 1929 inclusive. A comparison of Figures 1 and 2 shows that the acreage devoted to barley production is not as great in the southeastern part of the state, that is in the main corn producing section, as in the east-central portion. It is evident, however, from the standpoint of the number of bushels produced that barley is a very important crop in the main corn growing section of the state.

Chemical Composition of Barley and Other Feed Grain

Since corn is more widely used for feed than any other grain in American agriculture it may be looked upon as a standard in a comparison of the relative merits of other feed grains. Table 2, compiled from Henry and Morrison (4)*, gives the chemical compositions of grain crops commonly used for feed. It will be seen that the chemical composition of barley compares quite favorably with that of corn. The higher ash and crude protein content of barley makes it somewhat more valuable as a feed crop for young growing animals than corn. On the other hand, the higher percentage of fat and lower fiber content of corn makes it a better

Table 2.—Chemical compositions of commonly used feed grains on a percentage basis†

Kind of Grain	Water	Ash	Crude Protein	Carbohydrates Fiber	Carbohydrates N-free extract	Fat
Corn, dent, well dried	10.5	1.5	10.1	2.0	70.9	5.0
Corn, flint	12.2	1.5	10.4	1.5	69.4	5.0
Barley, common	9.3	2.7	11.5	4.6	69.8	2.1
Barley, hulless	9.3	2.8	10.8	2.9	71.6	2.6
Oats	9.2	3.5	12.4	10.9	59.6	4.4
Emmer (spelt)	8.7	3.7	11.9	10.1	63.7	1.9

† Compiled from Henry and Morrison, "Feeds and Feeding."

feed for fattening purposes than barley. The percentage of nitrogen-free extract in barley, consisting mainly of starches and sugars and consequently of value for putting fat on animals, compares favorably with that of corn.

As is to be expected because of the presence of hulls on common barley the percentage of fiber for barley is higher than for corn, but much lower than for oats and emmer. The percentage of fiber in the hulless barley is of course low. Common barley will show around 15 per cent of hull as compared to 30 per cent for oats. These figures on percentages of hull represent average values. The exact percentage of hull of any one sample of barley or oats depends upon the variety and upon the conditions of

* Reference by number is to "Literature Cited," Page 40.

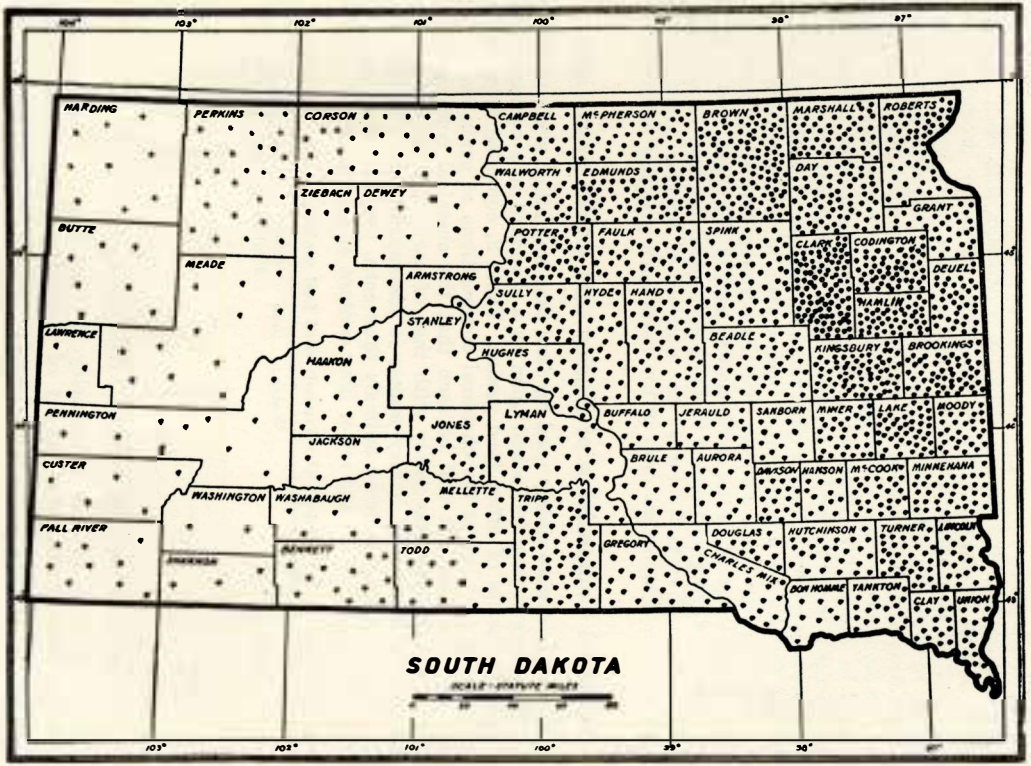

Fig. 1.—Distribution of barley acreage in South Dakota, season of 1929. Each dot represents 1000 acres.

growth. Barleys of the coast type such as California Feed or Coast will contain under equal growing conditions a higher percentage of hull than such types as Odessa, Manchuria or Velvet. Light poorly filled grain of both barley and oats will show higher percentages of hull than well filled kernels grown under favorable climatic and soil conditions. The amount of hull around the grains may vary from less than 10 up to 25 per cent in barley and from 20 to 40 per cent in the case of oats.

Comparative Feed Value of Barley, Corn, and Oats

Barley is the most important feed crop of sections where corn production is impossible or unprofitable. This does not mean that the crop has no place on farms producing corn; it has a place in the cropping system of the corn producing farms of the northwestern states. While corn is generally considered superior to barley for fattening purposes, and rightly so, barley has some points of superiority over corn as a feed for growing animals.

Even as a feed for fattening purposes it is not far inferior to corn. Kuhlman and Wilson (10) report that it required 395.02 pounds of barley and 23.81 pounds of tankage as compared to 374.12 pounds of corn and 32.46 pounds of tankage to produce 100 pounds of pork. It took 20.90 pounds more of the barley than of the corn, but 8.65 pounds less of the tankage where barley rather than corn was fed to produce a gain of 100 pounds. With the usual relationship between the prices of corn and tankage the barley fed in this experiment was equal in value to the corn used, which according to these investigators would grade No. 3 or No. 4.

Cattle also do well on barley. Wilson (13) reports cattle feeding results with corn, barley and oats fed in combination with corn silage and limited amounts of oil meal. Steers fed corn and corn silage consumed 6.9 pounds of corn, 7.7 pounds of silage, and 0.7 pounds of oil meal per pound of gain. Steers fed barley and corn silage consumed 7.2 pounds of barley, 7.6 pounds of silage, and 0.7 pounds of oil meal per pound of gain. The lot fed on oats and corn silage consumed 8.6 pounds of oats, 9.7 pounds of silage, and 0.8 pounds of oil meal per pound of gain. The cost of 100 pounds gain for the three respective lots were $9.37, $9.65, and $11.65. Numerous other experiments could be cited showing that barley can be used to advantage as a substitute for corn. Wilson et al (14) give results of feeding tests on cattle, sheep and swine with ground and whole corn, and barley and ground alfalfa hay. Oats, due to its high percentage of hull cannot be considered as a feed for fattening purposes. Its high percentage of ash and protein make it of special value for feeding growing animals.

Relative Amounts of Feed Produced Per Acre by Barley and Oats

Table 1 shows that oats production for the last ten year period, 1920-1929, was of greater importance both from the standpoints of value of the crop and acreage devoted to it than the production of barley. In the last few years, however, barley production has been gaining on oats production. Since both of these crops are used primarily for feed it will be worth while to consider the relative merits of barley and oats in the various portions of South Dakota from the standpoint of the amount of feed produced by each per unit of area.

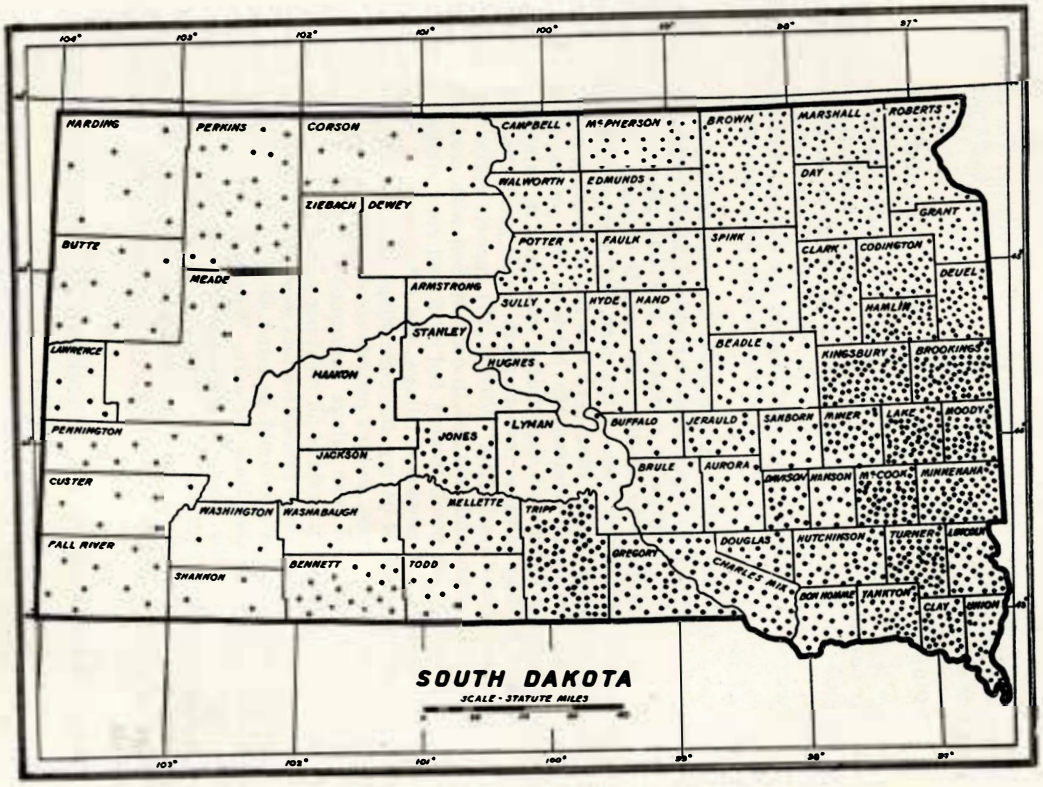

Fig. 2.—Distribution of barley production in South Dakota, season of 1929, Each dot represents 20,000 bushels.

Table 3 gives the comparative yields per acre and values of barley and oats at Brookings, the main station, and at the Highmore, Eureka, Cottonwood and Vivian substations of the South Dakota Agricultural Experiment Station. Fig. 3 shows the locations of these respective stations. Yields of Odessa barley and Sixty Day oats were available at Brookings and Highmore for a 25 year period, 1905-1929, inclusive . It was necessary to make use of the yields of two varieties of barley, Manchuria 1909-1924 and Odessa 1925-1929, in order to obtain comparative yields of barley and Sixty Day oats at Eureka for a 21 year period, 1909-1929, inclusive. The yields reported for Cottonwood were obtained from a rate of seeding test of Black Gatami barley and Sixty Day oats, the yields of the 4, 6 and 8 peck rates per acre were averaged. The crops were grown in a corn, small grain, sweet clover rotation. The barley and oats crops at Vivian were grown in an alfalfa, corn, small grain rotation. These rotations are discussed by Hume (5) in Bulletin 253 of this station.

Yields of oats and barley, since one weighs 32 and the other 48 pounds per bushel, cannot be compared directly on the basis of bushels per acre; it is necessary to express the yields in the common unit of pounds per acre. In order to set the feeding values of these two crops on a comparative basis it is necessary to make allowances for the amounts of hull of each. The hulls of oats and barley have practically no feeding value, or at any rate no more than straw, and serve only to increase the bulk. Since barley has around 15 per cent of hull and oats 30, these percentages were subtracted from the yields of barley and oats respectively. Justification

Table 3.—Average yields of barley and oats in bushels and pounds per acre together with evaluations of the feeding values of the two crops by means of corrections for differences in percentage of hulls and on the basis of Armsby's net energy values.

Station and number of years of comparison	Crop and variety	Yield in bu. per acre	Yield in pounds per acre		Net energy value in therms per acre
			Total	Less correction for hulls*	
Brookings	Barley—Odessa	44.1	2117	1859	1904
25 yrs., 1905-1929	Oats—Sixty Day	54.8	1754	1228	1185
Highmore	Barley—Odessa	31.1	1493	1269	1343
25 yrs., 1905-1929	Oats—Sixty Day	43.2	1382	967	934
Eureka	Barley—Manchuria†	21.5	1032	877	928
21 yrs. 1909-1929	Oats—Sixty Day	36.5	1168	818	789
Cottonwood	Barley—Black Gatami	15.6	749	637	674
16 yrs., 1914-1929	Oats—Sixty Day	25.7	822	575	555
Vivian	Barley—Odessa	22.0	1056	898	898
10 yrs., 1920-1929	Oats—Sixty Day	26.2	838	587	587

* Barley 15 and oats 30 per cent.
† Manchuria 1909-1924, Odessa 1925-1929.

for such corrections for differences in percentage of hull in oats and barley is found in the comparative feeding tests previously reported. This basis of comparison of these two crops applies especially where the grain is used for fattening purposes rather than as a comparison of their values for growing animals.

