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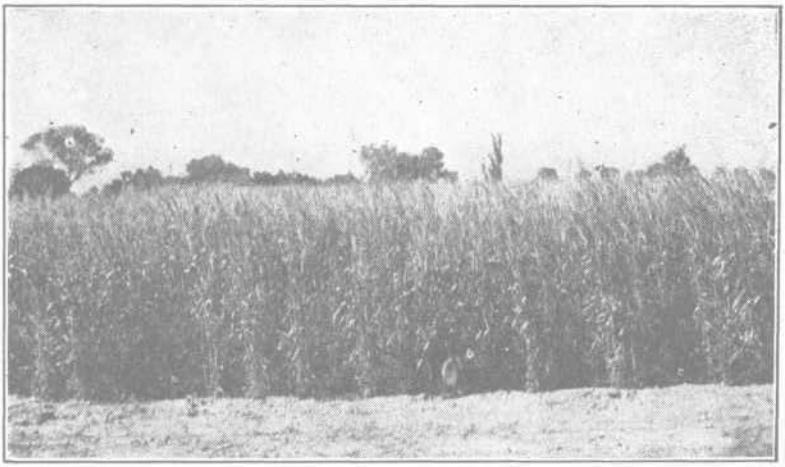
EXPERIMENTS WITH SMALL GRAINS IN SOUTHERN ARIZONA

By IAN A. BRIGGS AND R. S. HAWKINS



Early Baart wheat. Salt River Valley Experiment Farm.

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By IAN A. BRIGGS AND R. S. HAWKINS *

INTRODUCTION

Small grains occupy third place in importance among the field crops of Arizona; they are outranked by both cotton and hay. Wheat alone ranks with corn in acreage and value. Data for the period 1923 to 1927, inclusive, show that an average of 40,000 acres of wheat was grown during this period, which was slightly more than the combined acreage of barley and oats grown for grain during this same period. The 1927 wheat acreage was approximately 50 percent larger than was the 5-year average for this grain. The combined acreages of all small grains were approximately one-half that of the cotton acreage for the above-mentioned 5-year period.

A number of causes have prevented the small grains from becoming of greater importance in the State. Small grains fit into rotations with other cash crops with some difficulty. Attempts at following small grains with cotton generally have not been satisfactory, as the grain crop cannot be removed early enough to allow the cotton to be planted at the proper season. The practice of following cotton with a small-grain crop usually results in a lowered yield, due to the late planting of the grain crop. Such late-planted crops are more seriously affected by attacks of black stem-rust and by the hot weather of early summer than are earlier plantings of grain.

In many cases, the yields of small grains have not been satisfactory because these crops were usually planted following crops of cotton, corn, or sorghum which have removed large amounts of soil fertility. Barley is often planted following alfalfa but in this case the usual method is to plant the barley in the alfalfa and use the two as a pasture or hay crop. This method gives excellent results. The increasing demand for win-

* Acknowledgement is made of the assistance rendered by C. J. Wood, Foreman of the Salt River Valley Experiment Farm, who was in charge of the field work in connection with most of the experiments reported here. The authors are also indebted to G. E. Thompson, formerly Agronomist, and to W. E. Bryan, for field data obtained from some of the earlier small-grain experiments.

ter pasture for range stock in the irrigated valleys of southern Arizona and the larger amounts of barley and oats used for feed for dairy cattle and in feeding operations have increased the demand for the feed grains.

Rather unsatisfactory conditions have likewise tended to discourage the production of small grains in the past. Nearly all our grain is handled in sacks, which is an expensive method, but necessary under present conditions.