Another method of bringing out the comparative values of the two feeds is by means of Kellner's starch values or by Armsby's net energy

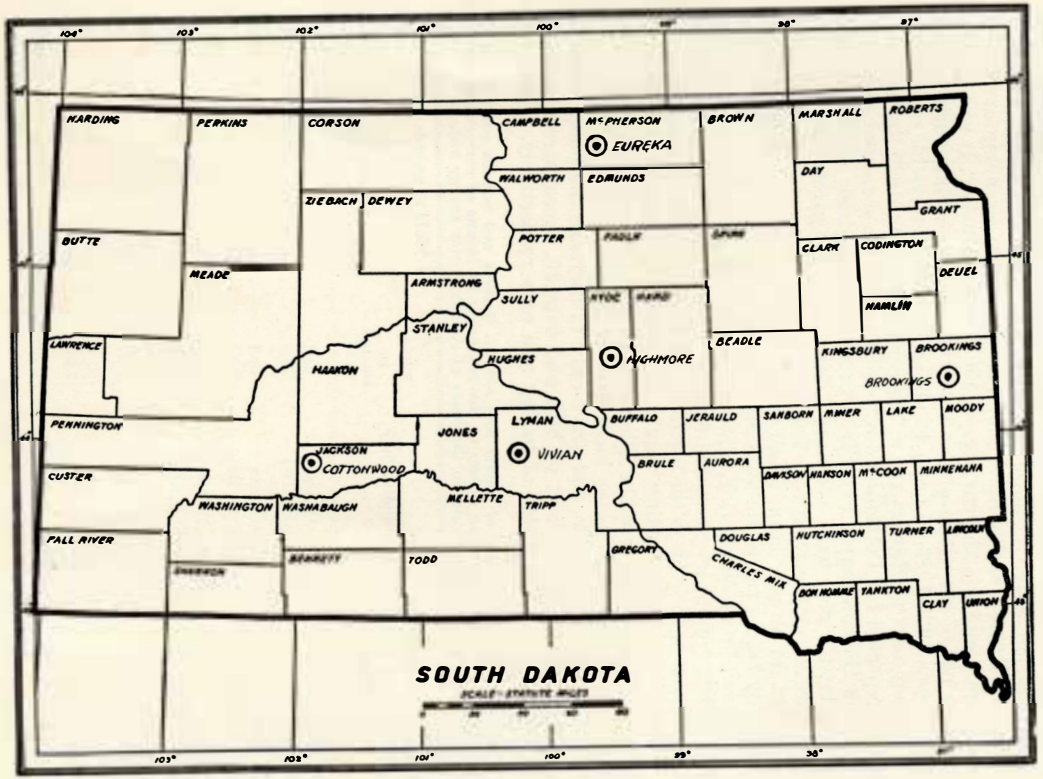

Fig. 3.—Location of the main station and substations of the South Dakota Agricultural Experiment Station.

values of the average yields of barley and oats, Table 3. Fig. 4 gives a mastication, digestion and assimilation of a feed. Armsby's net energy values are expressed in therms. Thus he finds that the net energy value for ruminants of barley is 0.8994 as compared to 0.6756 therms per pound for oats. By the use of these figures it is possible to express the net energy values of the average yields of barley and oats. Table 3. Fig. 4 gives a graphic view of the net energy values produced by oats and barley per unit of area at the various stations over the state.

It will be seen from Table 3 that the yields of barley in pounds per acre are greater than those of oats at three of the five stations, namely at Brookings, Highmore and Vivian. At Brookings oats was outyielded by barley by 363 pounds, at Vivian by 218 and at Highmore by 111 pounds, while at Eureka and Cottonwood barley was outyielded by oats by 136 and 73 pounds per acre respectively.

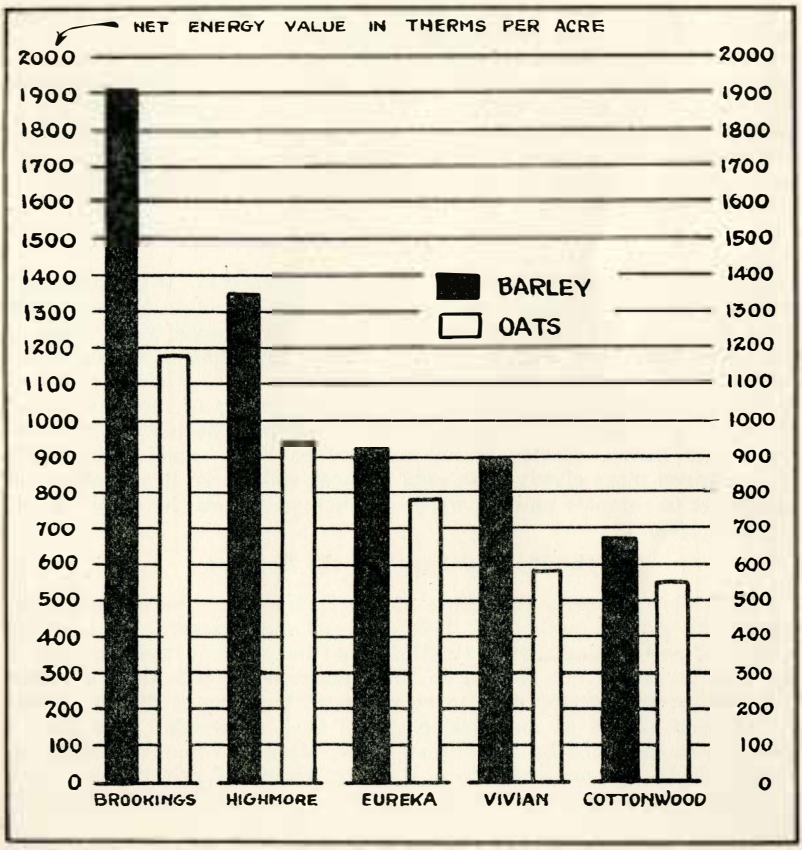

Fig. 4.—Net energy value in therms per acre produced by barley and oats at Brookings, Highmore, Eureka, Vivian, and Cottonwood.

When the yields of oats and barley at the various stations are examined on the basis of their feeding values, that is, when corrections are made for differences in the percentages of hull in these two crops or when they are compared on the basis of production of net energy values, then it becomes apparent that barley is the more valuable crop at all of the various stations. The differences in the net energy values produced by barley above those produced by oats are 719, 409, 311, 139 and 119 therms per acre for Brookings, Highmore, Vivian, Eureka and Cottonwood respectively.

The great differences in the actual yields and in the evaluations of such yields of oats and barley indicate very definitely that more feed can be produced in the eastern part of South Dakota by making use of barley rather than oats. This statement applies also, but to a less degree, to the central and south-central portions of the state as indicated by the comparative yields of these two crops at Vivian and Highmore. Even in the north-central and far western parts of the state, as shown by the yields and net energy values of such yields at Eureka and Cottonwood, barley produced slightly more feed per acre than oats.

What has here been said regarding the relative merits of barley over oats should not be misconstrued to mean that barley should be used in all cases to replace oats production. The type and fertility of the soil on which the crop is to be grown must be taken into consideration in making the choice between these two feed crops. Barley is more specific in its soil requirements than either oats or wheat. On many soils oats is the more desirable crop.

Soils for Barley Production

Barley is somewhat specific in its soil requirements. It produces best on well drained fertile soils with sufficient depth to retain a good supply of moisture for the needs of the crop. Oats has a much wider range of soil adaptation than barley. It does better than barley on both low, poorly drained areas and on rather thin dry soils. Unless a soil is fairly fertile and deep enough to hold a good supply of moisture barley grown on it is likely to be quite short in straw. The best barley soils are rather heavy. Barley is not adapted to light sandy soils. Since barley grows more slowly than oats on poor soils it is at a greater disadvantage to compete against weeds on such soils than the ranker growing oats crop.

The Place of Barley in the Rotation

The yields of barley like those of other cereals can be materially increased by proper methods of field and soil management. In a proper system of soil management attention must be given to the sequence of crops to be grown not only from the standpoint of providing a proper foothold for the specific crop to be produced but also to discourage the growth and spread of undesirable plants such as weeds. This may in part be accomplished by the successive growing of crops requiring different soil treatments and having different habits of growth, such as is found in a sequence of cultivated, drilled or cereal crops, and leguminous crops.

The cultivated crop, such as corn, and the cereal crop, are grown for either cash or feed crops while the leguminous crop, either alfalfa or clover, is included for the production of either pasturage or hay. The

inclusion of the cultivated crop serves to keep down weeds. Furthermore, cultivation leaves the soil in a better physical condition and facilitates the preparation of the seedbed for the crop to follow. This is true as in the case of barley following corn, thereby eliminating the need of plowing for the former crop. The leguminous crop is included not only for the production of hay but also for the favorable physical and chemical after effects on the soil incident to the accumulation of nitrogen and organic matter. Barley grown at Brookings in three different rotations yielded over a period of 18 years, from 1912 to 1929 inclusive, as follows in the respective rotations: corn, barley, sweet clover, 38.4 bu.; corn barley, field peas, 42.0 bu.; barley, millet, wheat, 29.2 bu. as compared to 31.6 bu. per acre for continuous barley. It is evident that the highest yields were obtained following corn and in those rotations including a cultivated and a leguminous crop.

Preparation of Seedbed

Where barley follows other grain in the rotation, the land should be plowed in preparation for this crop. In sections of the state where soil blowing is not a serious problem, early fall plowing is preferable to late fall or spring plowing. If plowing is delayed until spring it should be done as early in the season as possible. Other soil preparations are the same as for other cereal crops; the number of diskings, harrowings, etc. depends on the type and condition of the soil.

Where barley follows corn in the cropping system plowing is not necessary unless the land is exceedingly weedy. Double disking of the corn land followed by harrowing will put the soil in good condition for the crop.

Barley is not a good crop on sod land. Where it becomes necessary to grow it on such land, the sod should be broken in the spring or early summer previous to the seeding of the barley crop.

Date of Seeding Barley

Experiments on the optimum dates of seeding the various spring sown crops such as barley, wheat, oats and flax, have been summarized in Bulletin 227 of this station, Hume et al (6). The best date of seeding for any particular season is determined by specific soil and climatic conditions; nevertheless, it is worth while to find how yields fluctuate with plantings at different parts of the season.

Results of experimental seedings at Highmore indicate that the best date of seeding barley is about the middle of April. The April 15 seedings yielded nearly three bushels more per acre than the April 1 seedings and approximately six bushels more than the May 1 seedings. Relatively early seedings had, as may be seen from these figures, less harmful effects than later seedings. Highest yields were also obtained at Brookings with the early April seedings.

In ordinary farm practice the small grains are usually seeded in the following order: spring wheat, oats and barley. While this may be good farm practice, it is not conducive to the best yields of barley, as is apparent from the statements and yields given above. Nevertheless, it must be realized that it is impossible to seed all the various cereal crops at their respective optimum dates. The growth requirements of these crops are very much alike; where large areas are to be planted, it is

necessary to decide which should be planted first. The yields of spring wheat and oats are reduced more than those of barley by delay in seeding beyond the optimum dates. This is the reason for the order of planting as given above.

Rate of Seeding Barley

Table 4 gives the results of rate of seeding tests at Brookings, Highmore, Eureka and Cottonwood. Two factors become evident from a study of this table; first, that six pecks of seed per acre is sufficient; second that it is possible to plant too much, especially in the central and western portions of the state, as indicated by the somewhat lower average yields of the higher rates of seeding at Highmore, Eureka and Cottonwood. In

Table 4.—Rate of seeding experiments on barley at Brookings, Highmore, Eureka and Cottonwood.