VARIETY TESTS WITH SMALL GRAINS

Variety tests with small grains conducted in the Salt River and Yuma valleys have demonstrated the superiority of Early Baart wheat, Texas Red oats and Common Six-Row barley. This variety of barley is similar to if not identical with Coast barley. The outstanding popularity of these varieties among farmers generally supports the conclusions resulting from these experiments. Early Baart wheat which was introduced into Arizona by the United States Department of Agriculture and tested and increased by the Arizona Agricultural Experiment Station has become the leading variety of wheat in the Southwest. Common Six-Row barley is the most important barley from the standpoint of grain production although the beardless varieties are becoming more popular for hay and pasture purposes. Texas Red is practically the only variety of oats grown in the southern part of the State at the present time.

TABLE I.— WHEAT VARIETY TEST, SALT RIVER VALLEY EXPERIMENT FARM.

Variety	1921	1922	1923	1924	1925	1926	Average
	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds
Early Baart	1,945	1,091	2,190	1,591	1,553	2,121	1,752
Marquis	503*	1,836	1,553	1,456	1,462	2,535	1,767
Sonora	1,409	2,000†	1,682				1,697
Hard Federation			1,521	1,310	1,359		1,396
California Club		894	1,861	1,442	1,578		1,444

* Omitted from the average because not comparable.

† Followed a green-manure crop of tepary beans.

WHEAT

Tables I and II indicate something of the comparative yielding quality of different varieties of wheat.

It will be noted from the foregoing table that the average yield of Marquis was slightly higher than that of Early Baart wheat, if the 1921-yield of Marquis is not included in the average. However, a reference to Table II shows that Early Baart will generally outyield Marquis wheat under comparable conditions. For various reasons, it was often impossible to make duplicate plantings with the result that the yield data have not been as complete as is desired.

TABLE II.— COMPARATIVE TEST OF EARLY BAART AND MARQUIS WHEATS.

	1924		1925		1926		1927		
Variety	No. of plantings	Yield pounds	No. of plantings	Yield pounds	No. of plantings	Yield pounds	No. of plantings	Yield pounds	Average
Early Baart	8	2,136	9	1,782	7	2,394	5	1,974	2,072
Marquis	8	1,956	9	1,506	7	1,980	5	1,416	1,715

The preceding table compiled from yields in the date-of-planting tests, indicates that in these tests Early Baart averaged 357 pounds per acre more than did Marquis wheat.

The property of Early Baart to give satisfactory yields when planted late in the season together with the more uniform quality of the grain and the higher yield give it a decided advantage over Marquis wheat. In some seasons the latter variety produces grain of excellent quality but it has a tendency to produce a large percentage of "yellow berry" kernels. This tendency seems to be encouraged by variations in irrigation and climatic conditions.

Sonora wheat has been grown longer in Arizona than any other variety and it often gives very satisfactory yields. However, it is usually somewhat lower in yield than Early Baart and the quality of the grain is distinctly inferior to that variety. The pubescent chaff causes an irritation of the skin at threshing time which makes this variety rather objectionable. It is also very susceptible to rust.

The yields of Hard Federation and California Club wheats have not been sufficiently high to justify the recommendation of these varieties.

The results of earlier variety tests are given in the tables which follow.

TABLE III.— WHEAT VARIETY TESTS, SALT RIVER VALLEY.

Variety	Phoenix Experiment Farm		Salt River Valley Experiment Farm		
	1915	1916	1918	1919	Average
	Pounds	Pounds	Pounds	Pounds	Pounds
Early Baart..	2,868	2,460	2,180	2,921	2,607
Sonora	3,102	2,060	2,032	—	2,398
Turkey Red...	3,060	1,640	2,375	2,994	2,517

Other tests have failed to support the comparatively high standing shown for Turkey Red wheat in the preceding table. It resembles Marquis in that the quality of the grain is variable when produced under different conditions, and in many cases the yields have not been satisfactory. The variety tests at the Yuma Valley Experiment Farm included two durum wheats. While these gave fairly good yields and the quality was good, they are not looked upon with favor by millers, and consequently the demand for them is very limited. One of the most desirable qualities of the durum wheats is their resistance to rust.

TABLE IV.— WHEAT VARIETY TESTS, YUMA VALLEY EXPERIMENT FARM.