	BROOKINGS			HIGHMORE				EUREKA			COTTONWOOD		
Variety	Odessa*			Odessa				Hannchen			Black Gatami		
Rate of	S. D. 182			S. D. 182				S. D. 20			S. D. 122		
Seed'g	5	6½	7½	5	6½	7½	8¾	5	6½	7½	5	6½	7½
Year	pks.	pks.	pks.	pks.	pks.	pks.	pks.	pks.	pks.	pks.	pks.	pks.	pks.
1913	70.8	68.7	66.7	9.1	6.3	7.3	7.7	7.9	8.4	5.6	1.3	0.6	0.2
1914	52.1	53.1	53.1	47.9	47.9	60.4	47.9	30.3	30.2	29.8	7.5	7.7	7.7
1915	52.7	56.6	53.9	68.6	79.0	77.0	77.0	70.0	65.2	64.2	Failure—hail		
1916	8.8	11.9	14.2	43.7	45.8	54.2	45.8	20.6	21.7	19.6	26.5	26.4	27.1
1917	55.4	57.3	58.3	31.2	30.2	28.1	31.2	7.7	9.6	6.9	15.5	18.7	20.3
1918	55.4	60.0	60.6	34.3	32.5	33.3	26.0	7.1	7.1	5.2	12.4	16.7	10.1
1919	28.9	23.3	27.3	31.5	36.2	31.8	38.8	24.6	16.7	15.0	21.0	20.5	15.4
1920	37.3	29.8	34.6	39.6	31.3	36.5	33.3	33.8	32.1	33.3	45.0	42.9	40.6
1921	40.8	41.0	41.0	21.4	21.9	21.4	20.8	11.7	21.9	12.3	0.8	0.2	0.5
1922	50.6	52.1	58.7	50.0	52.1	40.6	40.2	27.0	33.7	25.4	15.3	13.8	11.6
1923	29.2	33.5	36.3	42.7	39.6	35.4	45.8	25.0	28.7	23.0	47.3	46.9	37.3
1924	56.5	60.6	60.4	44.7	45.8	43.8	40.6	19.1	23.9	18.7	6.7	7.7	6.7
1925	57.9	57.3	57.7					17.5	19.4	21.5	11.3	10.8	5.8
1926	41.6	40.2	31.6					Failure—drought			0.4	0.7	0.3
1927	56.3	59.2	58.8					48.9	48.8	41.9	38.3	35.2	38.5
1928	57.9	56.7	56.5					Failure—hail			4.8	3.3	2.6
1929	50.0	50.0	47.9					4.8	5.4	7.5	--	--	--
Av.	47.2	47.7	48.1	38.7	39.1	39.2	37.9	20.9	21.9	19.4	15.9	15.8	14.0
† Av. yields	47.2	47.3	47.5	38.7	38.7	38.4	37.0	20.9	21.5	18.8	15.9	15.4	13.4

* Manchuria 1913 and 1914, Odessa 1915-1929.
† Average yields minus seed in excess of 5 pecks.

the eastern part of the state, where more moisture is usually available for the development of the plants, a rate of six to seven pecks per acre gives good returns, while in the central and western portions the rate of seeding may well be cut down to five pecks per acre.

It is interesting to note that the differences in the yields with the employment of the respective rates of seeding given in Table 4, are relatively small. This is true especially when allowances are made for the greater amount of seed used with the higher rates of seeding. It shows that the barley plant is able to adapt itself to its environment. Where the rate of seeding employed is low and the stand obtained relatively thin but conditions are favorable to growth, a greater number of tillers are produced by each plant in the case of the thinner stand than in the case of denser stands from higher rates of seeding. This tendency towards equalization of stands by the greater or lesser production of stools accounts for the small differences in the yields of the respective plats planted at different rates.

Excessively high rates of seeding lead to an undue amount of competition between plants. Such unnecessary competition for water, nutrients and space is always detrimental to the plants and serves to reduce yields.

High rates of seeding result in the production of stunted plants with limited root development. Such plants are not able to draw as much water from the soil as plants grown under conditions with more space available for the production of a normal growth. Too thick a stand in the early part of the growing season is not economical from the standpoint of utilizing the available moisture in the soil. In sections with limited rainfall, moisture in the soil must be conserved until such time when it is most needed by the plants. Unless a sufficient amount of moisture is available for the crop at flowering time, yields will be materially reduced.

The best rate of seeding for any particular field is determined by the amount of moisture likely to be available, especially during critical periods in the development of the crop, by the fertility of the soil and by the size of the seed used. A lower rate of seeding should be employed on rich soils well supplied with moisture than on poorer, drier upland fields. Less trouble will be encountered from lodging where barley is grown on soils of high fertility if the rate of seeding is decreased. Reductions in the rate of seeding will lead to the development of stronger straw better able to support the weight of the heads. A high rate of seeding on such soils will, to be sure, result in a somewhat shorter straw; the individual stems, however, will not be as strong as where more space is allowed for the development of individual plants. When large seeded varieties are used, such as Trebi, more seed can be used than in the case where smaller seeded types such as Odessa or Glabron are sown.

The Importance of Good Seed of Superior Varieties

Crop yields are dependent on a great variety of factors, some within, others beyond the control of the producer. High yields are essential to economic production. Yields may be increased by such means as good tillage practices, the employment of rotations providing for the special needs of the crop in question, by the application of fertilizers, by controlling diseases and insect pests and last, by the use of good seed of adapted and proved varieties.

All these means are practical only in so far as they are economical. Tillage and the application of fertilizers make up items of expense to be charged against the crop as does also the cost of seed. Good seed of proved varieties often costs but little more than inferior seed of unadapted varieties. After a supply of good seed has been obtained and care taken to keep it free from mixture, it costs no more than seed of questionable quality. It is therefore evident that where an increase in yield amounting to from 10 to 20 per cent or more is obtained by the employment of good seed of a variety adapted to the conditions under which the crop is to be grown, this increase comes to the grower as extra profit. Increases of this magnitude resulting from good seed are not at all uncommon. The use of good seed of proved varieties offers one of the best means within the reach of every producer to increase his yields at little or no extra cost.

Methods Used in Testing the Yielding Abilities of Varieties

Two sets of plats are used in testing the yielding abilities of varieties—the nursery plats and the regular variety test plats.

The nursery consists of small plats of triplicate rows one foot apart and 18 feet in length. These plats are trimmed down to 16½ feet in length shortly before harvest in order to obviate border effects. Only the center

row is harvested for yield. The frontispiece shows the barley nursery at Brookings. The barley nursery was started in 1929. It is intended to advance to the regular variety test plat only such varieties or strains as have exhibited superior performance in the nursery for three or more years. The advantage of the nursery method of testing varieties is that a large number of strains due to the small size of plat used can be tested on a small area. Since each variety is grown four times and distributed through the plat, the average yields become quite reliable. Forty different varieties were grown in the barley nursery in 1929; in 1930 the number grown was 75. All varieties tested in the regular variety test plats at Brookings were also grown in the nursery.

The regular variety test plats used up to 1930 were 1/50 of an acre in area. They were separated by cultivated alleys three feet wide. All plats were repeated three times. Since the cultivated alleys led to a considerable border effect, a modification of Delwiche's (2) plan of laying out variety test plats was adapted in 1930 at Brookings and Highmore. Delwiche's plan was modified so that that only two rather than six drill rows were grown in the alleys between adjacent plats. The plats were separated from the two drill rows in the alley by a blank drill row on either side. The drill rows in the alley were arranged so that they were of the same variety as the plats they adjoined. The modified plan was found practical under South Dakota conditions in so far as it eliminated the need of cultivated alleys between plats, cut down border effects and reduced the possiblities of exaggerated yields. Due to the fact that a 14 disk drill was used in seeding the plats it became necessary to reduce their areas from 1/50 to 1/60 of an acre. This method of laying out variety test plats is discussed in detail by Klages (9). Figures 8 and 9 show several of the plats at Highmore in 1930, laid out as described here.

Results of Variety Tests at Brookings

Table 5 gives the annual acre yields of barleys tested in the regular variety test plats at Brookings for one or more of 15 years from 1916 to and including 1930, together with the 15, 5 and 4 year average yields of the varieties compared for those respective periods. Varieties tested previous to 1916 are reported on in Bulletin 183 of this station by Champlin et al (1). Table 6 gives, for the convenience of the reader, a summary of the average yields for the given periods of camparison expressed on a percentage basis of the yields of Odessa. The varieties mentioned are described in a later part of this publication.

Odessa, as may be seen from Tables 5 and 6, was the oustanding yielder for the first two periods of comparison—for the 15 year period 1916 to 1930, and again for the five year period from 1926 to 1930. Bonami and Sandrel silghtly outyielded Odessa in the last period from 1927 to 1930 inclusive.

Odessa outyielded all other varieties by a considerable margin for the longest period of comparison. Its nearest competitor was Oderbrucker, which it outyielded by 4.7 bushels per acre, or by nearly 10 per cent. Manchuria, Improved Manchuria and White and Black Gatami showed fair yields. The yields of these better varieties were, nevertheless, surpassed by those of Odessa by from 7.0 to 8.1 bushels per acre or by from 14.8 to 17.1 per cent.

In the second period of comparison Odessa surpassed in yield such

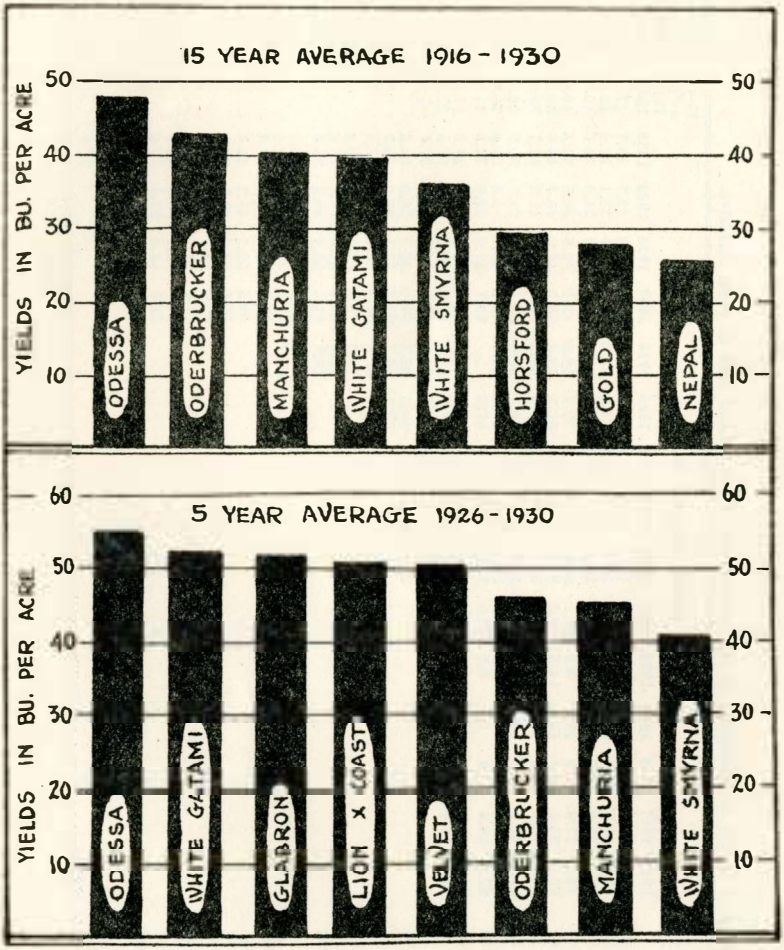

Fig. 5.—Average annual yields of prominent varieties of barley at Brookings for a 15 and a 5 year period of comparison.

varieties as Gatami, Glabron, Comfort, Velvet and those of the hybrid Lion x Coast S. Dak. No. 1342. It is interesting to note that the yields of White Gatami in this period were exceeded by those of Odessa by only 2.6 bushels or by only 4.7 per cent whereas the difference in the yields of those two varieties for the 15 year period of comparison amounted to 7.4 bushels or to 15.1 per cent. Oderbrucker and Manchuria yielded substantially less than Odessa. The relative performance of the smooth-awned varieties such as Glabron, Comfort, Lion x Coast, and Velvet merits attention. The yields of these varieties average from 6.6 to 8.4 per cent less than those of Odessa. However, because of their smooth beards, these

Table 5.—Annual acre yield of varieties of barley at Brookings in one or more of 15 years from 1916 to 1930, inclusive.