Variety	1914	1915	1916	Average
	Pounds	Pounds	Pounds	Pounds
Early Baart.	—	2,598	2,970	2,782
Sonora	—	3,102	2,346	2,724
Turkey Red....	1,620	2,592	—	2,106
White Algerian (durum)	2,400	2,676	1,740	2,272
Red Algerian (durum)....	2,400	2,676	1,572	2,216

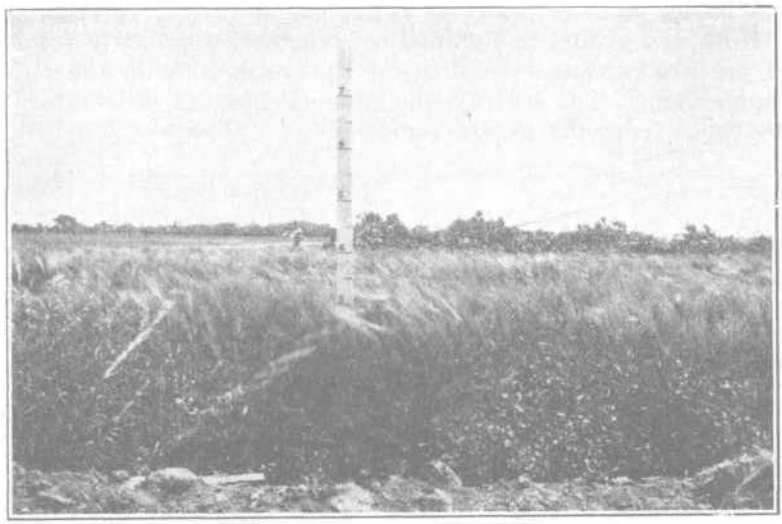

Fig. 1.— Common Six-Row barley. Salt River Valley Experiment Farm.

BARLEY

Variety tests have usually shown a fairly consistent advantage for Common Six-Row barley. It usually makes a greater growth than do the other varieties and it has a stiffer straw which gives it an advantage. Since quality of grain is not so important in barley as in wheat, yield is the chief factor which determines the value of a variety. In a number of cases, other than those reported in the following table, this variety has given the largest yields.

TABLE V.— BARLEY VARIETY TEST, SALT RIVER VALLEY EXPERIMENT FARM.

Variety	1920 Pounds	1921 Pounds	1922 Pounds	1923 Pounds	1924 Pounds	1925 Pounds	1926 Pounds	1927 Pounds	Average Pounds
Common Six-Row	2,628	1,952	2,737	1,815	3,287	2,565	1,618	1,893	2,312
Mariout	2,230	1,797	3,087	1,394	2,338	2,377	1,733	2,575	2,191
Trebi	-	—	—	—	2,415	1,557	2,021	2,678	2,168
Beldi	2,035	2,516	2,725	1,420	2,210	1,620	—	—	2,088
Beardless	—	1,670	2,608	1,265	2,227	—	2,362	1,433	1,928

A barley known locally as Beardless, a variety belonging to the Horsford group, has gained considerable popularity for hay and pasture purposes, because of its freedom from the objectionable awns. The grain yields have not been as satisfactory as have those from the awned varieties.

Fig. 2.—Mariout barley. Salt River Valley Experiment Farm. Lodging often occurs on fertile soils.

Several other varieties have been tried at various times with different degrees of success. Some make very good yields in favorable seasons but give very low yields in other years. For example, the Utah Winter which led all other varieties in 1915 with a yield of 3,686 pounds was next to the bottom of the list the following year when it yielded only 1,219 pounds.

OATS

Considerably less work has been done with oats than with wheat or barley because of the lesser importance of the crop in Arizona. In practically all of the tests conducted, the Texas Red variety has given the highest yields. This variety is the one most commonly grown in the southern part of the State at the present time. Yields of a number of varieties in a 1-year test are given in Table VI.