VARIETY	C. I. or State No.	S. D. Acc. No.	ACRE YIELDS (bushels)															15-yr. av'ge 1916-1930	5-yr. av'ge 1926-1930	4-yr. av'ge 1927-1930
			1916	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930			
Odessa	182	182	41.3	50.4	61.5	26.0	12.5	44.7	38.5	32.3	53.1	75.0	65.5	68.8	56.3	42.7	40.7	47.3	54.8	52.1
Oderbrucker Wisc.	26	1180	47.9	33.2	54.2	32.3	9.4	43.7	22.9	32.3	58.0	75.0	61.3	53.5	47.9	38.1	29.8	42.6	46.1	42.3
Manchuria	643	105	43.8	45.8	56.3	21.9	6.3	29.2	28.1	28.1	41.6	75.0	65.7	54.1	52.6	25.0	30.5	40.3	45.6	40.6
Improved Manchuria	--	1338	46.9	37.8	56.3	25.0	8.3	26.1	31.3	27.1	36.5	72.9	58.5	53.1	52.6	36.5	32.5	40.1	46.6	43.7
White Gatami	920	889	31.9	33.2	56.3	15.6	14.6	30.2	30.2	20.8	42.7	62.5	64.8	58.3	47.9	45.4	44.6	39.9	52.2	49.1
Black Gatami	595	122	36.5	33.2	79.2	16.7	5.2	39.6	25.0	16.6	45.8	45.8	64.2	54.1	41.7	41.2	42.7	39.2	48.8	44.9
White Smyrna	195	28	31.6	33.2	57.3	15.0	8.3	38.5	31.2	21.9	52.1	54.1	45.0	53.1	43.8	29.7	30.9	36.4	40.5	39.4
Horsford	507	294	14.6	32.1	50.0	17.7	2.1	29.2	21.9	19.8	43.7	47.9	56.4	33.3	40.7	5.8	29.6	29.7	33.2	27.4
Gold	1145	460	22.2	28.6	47.9	1.0	5.2	12.5	20.8	9.4	25.0	57.3	—	50.1	52.6	22.9	34.6	27.9	--	40.1
Nepal	262	262	13.3	20.0	49.0	5.2	1.1	10.4	26.0	9.4	27.1	46.8	44.5	42.7	43.3	21.9	27.3	25.9	35.9	33.8
Poppenheim	314	442	11.7	16.6	34.9	4.2	4.2	14.6	15.6	11.5	25.0	47.9	42.3	32.2	36.0	13.0	27.5	22.5	30.2	27.2
Minsturdi Minn.	439	1245							32.3	25.0	53.6	59.3	54.2	47.9	46.9	40.6	37.1		45.3	43.1
Ace	1853	1173							21.9	17.7	41.1	63.5	34.2	59.0	40.7	28.2	34.6		39.3	40.6
July	1563	1270										50.5	66.7	54.1	51.1	37.0	29.2		47.6	42.9
Glabron Minn.	445	1290											67.8	62.5	52.6	31.8	41.5		51.2	47.1
Comfort Minn.	451	1304											64.3	70.8	52.1	35.0	34.0		51.2	48.0
Lion x Coast	--	1342											55.8	67.7	64.6	35.4	30.4		50.8	49.5
Velvet Minn.	447	1286											79.8	51.0	50.7	33.9	35.4		50.2	42.8
Lion x Manchuria	--	1340											48.8	56.2	50.6	48.0	40.5		48.8	48.8
Svansota	1907	1285											57.7	47.9	48.5	26.1	31.5		42.3	38.5
Bonami	4664	1300												67.7	63.6	47.4	39.0			54.4
Sandrel	937	1301												68.8	62.5	41.7	40.4			53.4
Horfi	926	1299												65.6	69.3	36.5	33.8			51.3
Trebi	936	1298												69.8	69.3	28.7	34.4			50.6
White Smyrna x Svanhals	--	1344												59.4	57.3	39.1	37.3			48.3
Featherston	911	1306												57.5	62.1	30.8	35.0			46.4
Hero	1286	1303												63.5	43.3	27.1	50.0			46.0
Alpha	959	1305												54.2	66.2	25.0	31.7			44.3
(Success x Gatami) x (Arlington-awnless x Hanna)	--	1360												38.5	37.0	32.9	29.8			34.6
New Era	--	1355															27.9			

varieties are handled with less discomfort and also because of the greater value of the straw, it may be to the advantage of some producers to grow these varieties in preference to Odessa even at a slight discount in yield. The feeding value of straw from smooth-awned varieties is quite superior to that from the rough-bearded types. Figures 6 and 7 show plats of Odessa and Lion x Coast S. Dak. 1342 near Britton in the northeastern part of the state.

Odessa was again, with the exception of the two varieties previously enumerated, the highest yielder for the last period of comparison. The position of the smooth-awned varieties mentioned above is about the same as for the previous period. It is necessary on the basis of performance to add to this list of relatively high yielding smooth-awned barleys the hybrid Lion x Manchuria S. Dak. No. 1340. White and Black Gatami were again among the high yielders. Other high yielding varieties though surpassed in yield by Odessa by from 1.5 to 15.0 per cent, are Horn, Trebi, White Smyrna x Svanhals, Featherston, Hero and Alpha.

The variety test at Brookings may be summarized with the following statements. Odessa, a rough-awned six-rowed barley has shown itself to be the outstanding high yielder; it proved itself superior in yield to such rough-awned six-rowed types as Manchuria, Oderbrucker, Gatami, Minsturdi and Trebi. Glabron and Lion x Coast S. Dak. No. 1342 stand out as high yielding six-rowed smooth-awned varieties. Of the two-rowed varieties Horn gave the best yield, producing in the four years of comparison only 1.5 per cent less than Odessa. Other two-rowed varieties such

Table 6.—Average yields of barley varieties at Brookings for the years indicated expressed on a percentage basis of the yields of Odessa for the period of 1916 to 1930, inclusive.

VARIETY	S. Dak. Acc. No.	15 yrs. 1916-1930	5 yrs. 1926-1930	4 yrs. 1927-1930
Odessa	182	100.0	100.0	100.0
Oderbrucker	1180	90.1	84.1	81.2
Manchuria	105	85.2	83.2	77.9
Improved Manchuria	1338	84.8	85.0	83.9
White Gatami	889	84.4	95.3	94.2
Black Gatami	122	82.9	89.1	86.2
White Smyrna	28	77.0	73.9	75.6
Horsford	294	62.8	60.6	52.6
Gold	460	59.0	—	77.0
Nepal	262	54.8	65.5	64.9
Poppenheim	442	47.6	55.1	52.2
Minsturdi	1245		82.7	82.7
Ace	1173		71.7	77.9
July	1270		86.9	82.3
Glabron	1290		93.4	90.4
Comfort	1304		93.4	92.1
Lion x Coast	1342		92.7	95.0
Velvet	1286		91.6	82.1
Lion x Manchuria	1340		89.1	93.7
Svansota	1285		77.2	73.9
Bonami	1300			104.4
Sandrel	1301			102.5
Horn	1299			98.5
Trebi	1298			97.1
White Symrna x Svanhals	1344			92.7
Featherston	1306			89.1
Hero	1303			88.3
Alpha	1305			85.0
(Succes x Gatami) x (Arlington-awnless x Hanna)	1360			66.4

Fig. 6.—Odessa barley. This is the highest yielding variety of barley for the eastern portion of South Dakota.

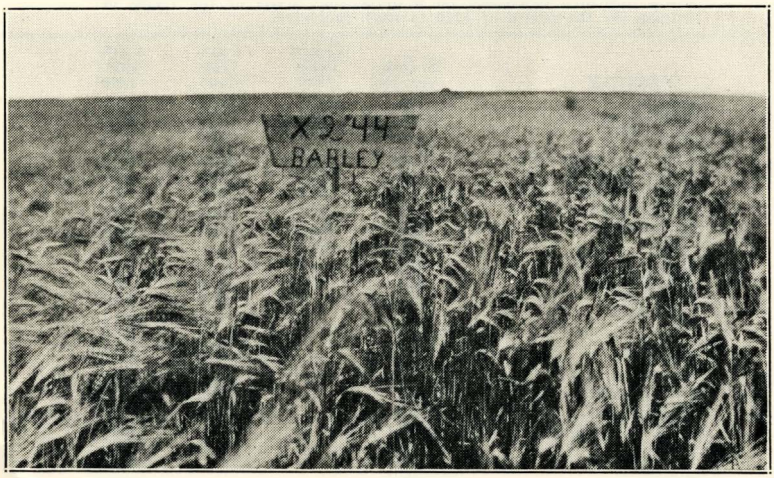

Fig. 7.—Lion x Coast S. Dak. No. 1342 barley. Nursery No. X244 .This is a relatively late maturing, high yielding, smooth-awned variety produced at the Highmore substation.

as White Smyrna, White Smyrna x Svanhals, Alpha, Ace and Svansota yielded considerably less than Odessa. Glabron was the best yielding general purpose smooth-awned variety. The beardless and hulless barleys such as Nepal, Poppenheim and (Success x Gatami) x (Arlington Awnless x Hanna) were not productive enough to be considered for general field production. New Era, another hulless variety, was tested only for one year, yielding 27.9 bushels as compared to 40.7 bushels per acre for Odessa. The yields of the hulless barleys, for sake of comparison with the hulled varieties, were calculated on the basis of 48 pounds per bushel. In comparing yields of hulled and hulless varieties it is necessary to make allowances for the presence of hulls on the former. For comparative purposes the yields of the hulless types should therefore be increased by 10 to 15 per cent, the average weight of the hulls. It will be seen that the yields of the hulless barleys even with such an allowance are considerably less than those of standard bearded hulled varieties.

The average yields of prominent varieties of barley at Brookings for a 15 and a 5 year period of comparison are presented graphically in Fig. 5.

Barley Nursery at Brookings

Table 7 gives the yields and agronomic data for varieties included in the nursery test in 1929 and 1930. The yields reported give further evidence of the yielding ability of Odessa at Brookings. In 1929, the first year of the barley nursery, Odessa was outyielded by only two varieties; namely, by a two-rowed late maturing variety, Segerkorn, and by Trebi, a coarse, rough-awned, six-rowed type. The hot dry season of 1930 was decidedly favorable to early maturing varieties. As a result the yields of Odessa, a medium maturing variety, were surpassed by 22 out of the 75 different strains grown in the nursery in that year. Not all varieties surpassing Odessa in yield in 1930 are early maturing. Exceptions are Wisconsin Barbless Ped. No. 38, Lion x Coast S. Dak. 1342, and Glabron. Of the 22 varieties surpassing Odessa in yield only six matured later than Odessa.

Too much emphasis should not be attached to a test extending over a period of only two years. It is interesting to note the relative performances of new varieties and of those previously mentioned. The nursery test gives favorable reports of such six-rowed rough-awned types at Trebi, McClymont, Han River and Peruvian. Outstanding yielders of smooth-awned varieties were Wisconsin Barbless Ped. No. 38, the rather low growing early maturing variety Hero, Lion x Manchuria S. Dak. 1340, Lion x Coast S. Dak. 1342 and Glabron. High yielding two-rowed varieties were Segerkorn and Ace. The hulless barleys, as in the variety test plats, were low producers,

Results of Variety Tests at Highmore

Table 8 gives the annual and average yields of barleys included in the variety test plats at Highmore for a 14 year period from 1917 to and including 1930. Average yields are given for varieties grown for fourteen, seven and three year periods. Table 9 gives the average yields of varieties included in the test for the given number of years on a percentage basis of the yield of Odessa.

Odessa is, as at Brookings, the outstanding yielder for the longer period of comparison. It is followed by Coast, Manchuria and White Smyrna. Horsford, a hulled and hooded, and Poppenheim, a bearded hul-

Table 7.—Yields and plant characteristics of barley varieties grown in the 1929 and 1930 barley nursery at Brookings

Rank	VARIETY	S. Dak. Acc. No.	No. of rows Awned Hooded or Smooth Awned*	1929 DATA				1930 DATA				Average yield 1929–30
				Yield in bu. per acre	Yield in % of Odessa	Days from emergence to maturity	Height of plants in inches	Yield in bu. per acre	Yield in % of Odessa	Days from emergence to maturity	Height of plants in inches	
1	Trebi	1298	6 A	57.2±2.84	102.0	77	28	38.1±2.33	108.9	76	27	47.7
2	McClymont	1346	6 A	56.0±2.78	99.8	75	28	38.7±2.37	110.6	73	29	47.4
3	Wisc. Barbless Ped. No. 38	1347	6 SA	52.7±2.62	93.8	82	32	39.5±2.42	112.9	80	30	46.1
4	Han River	1348	6 A	51.5±2.56	91.8	72	27	40.3±2.47	115.1	72	26	45.9
5	Odessa	182	6 A	56.1±2.79	100.0	76	33	35.0±2.14	100.0	75	30	45.6
6	Segerkorn	1349	2 A	58.7±2.92	104.6	79	26	32.2±1.97	92.0	80	27	45.5
7	Hero	1303	6 SA	50.1±2.49	89.3	75	26	38.4±2.35	109.7	73	23	44.3
8	Sandrel	1301	6 A	52.7±2.62	93.9	72	28	34.7±2.12	99.1	78	27	43.7
9	Ace	1173	2 A	49.6±2.47	88.4	72	24	37.1±2.27	106.0	74	23	43.4
10	Peruvian	1350	6 A	49.1±2.44	87.5	76	28	37.5±2.30	107.1	74	28	43.3
11	Lion x Manchuria	1340	6 SA	49.5±2.46	88.2	72	28	36.4±2.23	104.0	73	27	43.0
12	Lion x Coast	1342	6 SA	49.3±2.45	87.9	80	31	36.2±2.22	103.4	79	31	42.8
13	Glabron	1292	6 SA	44.1±2.19	78.6	77	35	40.8±2.50	116.6	78	32	42.5
14	White Smyrna x Svanhals	1344	2 A	47.9±2.38	85.6	72	30	36.0±2.20	102.9	72	26	42.0
15	White Gatami	889	6 A	44.0±2.19	78.4	73	30	38.4±2.34	109.7	71	30	41.1
16	Wisc. Ped. 5-1 R112	1351	6 A	48.1±2.39	85.7	77	31	35.0±2.14	100.0	79	30	41.2
17	Black Gatami	122	6 A	42.7±2.12	76.1	71	27	38.6±2.36	110.3	70	28	40.7
18	Svansota	1285	2 A	47.4±2.36	84.5	75	24	33.0±2.02	94.3	73	28	40.2
19	Bonami	1300	6 SA	47.2±2.35	84.1	74	31	33.2±2.03	94.9	74	31	40.2
20	Comfort	1304	6 SA	45.3±2.25	80.7	79	33	34.7±2.12	99.1	79	33	40.0
21	Spartan	1352	2 SA	43.9±2.11	77.9	72	31	35.5±2.17	101.4	73	28	39.7
22	Club Mariout	1353	6 A	42.9±2.12	76.5	74	24	35.0±2.14	100.0	73	25	39.0
23	Impr. Manchuria	1338	6 A	45.3±2.25	80.7	76	35	30.8±1.88	88.0	75	29	38.1
24	Horn	1299	2 A	48.7±2.42	86.8	79	31	26.9±1.65	76.9	77	29	37.8
25	Manchuria	105	6 A	39.6±1.97	70.6	76	32	34.5±2.11	98.6	77	33	37.1
26	Featherston	1306	6 A	46.5±2.31	82.9	75	31	25.4±1.55	72.6	74	30	36.0
27	July	1270	6 A	38.4±1.91	68.4	79	31	33.1±2.03	94.6	78	29	35.8
28	Minsturdi	1245	6 A	34.0±1.70	60.6	72	30	37.0±2.26	105.7	72	28	35.5
29	Velvet	1286	6 SA	45.8±2.28	81.6	76	33	25.0±1.53	71.4	79	32	35.4
30	Oderbrucker	1180	6 A	40.5±2.01	72.2	76	31	29.5±1.81	84.3	74	32	35.0
31	Gold	460	2 A	40.2±2.00	71.7	79	28	28.8±1.76	82.3	75	30	34.5
32	Alpha	1305	2 A	37.8±1.88	67.4	79	28	30.9±1.89	88.3	79	31	34.4
33	White Smyrna	28	2 A	35.8±1.78	63.8	74	23	28.1±1.72	80.3	73	23	32.0
34	Horsford	294	6 H	31.7±1.60	56.5	76	31	31.0±1.90	88.6	75	32	31.4
35	Nepal	262	6 H†	33.1±1.65	59.0	77	28	25.2±1.54	72.0	75	30	29.2
36	Hulless	1354	6 H†	30.0±1.49	53.5	76	28	27.1±1.66	77.4	79	27	28.6
37	(Success x Gatami) x (Arlington-Awnless x Hanna)	1360	6 H†	34.4±1.71	61.2	75	28	20.7±1.27	59.1	76	25	27.6
38	Poppenheim	442	2 A†	28.9±1.44	51.5	77	24	24.0±1.47	68.6	75	28	26.5