Texas Red was the leading variety at the Phoenix Experiment Farm in 1913 and in 1915, when a yield of 2,970 pounds

per acre was obtained from that variety. San Saba and Texas Red oats were grown on the Salt River Valley Experiment Farm on a commercial basis in 1918. Texas Red oats was the better of the two and gave a yield of between 2,850 and 3,000 pounds per acre.

TABLE VI.— OAT VARIETY TEST, PHOENIX EXPERIMENT FARM.

Variety	Pounds per acre planted	Date planted	Date harvested	Yield in pounds
San Saba	75-80	11-15	5-23	2,900
Texas Red	75-80	11-26	5-17	2,680
Australian Rust-Proof	75-80	11-15	5-17	2,400
Alberta Red	75-80	11-29	5-31	2,060
Red Algerian	75-80	11-29	5-31	2,020
California Red	75-80	11-15	5-11	1,680

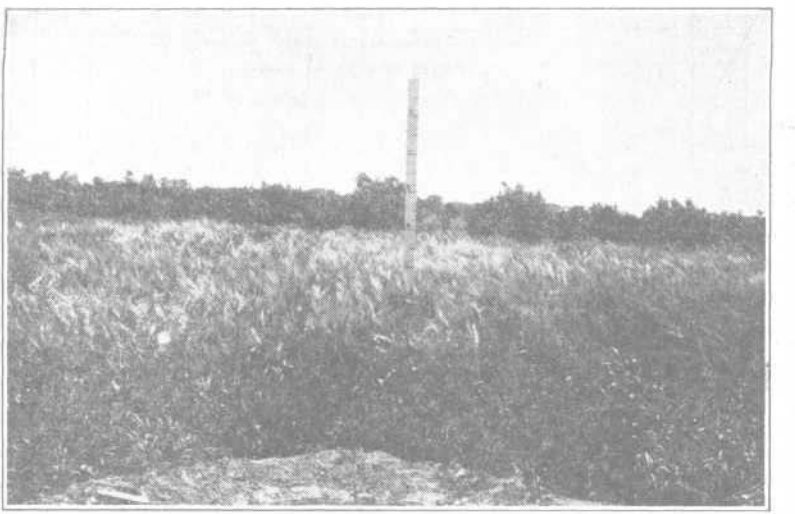

Fig. 3.— Beldi barley. Salt River Valley Experiment Farm.

Rye, speltz, and emmer have been included in variety tests at different times at both the Salt River Valley and the Yuma Valley Experiment farms, but have not proved satisfactory.

Rye has never produced satisfactory yields and although good yields of speltz and emmer have been obtained they canont compete with barley or oats as feed crops.

EFFECT OF DATE OF PLANTING ON YIELDS OF SMALL GRAINS

Date-of-planting tests have been conducted with Early Baart and Marquis wheats for the past 4 years, 1924 to 1927 inclusive. The purpose of these tests was to determine the time of year at which wheat should be planted to insure the highest average yields. The importance of such tests is evident when it is realized that small grains are planted from late in September to early March. Failure to secure a stand sometimes occurs when plantings are made before the hot summer weather has passed, and shriveled grain and low yields often result when the planting is delayed so long that the kernels do not fill out before the hot weather of early summer begins. In this experiment it was considered best to limit the test to plantings made from the middle of October to the early part of February.