* The numbers indicate the number of rows per spike. The letters used indicate the following head characteristics. A, rough awned; SA, smooth awned; H, hooded.

† Hulless.

less type, were low yielders. Fig. 8 shows plats of Manchuria and Odessa at Highmore in 1930.

Climatic conditions during the second and also during the last period of comparison were favorable to early maturing varieties. During the second period from 1924 to 1930, the yields of Odessa were surpassed by such six-rowed rough-awned types as Coast, July, Manchuria, Oderbrucker, and

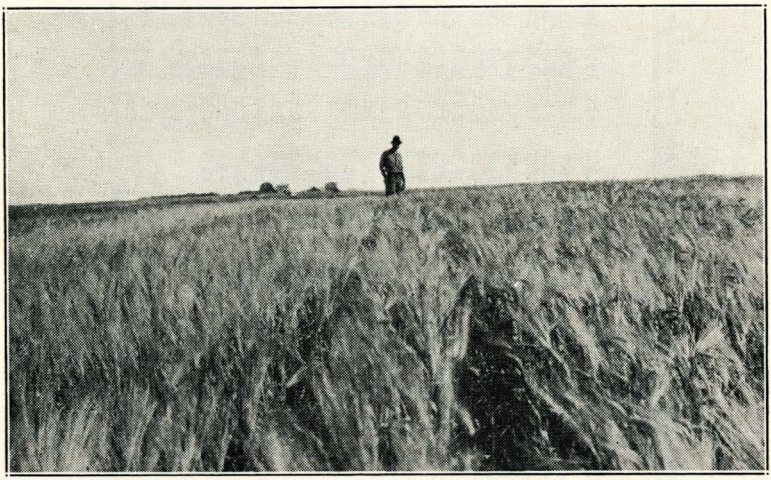

Fig. 8.—Manchuria and Odessa barley in the variety test plats at Highmore. 1930. This illustration shows the method of laying out test plats in 1930. Two drill rows are grown in the alley between the plats arranged so that each drill row in the alley is of the same variety as the plat it adjoins.

Minsturdi; by the two-rowed varieties Binder and the hybrid White Smyrna x Svanhals, and by the six-rowed smooth-awned cross Lion x Manchuria. These same varieties outyielded Odessa in the three year period of comparison, from 1928 to and including 1930. As may be seen from Table 8 the yields during this period were low, consequently the percentage differences in the average yields of the different varieties as given in Table 9 are relatively high.

The comparatively high yields of the smooth-awned types during the last period of comparison are outstanding. Lion x Manchuria S. Dak. No. 1340, Glabron, Coast x Lion S. Dak. No. 1343, Comfort, Velvet, and Lion x Coast S. Dak. No. 1342, all of them smooth-awned varieties, outyielded Odessa by 27.1, 15.1, 8.3, 6.8, 1.6, and 1.0 per cent respectively. Glabron, as at Brookings, was superior in yield and strength of straw to Velvet. The yields of the smooth-awned hybrids, Lion x Manchuria S. Dak. No. 1340 and Coast x Lion S. Dak. No. 1343, also compared favorably with those of Odessa for the seven year period of comparison from 1924–1930, inclusive. Fig. 9 shows plats of smooth-awned barleys at Highmore.

High yielding two-rowed varieties were Ace, Horn, the hybrid White Smyrna x Svanhals, and Binder. These varieties surpassed the yield of Odessa for the last period of comparison by 14.1, 13.5, 8.9, and 1.0 per cent respectively. The variety Ace is objected to because of its low growth. Horn is a fairly tall growing variety with a good strength of straw; it is

Table 8.—Annual acre yields of varieties of barley at the Highmore substation in three or more of 14 years from 1917 to 1930, inclusive.

VARIETY	C. I. or State No.	S. D. Acc. No.	ACRE YIELDS (bushels)														14-yr. av'ge 1917-1930	7-yr. av'ge 1924-1930	3-yr. av'ge 1928-1930
			1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930			
Odessa	182	182	33.8	31.3	40.6	40.6	19.8	51.1	45.8	55.0	37.5	0.	36.7	6.4	28.9	22.3	32.1	26.7	19.2
Coast	626	126	30.7	22.9	31.3	32.3	21.8	42.7	31.2	71.3	29.2	1.8	41.3	6.8	32.6	23.9	30.0	29.6	21.1
Manchuria	643	105	29.7	14.5	23.7	41.7	16.1	41.6	46.9	62.5	34.9	0.	40.2	8.6	29.5	21.5	29.4	28.2	19.9
White Smyrna	195	28	30.7	26.0	26.7	28.2	20.3	34.4	26.0	62.5	31.7	1.7	35.0	2.1	33.9	18.8	27.0	26.5	18.3
Horsford	507	294	22.6	13.0	22.9	29.2	17.2	35.4	14.6	44.0	27.1	0.	31.0	8.6	19.8	18.3	21.7	21.3	15.6
Poppenheim	314	442	17.7	17.7	21.3	19.8	10.4	19.8	16.7	32.0	26.1	0.	21.4	5.7	18.2	17.6	17.5	17.3	13.8
Oderbrucker Wisc.	6	1180			28.9	43.7	16.7	34.4	42.7	62.5	33.3	0.	41.1	9.4	28.1	21.7		28.0	19.7
Minsturdi Minn.	439	1245						36.4	28.1	64.5	25.5	0.	40.5	7.2	27.1	23.9		27.0	19.4
July	1563	1270								60.5	42.3	0.	39.6	6.7	36.5	18.7		29.2	20.6
Binder	1909	1269								62.5	39.5	0.	43.3	11.1	24.7	22.3		29.1	19.4
Lion x Manchuria	--	1340								42.7	31.7	1.2	41.8	6.0	39.1	28.0		27.2	24.4
White Smyrna x Svanhals	--	1344								43.0	41.3	3.3	38.6	1.5	35.9	25.3		27.0	20.9
Coast x Lion	--	1343								35.4	33.3	6.7	46.5	4.9	29.2	28.2		26.3	20.8
Lion x Coast	--	1342								43.8	30.7	0.	45.0	11.4	29.2	17.7		25.4	19.4
Lion x Coast	--	1341								41.0	34.3	0.	45.8	9.4	19.8	21.1		24.5	16.8
Rex	--	1268								57.0	25.0	0.	38.4	5.4	21.1	13.0		22.8	13.2
Gold x Nepal	--	1345								29.2	33.3	0.	36.5	9.0	16.4	12.5		19.6	12.6
Nepal x Manchuria	--	1339								37.0	30.7	0.	28.7	5.8	17.4	12.7		18.9	12.0
Ace	1853	1173											39.2	2.8	39.1	23.8			21.9
Svansota	1907	1285											44.1	6.8	33.6	19.5			20.0
Velvet Minn.	447	1286											47.5	10.2	21.9	26.3			19.5
Glabron Minn.	445	1292												12.7	24.3	29.3			22.1
Horn	1299	1299												12.5	27.4	25.6			21.8
Comfort Minn.	451	1304												11.3	23.4	26.9			20.5
Trebi	936	1298												8.9	18.8	23.3			17.0

a promising variety for the central part of the state. Binder is another promising variety. Next to Coast and July, it is the highest yielding variety for the seven year period of comparison from 1924 to 1930. The hybrid White Smyrna x Svanhals gave good returns both at Highmore and Eureka. Due to the fact that the last period of comparison extended over only three years, the results reported for it must be regarded with cau-

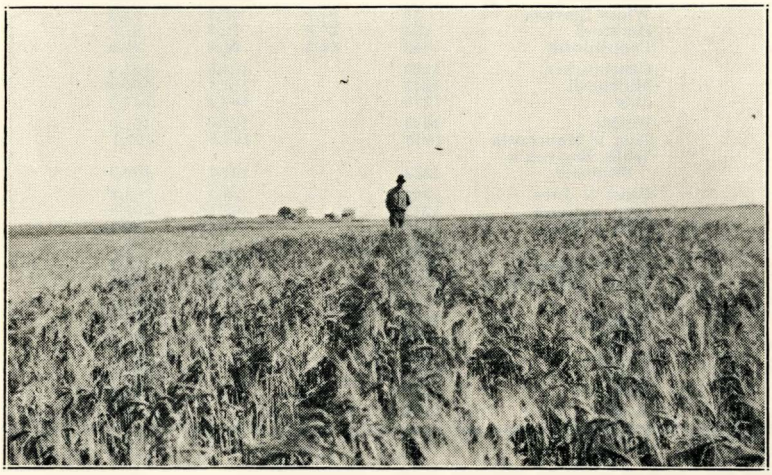

Fig. 9.—Lion x Coast S. Dak. No. 1342 and Velvet in the variety test plats at Highmore, 1930. Both of these varieties are smooth awned. Glabron, another smooth awned variety, has given better results than Velvet.

tion. When comparing varieties included in the test for the last two periods, more weight should be given to results from the seven year rather than from the three year period of comparison.

Attention is called at this time to the relative performances of two and six-rowed varieties of barley at Brookings and Highmore. At Brookings Odessa outyielded White Smyrna by 23.0, 26.1 and 24.4 per cent for the respective periods of comparison. At Highmore, Odessa, as at Brookings, outyielded White Smyrna during all periods of comparison. The differences in the yields of these two varieties were, however, much smaller at Highmore than at Brookings, amounting for the three respective periods of comparison to only 13.9, 0.7 and 4.7 per cent. Horn at Brookings was outyielded by Odessa. At Highmore Horn outyielded Odessa and other six-rowed varieties.

Table 10 shows the average yield and the degrees of variability of such yields from season to season, expressed by the coefficient of variability, of two and six-rowed barleys grown in the variety test plats at Brookings, Highmore and Eureka for a period of 21 years, 1909 to 1929, inclusive. As may be seen from Table 10, Odessa outyielded the two-rowed barley by 11.8 bushels at Brookings, but by only 4.2 bushels at Highmore, while at Eureka the six-rowed barley was outyielded by the two-rowed type by 1.7 bushels per acre. It was necessary at Eureka to make use of the yields of Hannchen instead of those of White Smyrna. With the exception of the returns at Brookings the differences in the yields of the six

Table 9.—Average yields of barley varieties at Highmore for the years indicated expressed on a percentage basis of the yields of Odessa for the period of 1917 to 1930, inclusive.

VARIETY	S. Dak. Acc. No.	14-yrs. 1917-1930	7-yrs. 1924-1930	3-yrs. 1928-1930
Odessa	182	100.0	100.0	100.0
Coast	126	93.5	110.9	109.9
Manchuria	105	91.6	105.6	103.6
White Smyrna	28	84.1	99.3	95.3
Horsford	294	67.6	79.8	81.3
Poppenheim	442	54.5	64.8	71.9
Oderbrucker	1180		104.9	102.6
Minsturdi	1245		101.1	101.0
July	1270		109.4	107.3
Binder	1269		109.0	101.0
Lion x Manchuria	1340		101.9	127.1
White Smyrna x Svanhals	1344		101.1	108.9
Coast x Lion	1343		98.5	108.3
Lion x Coast	1342		95.1	101.0
Lion x Coast	1341		91.8	87.5
Rex	1268		85.4	68.8
Gold x Nepal	1345		73.4	65.6
Nepal x Manchuria	1338		70.8	62.5
Ace	1173			114.1
Svansota	1285			104.2
Velvet	1286			101.6
Glabron	1292			115.1
Horn	1299			113.5
Comfort	1304			106.8
Trebi	1298			88.5

and two-rowed barleys are not very significant.

The differences in the yields and in the degrees of variability of these yields at the various stations are considerable. The yields per acre are lower, while the variation in such yields from season to season is greater in the central than in the eastern portions of the state. This reflects directly the greater hazards encountered in barley production in the central than in the eastern and more humid portion of South Dakota. Differences in the yields and variability in the seasonal yields of cereal crops in larger sections of the Mississippi valley and in South Dakota are analyzed by Klages (7), (8) in two recent publications. They will therefore not be discussed here. It is interesting to note at this point that the coefficient of variability of the yields of these two types of barley are lower in the central part of the state for barleys of the White Smyrna (two-rowed) than of the Manchuria (six-rowed) type. This indicates, even though the differences in the two values are not great enough to be statisticially significant, that the two-rowed barleys of the White Smyrna type, due to their earlier maturity may be more drought resistant, or in reality able to escape drought better than the six-rowed barleys like Odessa. White Smyrna will at times produce at least a partial crop under conditions too severe for the survival of Odessa. On the other hand White Smyrna lacks yielding ability under favorable conditions, consequently the lighter average returns at two of the three stations.

According to Harlan et al (3) the six-rowed barleys of the Manchuria type yield best in the eastern portion of the Great Plains area while the two-rowed barleys of the White Smyrna type are reported to do better in the western and drier portion of this area. Tables 8 and 9 show that White Smyrna is not the highest yielding variety at Highmore; it was surpassed

in yield by such taller growing two-rowed varieties as Binder and Horn. The results given above seem to indicate that the Highmore and Eureka substations are located near the border line of the two above mentioned barley regions. The yields of two and six-rowed varieties are about equal at Highmore and Eureka. At both stations the two-rowed types showed a somewhat greater consistency in yield. In the eastern part of the state, however, Odessa not only outyielded White Smyrna and other two-rowed varieties but showed also a lower degree of variability in yields than the latter type.

Table 10.—Average yields and degrees of variability of yields of two and six rowed barleys in the eastern and central portions of South Dakota for a 21 year period, 1909-1929.

	BROOKINGS		HIGHMORE		EUREKA	
Type of Barley	Average yield in bu. per acre	Coefficient of variability of yields	Average yield in bu. per acre	Coefficient of variability of yields	Average yield in bu. per acre	Coefficient of variability of yields
Six rowed*	45.1±2.74	41.19±4.96	30.5±3.12	69.38±10.12	21.5±2.55	80.26±12.66
Two rowed†	33.3±2.22	47.94±6.03	26.3±2.44	62.99±8.78	23.2±2.47	72.22±10.75
Difference in yield of six and two rowed type	+11.8		+4.2		-1.7	
Difference in coefficients of variability of yields of six and two rowed types		+6.75		-6.39		- 8.04

* Variety grown at Brookings and Highmore was Odessa; at Eureka, Manchuria from 1909-1924, Odessa from 1925-1929.

† Varieties grown were: at Brookings, Chevalier 1909-1912, White Smyrna 1912-1929; at Highmore White Smyrna, 1909-1929; at Eureka, Hannchen 1909-1929.

Results of Variety Tests at Eureka

The relative performances at Eureka of Hannchen, a two-rowed barley, and Manchuria and Odessa, six-rowed varieties, are given in Table 10. Over a 16 year period, 1909 to 1924, Hannchen yielded 26.1 as against 24.4 bushels per acre for Manchuria. Over the five year period from 1925 to and including 1929 with two complete failures, Hannchen yielded 14.2 bushels as compared to 12.3 bushels for Odessa. There was a complete crop failure in 1926 due to drought and another failure in 1928 due to hail.

Table 11 gives the annual and average yields of varieties of barley included in the variety test plats at Eureka for a period of four years, 1927 to 1930. Velvet, a smooth-awned variety, produced the highest average yield, followed closely by the early maturing hybrid White Smyrna x Svanhals, Odessa, and the late maturing smooth-awned hybrid Lion x Coast.

Deductions to be drawn from the limited tests at Eureka are that Hannchen is a good variety for the north-central portion of the state. Velvet and no doubt Glabron, since it has given even better results than Velvet at Highmore and also at Brookings, are good smooth-awned varieties. The hybrid White Smyrna x Svanhals looks promising. This variety also gave good results at Highmore. Lion x Coast, S. Dak. No. 1342, is too late for the north-central portion of the state.

Barley Varieties Tested at Cottonwood

No definite variety tests on barley can be reported at this time. Two

Table 11.—Annual and average yields of barley varieties tested at Eureka

VARIETY	S. Dak. Acc. No.	ACRE YIELDS (bushels) 1927	1928	1929	1930	4-yr. average
Velvet	1286	54.5	0.	17.3	21.5	23.3
White Smyrna x Svanhals	1344	60.0	0.	14.3	17.0	22.8
Odessa	182	49.6	0.	15.7	24.3	22.4
Lion x Coast	1342	52.1	0.	13.3	18.2	20.9

varieties, Odessa and Black Gatami, have been grown, but since they were grown on two different rotations the yields cannot be used for direct comparison. The yields of Black Gatami from the rate of seeding tests are presented in Table 4. Due to lack of moisture an early maturing type of barley like Gatami is to be recommended over the later maturing Manchuria type of barley. Two-rowed varieties such as White Smyrna and Ace merit testing on the dry lands in the far western portion of the state. The criticism of these varieties is that the straw is too short. With the employment of the combine in the harvesting of cereals this shortcoming of these varieties is not so serious as when the binder is used.

Results of 1930 Cooperative Barley Variety Tests

Through the courtesy of farmers enumerated in Table 12 it was possible for the Experiment Station cooperating with the Extension agronomist to grow on their farms, plats of barley of the varieties indicated. Fig. 10 shows one of these cooperative barley variety test plats on the J. J. Wallace farm near Britton.

It will be seen from Table 12 that Trebi was the highest yielding variety in the three tests where it was included. Odessa gave a good account of itself in all of the test plats. The smooth awned barleys Glabron and Velvet, yielded less than Odessa in these tests in the northeastern portion of the state. This agrees with the relative performances of these types at Brookings. The hybrid Lion x Coast, a smooth-awned variety, outyielded Odessa in the one test where it was included. The variety designated "Local Variety" in the test on the J. J. Wallace farm was a six-

Table 12.—Results of cooperative barley variety tests—1930

VARIETY	S. Dak. Acc. No.	PLACE TESTED	Yield in bu. per acre	Yield in per cent of the yield of Odessa
1 Trebi	1298	F. J. McHugh farm Ordway	68.4	122.1
2 Odessa	182	" " " " "	56.0	100.0
3 Velvet	1286	" " " " "	48.5	86.6
4 New Era	1355	" " " " "	43.7	78.0
1 Local Variety		J. J. Wallace farm Britton	22.8	111.8
2 Trebi	1298	" " " " "	22.8	111.8
3 Lion x Coast	1342	" " " " "	22.5	110.3
4 Odessa	182	" " " " "	20.4	100.0
5 Velvet	1286	" " " " "	19.1	93.6
6 New Era	1355	" " " " "	15.5	76.0
1 Trebi	1298	T. C. Wenz farm Bath	37.7	115.3
2 Odessa	182	" " " " "	32.7	100.0
3 New Era	1355	" " " " "	20.0	61.2
1 Odessa	182	T. C. Wenz farm Bath	29.9	100.0
2 Glabron	1290	" " " " "	25.5	85.3

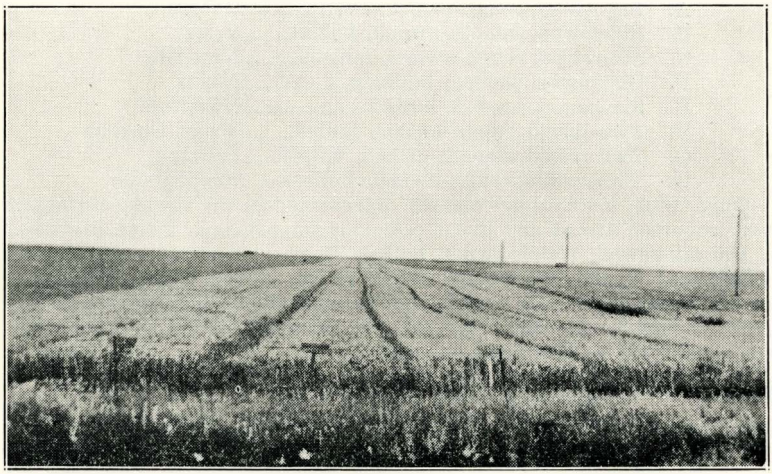

Fig. 10.—View of the cooperative barley variety test plats on the J. .I. Wallace farm near Britton, S. Dak., 1930.

rowed rough-awned barley like Odessa. New Era yielded substantially less than Odessa. Even with an addition of 10 to 15 per cent to the yield of this variety, due to the absence of hulls, it does not come up to Odessa in performance.

Since the results given in Table 12 are for one season only, too much attention should not be attached to them. Nevertheless, they indicate that Trebi is a high yielding variety in the northeastern portion of the state, that Odessa is well adapted and tends to yield somewhat more than the smooth-awned varieties like Glabron and Velvet. Trebi is a coarse, harsh-bearded variety producing grain of a lower quality than Odessa. The trade objects to it on account of the hard kernels, frequent presence of beards in the threshed grain and the relatively high percentage of hull it caries. It yields less than Odessa at Brookings and Highmore. It is in need of further testing in the northeastern counties. Stoa (11) of the North Dakota Agricultural Experiment Station reports high yields for Trebi in the eastern portion of that state. Wilson and Arny (12) of the Minnesota Agricultural Experiment Station also report high yields for Trebi from tests in Minnesota. These last two investigators point out that Trebi is "susceptible to disease, particularly the spot blotch disease caused by Helminthosporium sativum." This disease is also found in the eastern portion of South Dakota.

Classification, Source, Description, Adaptation, and Utilization of Barley Varieties Tested

The varieties to be discussed are grouped into classes based on head characteristics. The classes used, together with a type variety of each class are as follows:

Classes	Type Variety
A. Six-rowed, rough-awned, hulled	Odessa
B. Six-rowed, smooth-awned, hulled	Velvet
C. Six-rowed, rough-awned, hulless	New Era
D. Six-rowed, hooded, hulless	Nepal
E. Six-rowed, hooded, hulled	Horsford
F. Two-rowed, rough-awned, hulled	White Smyrna
G. Two-rowed, smooth-awned, hulled	Spartan
H. Two-rowed, rough-awned, hulless	Poppenheim

Only three of the above classes represented in the variety tests previously reported are of any great economic importance. These are classes A, the six-rowed, rough-awned hulled; B, the six-rowed, smooth-awned hulled; and F, the two-rowed, rough-awned, hulled types. Hulless and hooded barleys have not shown high enough yields to justify their being grown except for special purposes. The varieties falling into the respective clesses will be discussed separately.

A. Six-rowed awned hulled types.

1. **Odessa, S. Dak. Acc. No. 182, C. I. No. 182.**—Odessa belongs to the same general group as Manchuria. Imported by the United States Department of Agriculture from southern Russia. Obtained from the Bureau of Plant Industry in 1912. This is the best general purpose variety for South Dakota. It does especially well in the eastern portion of the state, as indicated by its uniformly high yields at Brookings. Odessa has also given good yields in the central part of the state. Its yields are, however, not so outstanding there as in the eastern portion of the state.
2. **Manchuria, S. Dak. Acc. No. 105, C. I. No. 244.**—This variety originated, according to the best reports available, in the humid plains of eastern Manchuria. Obtained from the Minnesota station in 1912. Manchuria is similar to Odessa but has weaker straw and does not yield as well in the eastern part of the state. In the central part of the state, as indicated by the yields at Highmore, Manchuria yields as well as Odessa.
3. **Improved Manchuria, S. Dak. No. 1338.**—A selection from Manchuria. It does not differ materially in characteristics or yielding ability from Manchuria.
4. **Oberbrucker, S. Dak. Acc. No. 1180, Wisc. No. 6.**—Originated as a plant selection from Manchuria. Obtained from the Wisconsin station in 1919. Very similar to Odessa and Manchuria with slightly better strength of straw than these two varieties. Oderbrucker yielded somewhat better than Odessa at Highmore but materially less than this variety at Brookings. A good six-rowed variety for for the central part of the state.
5. **Minsturdi, S. Dak. Acc. No. 1245, Minn. No. 439.**— Produced from a cross of South African x Manchuria by the Minnesota station. Obtained from the Minnesota station in 1922. Minsturdi is a stiff-strawed dense-headed type. Inferior to Odessa in yield at Brookings but yielded as well as this variety at Highmore. Recommended on heavy lands where there is danger of lodging. Minsturdi is very susceptible to barley stripe disease.
6. **Featherston, S. Dak. Acc. No. 1306, C. I. No. 911.**—A Manchuria type of barley inferior in yielding ability and strength of straw to

Odessa. Obtained from the New York, Cornell station in 1927. Not recommended.