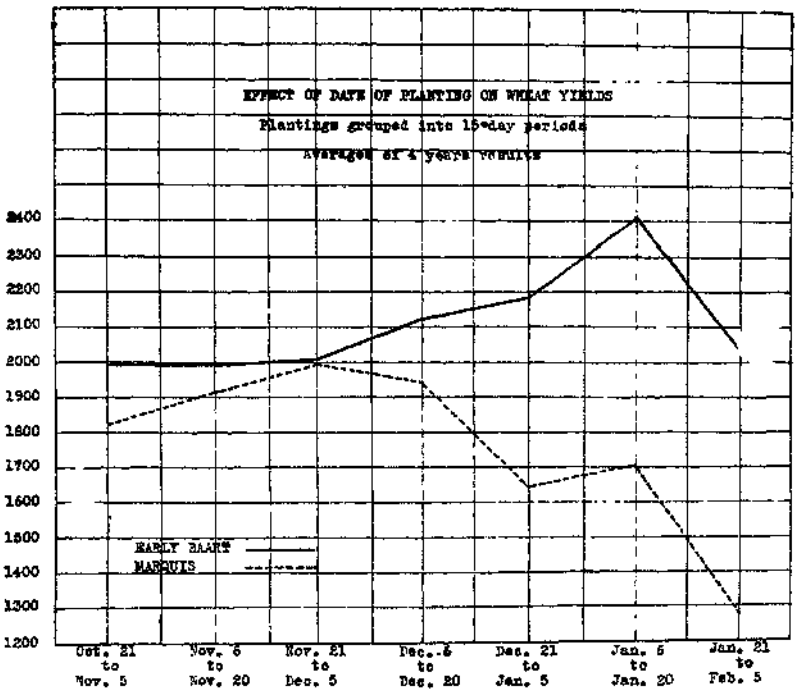

Fig. 4.—Effect of date of planting on wheat yields. Early Baart gives much better results from late plantings than does Marquis.

Some variation in time of planting was occasioned by rain and cold weather and it has been necessary to group the plantings for the different years into 15-day intervals because of these variations. Yields for the different dates of planting for the 4-year test are given in the following table and in the accompanying chart which presents graphically the tabulated data.

TABLE VII.— EFFECT OF DATE OF PLANTING ON YIELDS OF WHEAT.

Year	Oct. 21 Nov. 5	Nov. 6 Nov. 20	Nov. 21 Dec. 5	Dec. 6 Dec. 20	Dec. 21 Jan. 5	Jan. 6 Jan. 20	Jan. 21 Feb. 5
	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds
Early Baart							
1924	2,384	1,971*	1,942	2,140	2,135	2,537	1,989
1925	1,576	2,256	1,769*	1,629	1,649	2,053	2,344
1926	2,020	1,945	2,311	2,866	2,866	2,754	1,985
1927	—	1,800	—	1,848	2,082	2,316	1,812
Average	1,993	1,993	2,007	2,121	2,183	2,415	2,032
Marquis							
1924	2,221	2,161*	2,057	2,047	1,751	1,803	1,421
1925	1,285	2,257	1,391	1,499	1,527	1,599	1,288*
1926	1,960	1,749	2,535	2,647	1,874	1,863	1,222
1927	—	1,488	—	1,570	1,422	1,548	1,146
Average	1,822	1,914	1,994	1,941	1,644	1,703	1,269

Note: It was estimated that the damage caused by birds to the early plantings in 1925 amounted to between 20 and 30 percent.

As previously noted, the table indicates that Early Baart not only outyields Marquis wheat but also produces a much higher comparative yield when planted late in the season. Marquis produced its highest yields when planted late in November and early in December, while Early Baart wheat averaged highest when planted about the middle of January. Yields for the last plantings of the season for both varieties showed marked decreases, although in the case of Early Baart, these yields were

* Averages for two plantings.

not as low as were those from the early-season plantings. The property of this variety to give good yields more or less irrespective of the time of planting has been one of the principal reasons for its continued popularity. However, numerous reports from farmers and others indicate that plantings of Early Baart wheat made after January 1 are usually successful only on good land and that late plantings on very poor soil or on new lands are often not as successful as plantings made earlier in the season.

A 1-year test comparing fall and spring plantings of wheat and oats was conducted at the Phoenix Experiment Farm in 1915. The test included three varieties of wheat and two varieties of oats. Yields are reported in the table which follows.

TABLE VIII.—FALL VERSUS SPRING PLANTINGS OF WHEAT AND OATS.