7. **Sandrel, S. Dak. Acc. No. 1301, C. I. No. 937.**—This variety was selected from a bulk lot of seed from Moravia by the United States Department of Agriculture. Seed was obtained in 1927. A weak strawed low growing variety, not recommended even though its yields at Brookings were slightly higher than those of Odessa.
8. **July, S. Dak. Acc. No. 1270, C. I. No. 1563.**—Obtained from the Holtegaard Experimental Farm, Denmark, in 1927. July is a weak-strawed medium maturing variety inferior in yield to Odessa at Brookings. It produced good yields at Highmore. Not recommended on account of lack of strength in straw.
9. **Black Gatami, S. Dak. Acc. No. 122, C. I. No. 575.**—Probably introduced from Manchuria. Obtained from the Wyoming station in 1912. Black Gatami is an early maturing, black grained, easily shattering, weak strawed variety. It is a good yielder, especially in dry season. Not recommended for the eastern half of the state. It has given good returns at Cottonwood in the far western portion of the state and is recommended for that section.
10. **White Gatami, S. Dak. Acc. No. 889, C. I. No. 920.**—Obtained from the Dickinson, N. Dak., Field station in 1924. Like Black Gatami except that the kernels are white and that the straw is stronger. White Gatami yielded slightly better than the Black Gatami.
11. **Coast, S. Dak. Acc. No. 126, C. I. No. 626.**—This variety is also known under the names of California Feed and Bay Brewing. It is of north African origin. Obtained from the California station in 1912. Coast was grown at Highmore only. In the first period of comparison comprising 14 years it was surpassed in yield by Odessa by 6.5 per cent. In the second period of comparison extending over seven years, Coast yielded 10.9 per cent more than Odessa. The grain is of rather low quality as compared with that of Odessa. The percentage of hull is high. The straw is shorter than that of Odessa or Manchuria. Coast is not recommended because of the shorter straw, lower quality of grain produced and longer, coarser beards found on this variety as compared with Odessa or Manchuria.
12. **Trebi, S. Dak. Acc. No. 1298, C. I. No. 936.**—This variety is also known in this state as "Canadian barley." Seed was in many cases imported from Canada. Trebi originated from a plant selection made from barley imported in 1905 by the United States Department of Agriculture from Asiatic Turkey. Trebi is similar in appearance and general characteristics to Coast and is objected to for the same reasons as that variety. The straw of Trebi is rather short and soft. Trebi is very susceptible to the spot blotch disease of barley. It yielded less than Odessa in the variety test plats at Brookings and Highmore. The differences in the yields of Trebi and Odessa in the nursery at Brookings were not great enough to be significant. Due to hard kernels and slow rate of germination, this variety as well as barleys containing admixtures of Trebi are objected to by the malting trade. Preliminary feeding tests with Trebi have given good results. This variety should be grown for feed only.
13. **Wisconsin Pedigree No. 5–1. R 112, S. Dak. Acc. No. 1351.**—Ob-

tained from the Wisconsin station in 1929. A Manchuria type of barley yielding less than Odessa. Grown in the nursery only.

14. **McClymont, S. Dak. Acc. No. 1346, C. I. No. 2126.**—Obtained from the Nebraska station in 1929. Introduced from Russia. Similar to Odessa but has shorter and weaker straw. Yields were not significantly different than those of Odessa. Grown in the nursery only.
15. **Han River, S. Dak. Acc. No. 1348, C. I. No. 206.**—Obtained from the Idaho station in 1929. Introduced from China. A promising early maturing stiff strawed variety. Yields were equal to those of Odessa. This variety was grown in the nursery only; it requires further testing.
16. **Peruvian, S. Dak. Acc. No. 1350, C. I. No. 935.**—A promising barley of the Coast type obtained from the Idaho station in 1929. Grown in the nursery only; requires further testing.
17. **Club Mariout, S. Dak. Acc. No. 1353, C. I. No. 261.**—Imported from Egypt. Obtained in 1929 from the Nebraska station. An early maturing barley with a dense head. It has been grown in the nursery only and is in need of further testing.

B. Six-rowed, smooth awned hulled types.

1. **Glabron, S. Dak. Acc. No. 1290, Minn. No. 445.**—Developed by the Minnesota station from a cross between a smooth-awned selection and Manchuria. Obtained from the Minnesota station in 1926. This is the best smooth-awned variety now available. It is of medium maturity and has a strong straw. Glabron yielded less than Odessa at Brookings but more than this variety at Highmore for a three year period of comparison.
2. **Velvet, S. Dak. Acc. No. 1286, Minn. No. 447.**—Developed by the Minnesota station from a cross between a smooth-awned selection and Luth. Obtained from the Minnesota station in 1926. This variety is similar to Glabron but has weaker straw. Glabron yielded slightly higher than Velvet and because of this and the stronger straw is more desirable.
3. **Comfort, S. Dak. Acc. No. 1304, Minn. No. 451.**—Developed by the Minnesota station from a cross between a smooth-awned selection and Luth. Obtained from the Minnesota station in 1926. Comfort is similar to Glabron but does not yield quite as high and does not have as good a strength of straw.
4. **Bonami, S. Dak. Acc. No. 1300, C. I. No. 4664.**—This variety was obtained from the United States Department of Agriculture in 1927. It has given high yields in the four years tested at Brookings. Since the beards are not so smooth as those of Glabron or Velvet it is not as desirable.
5. **Hero, S. Dak. Acc. No. 1303, C. I. No. 1286.**—Developed from a cross between Club Mariout and Lion. Obtained from the United States Department of Agriculture in 1927. Hero is a low growing, weak strawed, early maturing variety. Not recommended because of its short weak straw.
6. **Lion x Manchuria, S. Dak. No. 1340, Nursery No. X242.**—A hybrid produced at the Highmore substation. This is the highest yielding smooth-awned barley at Highmore. It is medium to early in maturity and has a midstrong to strong straw. Not as desirable as Glabron in the eastern part of the state.

7. **Lion x Coast, S. Dak. No. 1341, Nursery No. X243.**—A hybrid produced at the Highmore substation. It is too late for conditions in the central part of the state..
8. **Lion x Coast, S. Dak. No. 1342, Nursery No. X244.**—A hybrid produced at the Highmore substation. A high yielding, fairly early turing variety with midstrong straw that has given good yields at Brookings and Highmore.
9. **Coast x Lion, S. Dak. No. 1343, Nursery No. X245.**—A hybrid produced at the Highmore substation. A tall growing, rather late mamaturing variety with a purple straw of good strength. The nerves on the lemma are purple. This is a promising variety for the central part of the state.

C. Six-rowed, rough awned, hulless types.

1. **Nepal x Manchuria, S. Dak. No. 1345, Nursery No. X 238.**—A hybrid produced at Highmore. Low yielding, not recommended.
2. **New Era, S. Dak. No. 1355, Nursery No. X239.**—A hybrid produced by E. S. McFadden. Does not yield as much as Odessa. May be grown where an early hulless variety is desired for hogging off purposes.

D. Six-rowed, hooded, hulless types.

1. **Nepal, S. Dak. Acc. No. 262, C. I. No. 262.**—Probably imported from India. Obtained from the Newell Field station in 1912. This variety was grown at Brookings only. The yields are too low to compete with Odessa.
2. **(Success x Gatami) x (Arlington Awn-less x Hanna), S. Dak. No. 1360, Nursery No. X256.**—A hybrid produced at the Highmore substation similar to Nepal in appearance and yield.
3. **Hulless, S. Dak. Acc. No. 1354.**—Obtained from the Nebraska Station in 1929. Grown in the nursery only where it yielded less than Nepal.

E. Six-rowed, hooded, hulled types.

1. **Horsford, S. Dak. Acc. No. 294, C. I. No. 507.**—Resulted from a cross of Nepal on a six-row beared variety. Obtained from the Bureau of Plant Industry in 1913. A low yielding variety, not recommended.

F. Two-rowed, rough awned types.

1. **White Smyrna, S. Dak. Acc. No. 28, C. I. No. 195.**—Imported from Smyrna, Asia Minor, in 1901. The original seed for the test plats was obtained from Fresno, California, in 1912. White Smyrna is a drought resistant, early maturing variety with rather short and weak straw. The heads when fully emerged usually remain about half inclosed in the boot. White Smyrna yielded around 25 per cent less than Odessa at Brookings. At Highmore the yields were close to those of Odessa. They were surpassed, however, by those of such varieties as Binder, Horn, Ace and White Smyrna x Svanhals. White Smyrna, because of its drought resistance, is recommended for the far western portion of the state. In the central part of the state it is possible to grow higher yielding varieties with longer and stronger straw.

2. Ace, S. Dak. No. 1173, C. I. No. 1853.—A selection from White Smyrna made at the Highmore substation in 1915. Ace is very similar to White Smyrna; it is slightly taller and has a somewhat stronger straw. The yields of Ace at Highmore for a three year period were considerably higher than those of White Smyrna. At Brookings the yields of these two varieties were about the same. Ace, like White Smyrna, has too short a straw to be desirable for general field production. It is recommended for the drier far western portion of the state.
3. Horn, S. Dak. Acc. No. 1299, C. I. No. 926.—A plant selected from seed originally imported by the United States Department of Agriculture from Austria. A barley of the Chevalier group, with good length and strength of straw. The stems and also the heads are rather slender. It has given good yields at both Brookings and Highmore. It was one of the highest yielding varieties at the latter station for a three year period of comparison. This variety is in need of further testing in the central part of the state.
4. Hannchen, S. Dak. Acc. No. 20, C. I. No. 531.—Developed by the Svalof Plant Breeding association, Svalof, Sweden. A variety of the Hanna type with rather good length of straw. The straw is slender and under adverse weather conditions subject to lodging. This variety has given good results at Eureka and is recommended for the north central portion of the state.
5. White Smyrna x Svanhals, S. Dak. Acc. No. 1344.—A hybrid obtained from the Minnesota station in 1919. It is similar in appearance to Svansota except that the heads are broader. The straw is of fair length and midstrong. This hybrid has given outstanding results at Eureka and has yielded well in comparison with other varieties at Highmore.
6. Svansota, S. Dak. Acc. No. 1285, C. I. No. 1907.—Developed by the Minnesota station from a cross between U. S. Dept. No. 456 and Svanhals. Obtained from the Minnesota station in 1926. A variety with medium length to short midstrong straw. It produced good yields at Highmore. At Brookings it was a low yielder. In the central part of the state it did not yield as well as White Smyrna x Svanhals or Horn.
7. Alpha, S. Dak. Acc. No. 1305, C. I. No. 959.—A two-rowed selection from a cross between Manchuria and Champion of Vermont, made at the Minnesota station. Alpha is similar in appearance to Horn but yielded less than that variety.
8. Gold, S. Dak. Acc. No. 460, C. I. No. 1145.—Introduced from the Svalof Plant Breeding station, Svalof, Sweden. Gold is a barley of the Hanna type. It yielded less than Horn or Alpha.
9. Binder, S. Dak. Acc. No. 1269, C. I. No. 1909.—Obtained from the Holtegaard Experimental Farm, Denmark, in 1924. A variety of the Chevalier group with a good length and fair strength of straw. Binder was surpassed in yield over a seven year period of comparison at Highmore by only two out of 18 competing varieties, and these two, Coast and July, had objectionable characteristics as has already been indicated. Recommended for the central part of the state.
10. Rex, S. Dak. Acc. No. 1268.—Obtained from the Holtegaard Experimental Farm, Denmark, in 1924. Similar to Binder but later in

maturity, consequently not so well adapted to conditions in the central part of the state. This is substantiated by its much lower yields at Highmore.

11. **Segerkorn, S. Dak. Acc. No. 1349.**—Obtained from Mr. G. Svensson of Ethan, S. Dak., in 1928. Mr. Svensson obtained the seed from the Svalof Plant Breeding station, Svalof, Sweden, in 1927. This variety was grown in the nursery only. It is a late maturing high yielding variety of medium height. It requires further testing.