Variety	Fall Planting	Spring Planting
	Pounds	Pounds
Early Baart wheat	2,868	2,160
Bluestem wheat	3,234	2,118
Turkey Red wheat	3,060	870
Texas Red oats	2,970	880
Sixty-Day oats	2,902	1,680

This table shows a very marked advantage for the fall planting, an advantage which the more complete work with Early Baart and Marquis wheats does not entirely support. In 1916, Marquis and Pacific Bluestem wheats planted November 15 outyielded plantings of these varieties made from 2 weeks to a month later.

Very little data are available on the effect of the date of planting on the yields of barley and oats. The table given above indicates that fall-planted oats have a decided advantage over spring-planted oats, but it is probable that the advantage is not generally as great as is shown. It is well known, however, that early-fall plantings for pasture purposes are much more satisfactory than are those made later in the season. The hastened maturity brought about by the earlier planting also means that

the crop, if intended for hay, may be cut from 2 to 3 weeks earlier. This is a factor of considerable importance to farmers who make a practice of using barley as a nurse crop for alfalfa since the barley must be removed for hay as early in the spring as possible Planting should be delayed until the hot weather of late summer is over or the seed will not germinate satisfactorily.

One of the drawbacks to the production of early-planted small grain is the loss caused by birds. Since the early plantings always ripen ahead of the late-planted grain, they are attacked by different birds, particularly doves. In 1925, the loss on the early-planted plots in the date-of-planting test on the Salt River Valley Experiment Farm from this source was estimated at between 20 and 30 percent of the crop. Where fields are isolated as on new lands or where the grain ripens ahead of other fields, this is a matter of much importance

Winter or spring frosts may cause some loss especially if they occur when the grain is blossoming At this stage, grains are quite susceptible to injury from frost and the heads fail to fill. Such damage is quite infrequent, however, and probably greater damage to late-planted grain is caused by the attacks of the green soldier bug. Usually such attacks do not result in much damage unless the maturing of the grain is delayed.

Another advantage of growing early-maturing varieties of wheat or of hastening the ripening by early planting is that such varieties and plantings tend to escape the damage from black stem-rust which is severe during some years. While plots of wheat on the Salt River Valley Experiment Farm have not been affected as severely as have many of the fields in the Salt River Valley, still considerable damage has been done. Rust was responsible for most of the decrease in yields on the last plantings of Marquis and Early Baart wheats in 1926 in the date-of-planting test. So many factors affect yields that the importance of damage caused by rust is hard to determine. The following quotations from annual reports of the foremen on the experiment farms in the Yuma and Salt River valleys indicate the advantage of early-planted over late-planted wheat in those years in which rust is a factor.

1915 REPORT, PHOENIX EXPERIMENT FARM

"California Club planted in the spring was ruined by rust, but the fall planting was almost free from the disease. The same condition holds true for each variety, the spring planting in each case being much more affected than was the fall planting."

1914 REPORT, YUMA VALLEY EXPERIMENT FARM

"Turkey Red and White Sonora were most susceptible (to rust)—the Sonora was injured much less than the Turkey Red on account of its earlier ripening. Low night temperatures which continued late into the spring growing season caused an excessive amount of dew which, in turn, favored the growth and distribution of rust."

1915 REPORT, YUMA VALLEY EXPERIMENT FARM

"The early plots of Turkey Red were nearly free from rust, but a late plot of this variety was badly rusted and yielded only 36.4 bushels per acre whereas the average of this variety was 43.2 bushels per acre. The Algerian macaroni was practically immune to rust which attacked the Sonora most severely."

1926 REPORT, SALT RIVER VALLEY EXPERIMENT FARM

"Most small grain in the valley was damaged by rust this season. The late plantings and late-maturing varieties were quite badly damaged, while early plantings and early-maturing varieties escaped with only slight damage."

EFFECT OF RATE OF SEEDING ON YIELDS OF SMALL GRAIN.

Rate-of-seeding tests with Early Baart wheat were conducted at the Salt River Valley Experiment Farm for the period, 1920 to 1922, inclusive. The results obtained in these tests are summarized in the following table.

TABLE IX.—EFFECT OF RATE OF SEEDING ON YIELDS OF EARLY BAART WHEAT.

Rate	Time	Yield	Rate	Time	Yield
Pounds	Years	Pounds	Pounds	Years	Pounds
30	2	1,716	90	3	1,819
45	3	1,663	105	2	1,671
60	3	1,781	120	2	1,820
75	3	1,986	—	—	—

This table indicates that the highest yields were secured where 75 pounds of seed were sown per acre. The usual rate for wheat is 60 pounds per acre for the earlier plantings while increased rates of seeding for the later plantings are generally recommended, because of the smaller amount of stooling of the

plants. Satisfactory yields with small rates of seeding are possible only when soil fertility, seedbed, and weather conditions are ideal. The first and second factors were probably more favorable on the experiment plots than would be the case on any except the best farms.

Very little experimental data are available concerning the rate of planting of barley and oats under southern Arizona conditions. The usual practice is to plant from 70 to 90 pounds of barley per acre. The heavier rate of seeding should be used for late plantings or when planting early in the fall for pasture purposes. The rate of seeding for oats is usually a little lighter than that for barley with 65 to 80 pounds per acre as the recommended rate. For early plantings on fertile soils, the rate of seeding for both barley and oats should be somewhat less than that recommended above.

EFFECT OF FERTILIZERS, PREVIOUS CROPPING, AND IRRIGATION ON WHEAT YIELDS

Five 1-acre plots on the Salt River Valley Experiment Farm were set aside for a wheat-fertility test in 1919. These plots had been fallowed in 1916 and 1917 in order to rid them of the heavy infestation of Johnson grass. They were cropped to wheat the following 2 years and so were in rather poor condition as to fertility when the test was started. The two outside plots were planted to wheat continuously and were not cropped during the summer time, thus serving as checks. One of the remaining plots was fertilized with a commercial fertilizer containing nitrogen and phosphorus in amounts removed by the preceding crop. One plot received 200 pounds of superphosphate while the third plot received an application of 5 tons of barnyard manure per acre annually.

The results obtained are given in Table X.

A study of the table shows that following 1921 and with the exception of 1924 which was a very good year for wheat, there was a more or less gradual decrease in the average yield, although the two borders receiving nitrogenous fertilizers maintained their yields better than did the other plots. The effect of nitrogen on the yields was very apparent, whether it was supplied in the form of barnyard manure or nitrate of soda. Since no results were obtained from the superphosphate applications, it is clear that it was the nitrogen in the fertilizer which was responsible for the increased yields. There appears to be no deficiency of potassium in Arizona soils. The results of this 6-year test would

TABLE X.— WHEAT FERTILITY TEST, SALT RIVER VALLEY EXPERIMENT FARM.

Treatment	1920	1921	1922	1923	1924	1925	Average
	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds
Check	1,159	1,971	1,947	1,753	1,904	1,577	1,719
Commercial fertilizer	1 292	2,804	2,716	2,428	2,507	1,949	2,283
200 pounds P O	1,358	2,150	1,829	1,772	1,763	1,373	1,708
5 tons manure	1,689	2,149	2,045	2,330	2,252	1,576	2,007
Check	1 358	1,778	1,810	1,760	2,283	1,592	1,780
Average of all plots	1,371	2 171	2,029	2 009	2,142	1,613	—

seem to justify the conclusion that, under similar conditions, the application of nitrogenous fertilizers in appropriate amounts will increase the yields of wheat from 300 to 500 pounds per acre. It must be remembered that in this test wheat alone was grown on the land and that the test was coninued over a period of several years on land which had been cropped to wheat for 2 years before the test was started. Where a commercial nitrogenous fertilizer is desired, ammonium sulphate rather than nitrate of soda is recommended for the reason that it tends to decrease the naturally over-alkaline condition of the soil, whereas the nitrate of soda has the opposite effect.