G. Two-rowed, smooth awned types.

1. **Spartan, S. Dak. Acc. No. 1352.**—Developed by the Michigan station as a result of a cross between Michigan Black Barbless and Michigan Two-row barleys. Obtained from the Nebraska station in 1929. Spartan has been tested in the nursery only. It is an early maturing variety with purple straw of good height and strength It requires further testing.

H. Two-rowed, rough awned, hulless types.

1. **Poppenheim, S. Dak. Acc. No. 442, C. I. No. 314.**—Obtained from the Bureau of Plant Industry in 1913. Not recommended because of low yielding ability.
2. **Gold x Nepal, S. Dak. No. 1345, Nursery No. X248.**—A hybrid similar in appearance to Poppenheim produced at the Highmore substation, not recommended because of low yielding ability.

Barley Diseases

Covered Smut. (Ustilago hordei).—Covered smut is recognized by the occurrence of black masses of spores in the place of kernels at heading time. These aggregates of spores, known as smut balls, are covered by thin membranes which serve to hold them together. During harvesting operations and in the course of the handling of the grain many of these smut balls break, liberating the spores they contain to be distributed throughout the grain. The disease is carried over from season to season in the form of these spores. The spores upon the planting of the kernels to which they are attached infect the seedling at the time of germination.

The first step in treating barley or any of the other cereals for covered smut is to run the grain over a fanning mill with a good blast of air for the purpose of removing the smut balls. Since they are lighter than the grain they can be quite effectively removed by this method. A more effective way of removing the smut balls is by floating them off. This is accomplished by immersing the barley in a vat with the formaldehyde solution used in treating the grain. With stirring, the smut balls and light kernels come to the top where they may be skimmed off. It is essential to successful treatment that all the smut balls be removed. The formaldehyde treatment kills only spores adhering to the kernels; the solution used does not penetrate the smut balls. Unless they are removed, a large enough number of them may break in the handling of the seed after treatment and during seeding to reinfect the treated grain.

With the precautions pointed out, covered smut of barley can be fully controlled by means of the formaldehyde treatment. This treatment is applied by either immersing the grain or sprinkling it and shoveling it

over so that each kernel is moistened with a solution made up of one pint of formaldehyde to 40 gallons of water. If the immersion method is used the excess water should be drained off after the grain has been in the solution for two hours. After the grain has been treated it should be put in a pile so that the excess water can drain off, and covered with a canvas or with sacks for from 4 to 8 hours. After that it should be sacked up and planted immediately. The immersion method is recommended over the sprinkling method in that it permits floating off of smut balls, and insures a better penetration of the solution to covered spores.

A dust treatment has been used with success in the last few years. In this method the seed is thoroughly covered with "Ceresan" dust. Three ounces of the dust are mixed with one bushel of the grain with the aid of a dusting machine. Such a machine can be readily constructed by putting dividing boards in a barrel and mounting it so that it can be rotated. Where large quantities of grain are to be dusted a concrete mixer may be used. There are on the market at the present time special dusting machines. Complete covering of the grain is essential to success. Do not attempt to mix the dust with the grain by shoveling. The dust is poisonous and should not be inhaled. Treated grain should not be fed to livestock.

Ceresan dust will control not only covered smut but also the barley stripe disease. Another advantage of the Ceresan dust method over the formaldehyde treatment is that the grain can be treated in advance of the time of seeding without injuring its germination. Grain treated with formaldehyde should be sown not later than one day after having been treated.

The copper carbonate dust treatment commonly used for the control of covered smut of wheat may be used to advantage in the treatment of covered smut of hulless barley. It is not, however, effective for the control of smut in the common hulled barleys.

Loose Smut. (Ustilago nuda).—Loose smut differs from covered smut in that the masses of spores which replace the kernels are inclosed by a thinner membrane which breaks soon after the smutted heads come out of the boot and coincident with the heading of healthy plants. After the smut spores are dispersed there remains only the rachis, the central portion of the head. In covered smut most of the smut balls remain intact until harvest time. To the touch, masses of spores of loose smut before dispersion, have a soft, velvety feeling as contrasted to a rather hard, granular feeling in the case of covered smut.

Since these two kinds of smut require different treatments it is important to distinguish between them. In the case of covered smut the causal organism is carried over from season to season on the surfaces of infected seeds. Consequently any treatment disinfecting the surfaces of these seeds is effective in controlling the disease. In the case of loose smut, infection takes place at the time of heading. The fungus from one of the masses of spores previously described comes in contact with a developing seed, grows into it and establishes itself there. Kernels thus infected cannot be distinguished from healthy ones. Since the fungus is on the inside of the seed it is quite out of reach of treatments disinfecting the outside of kernels only. The fungus in the kernel resumes activity with the germination of the grain, grows up in the plant and produces spores at heading time.

The modified hot water treatment is the only method known for controlling this disease. The grain to be treated is soaked in water at room

temperature for from 5 to 7 hours. It should be in small lots such as in sacks half full so that the temperature of the mass can be brought up to the desired point in a short time. The grain is then dipped momentarily in water of a temperature of 120° F and is then soaked in a second vat for a period of 13 minutes in water of a temperature of 126° F. The preliminary dipping in the first vat is for the purpose of raising the temperature of the barley so that the temperature of the water in the second vat may be kept more uniform. The temperature of the water in which the grain is soaked should not fall below 124° F and should at no time exceed 129° F. If the temperature drops below 124° F it is not high enough to kill the fungus; if, on the other hand, it exceeds 129° F the germination of the grain is impaired. Since this method is tedious it should be used in connection with a seed plot, enough seed being treated for the planting of a plot large enough to provide seed for the next year's field planting. Care must of course be taken to locate the seed plot at some distance from other barley to prevent reinfection. Considerable loose smut has been observed in South Dakota barley fields. In places the loss due to it amounts to as high as 10 per cent of the crop.

Stem Rust. (Puccinia graminis).—Stem rust may be recognized by the occurrence of elongated orange red spots, called pustules, filled with spores, on the stems and also on the leaves of plants. The same organism attacking wheat also attacks barley but rarely does as much damage to it as to wheat. There is no direct method of control. Some varieties show a greater degree of resistance than others. Early maturing varieties escape damage better than late maturing ones. Early seeding will also help to reduce loss from this disease.

Leaf Rust. (Puccinia simplex).—Leaf rust of barley does comparatively little damage. The pustules are found on the leaves and stems of plants. They are much smaller than those of stem rust and are round rather than elongated.

Stripe Disease. (Helminthosporium gramineum).—Stripe disease, as the name indicates, is recognized by the occurrence of yellowish brown stripes on the blades of the plants. In the case of severe attacks plants may die prematurely. This disease is rather common in the eastern portion of the state. Ceresan dust, the same material recommended for the control of covered smut, offers the best means of control. The formaldehyde sprinkling method is not effective for the control of this disease. It may be controlled rather effectively by soaking the grain two hours in a formaldehyde solution of the same strength as recommended for covered smut. This is not so convenient as the dusting method and is likely to result in greater damage to the seed.

Spot Blotch. (Helminthosporium sativum).—This disease is similar to barley stripe. Brown spots appear on the leaves, stems, and kernels. In severe cases the leaves may be killed; usually, however, the disease does not progress that far. Barley stripe, since the causal organism is carried over from season to season on the kernels, is easily controlled by means of seed treatment. The fungus causing spot blotch and also net blotch lives over from one season to another in the soil as well as on the seed. These two diseases can therefore not be controlled entirely by seed treatment. Seed treatments will kill the fungi on the seeds but will of course not have any effect on the spores living over in the soil. The growing of the barley crop in a rotation and the use of resistant varieties offers the best means of control. Trebi is very susceptible to spot blotch while Manchuria and Odessa are quite resistant to it.

Net Blotch. (Helminthosporium teres).—Net blotch is very similar to spot blotch except that a network of fine brown lines is found around the narrow outer yellowish colored margin of diseased areas. The fungus causing this disease lives over in the soil as well as on the seed of affected plants.

Scab. (Gibberella saubinettii).—The presence of this disease is recognized by the occurrence of a dense pink to red fungus growth on individual spikelets, or parts of the head, or over the entire head soon after flowering. It is observed in threshed grain by a brownish discoloration near the base of the kernels and a dusty gray color over the other parts. In severe cases the kernels are more or less shrunken and covered with pink to red masses of fungus growths or by scattered masses of black winter spores. Usually the disease attacks the plants after or about the time of heading, producing the above described head blight. If scabbed seed is sown the organism may under favorable climatic conditions attack young plants and produce seedling blight. Blighting may occur before the emergence of the seedling, resulting in a poor stand. Scab is a wet season disease. It has been found in moist seasons in the eastern and especially in the southeastern portion of the state. If any appreciable number of scabbed kernels are found in the grain it becomes unpalatable to livestock.

The disease producing organism is carried over from season to season on the seed as well as on organic matter in the soil, especially on corn stalks. Seedling blight can be prevented by the Ceresan dust treatment, described under control measures for covered smut. Head blight cannot be controlled by seed treatment alone. Scabby kernels can and should be removed from seed; this can be accomplished, since they are lighter than healthy kernels, by running the seed over a fanning mill with a good draft of air. Where barley, or other cereals follow corn in sections where scab is prevalent, it is necessary to cover completely all the corn stalks in plowing. Clean plowing has been found the best means of control. Fortunately scab is not very common over the state at this time; consequently the precautions relative to the plowing of corn land need not be taken. except in sections where this disease is prevalent. It is good practice, however, to clean seed thoroughly and to treat it with Ceresan dust regardless of whether scab is present in the fields or not. Ceresan controls not only seedling blight but also covered smut and the barley stripe disease.

Ergot. (Claviceps purpurea).—This disease manifests itself by the production of dark elongated shank like projections from parts of heads in place of one or more of the kernels. Ergot is common on rye but is found also on barley. It is controlled effectively by the use of ergot free seed. Where this is not available the ergotized seed may be removed by means of a fanning mill. A more certain way of removing these ergotized seeds is by floating them off in a 20 per cent salt solution, made by dissolving 40 pounds of common salt in 25 gallons of water. When the grain is immersed in this solution ergotized and light kernels will with stirring come to the surface where they can be skimmed off. The grain must be washed after immersion in order to remove all traces of the salt, otherwise serious injury to germination may result. Usually it is possible to obtain seed not affected with ergot, thus making it unnecessary to go through with this treatment.

SUMMARY

Barley ranks next to corn and oats in importance as a feed crop in South Dakota. Its production is increasing. This increase may well proceed at the expense of acreage now devoted to oats production. Barley will on most farms yield more feed per acre than can be obtained with oats.

Barley is an important crop over the eastern half of South Dakota with production centered in the east-central portion of the state.

More actual feed per acre was produced at Brookings and at the Highmore, Eureka, Cottonwood and Vivian substations by barley than by oats.

Since barley production fits well into the now prevailing systems of cropping, a shift to less oats and more barley can, in view of the greater value per acre of the crop, be made to advantage on many farms.

For maximum yields barley should be seeded about the middle of April. Delays beyond that date will in most seasons result in decreased yields.

The best rates of seeding barley are six pecks in the eastern part, five pecks in the central and four pecks per acre in the far western part of the state.

The use of good seed of superior and proved varieties offers the best means available to the producer of increasing yields at very little cost.

Odessa, a rough-awned, six-rowed type, is the highest yielding variety for the eastern third of the state. It has proved itself superior in yielding ability to such other commonly used six-rowed rough-awned varieties as Manchuria, Oderbrucker, Minsturdi, Gatami, and Trebi. Glabron and Lion x Coast, S. Dak. No. 1342, stand out as desirable and high yielding six-rowed smooth-awned varieties. The yields of these smooth-awned varieties in the eastern part of the state were somewhat less than those of Odessa. Two-rowed varieties yield decidedly less in the eastern part of South Dakota than six-rowed types.

In the central part of the state, as indicated by the yields at Highmore, two-rowed varieties such as Binder, Horn, White Smyrna x Svanhals and Ace yield about as much as six-rowed types. Manchuria and Oderbrucker gave as good yields as Odessa in this section. For a three year period of comparison, Odessa was outyielded at Highmore by such smooth-awned varieties as Lion x Manchuria, S. Dak. No. 1340, Glabron, Coast x Lion S. Dak. No. 1343 Velvet and Comfort. The yields of the smooth-awned hybrids Coast x Lion S. Dak. No. 1343, and Lion x Manchuria, S. Dak. No. 1340, also compare favorably with those of Odessa for a seven year period.

Good varieties for the north-central portion of the state as indicated by the yields of varieties tested at Eureka are Odessa, the hybrid White Smyrna x Svanhals, and Velvet.

Gatami, Ace and White Smyrna are good varieties for the far western portion of the state.

Due to their low yielding ability and generally weak straw, hulless and hooded varieties of barley are not recommended for general field production.

Dusting of seed with Ceresan dust, an organic mercury product, offers the best means of combating seed borne diseases of barley insofar as it can be easily applied and is effective in the control of not only covered smut but also of the barley stripe disease and seedling blight.

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