A further test to determine the effect of the time of the last irrigation alone, and combined with nitrate-of-soda applications was started in the fall of 1922. Attempts were made to secure maximum hardness of the grain by giving the last irrigation in the bloom stage, and maximum yield by irrigating in the early hard-dough stage. These were compared with plots receiving similar irrigation plus 150 pounds of nitrate of soda per acre and with a check plot irrigated in the ordinary manner at the soft-dough stage. The results of the 3-year test are given in Table XI.

Because the results secured in 1925 are not entirely comparable with those of the first 2 years, the average yields for the different plots for 1923 and 1924 have been included. A study of the table shows that, in general, the application of nitrate of soda increased the yield. This supports the results

Fig. 5.—Wheat fertility plots showing effect of applications of nitrate of soda (right) and superphosphate (left) on Early Baart wheat.

TABLE XI.—EFFECT OF IRRIGATION AND NITRATE OF SODA ON YIELDS OF EARLY BAART WHEAT, SALT RIVER VALLEY EXPERIMENT FARM.

Treatment	1923	1924	1925	Average	Average '23 and '24
	Pounds	Pounds	Pounds	Pounds	Pounds
Last irrigation at early-bloom stage (for maximum hardness)	2,157	2,281	1,460	1,966	2,219
Last irrigation in soft-dough stage (ordinary method)	2,190	2,085	1,269	1,848	2,138
Irrigated as above with 150 lbs. nitrate of soda per acre	2,368	2,249	1,964	2,194	2,309
Last irrigation in hard-dough stage (for maximum yield)	2,143	2,624	1,754	2,174	2,384
Last irrigation as above with 150 lbs. nitrate of soda per acre	2,363	2,627	1,538	2,176	2,495

reported in Table X which show marked increases in yields from the application of nitrogenous fertilizers. There is also some indication that irrigation at a stage later than the beginning of

heading or early bloom also increases the yield. Duplication of plots under more carefully controlled irrigation conditions may be necessary in order to establish the effect of the relationship between irrigation and the stage of maturity on yield.

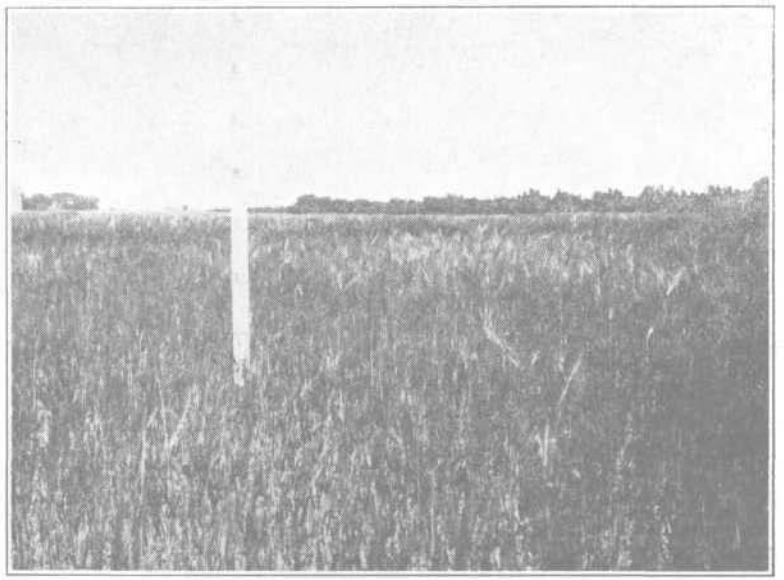

Fig. 6.— Effect of irrigation on the growth of barley. The border in the foreground was irrigated before the plants were up, while the border in the background was not irrigated until the plants were well along.

In order to determine the effect of various treatments on the quality of the wheat produced, protein analyses were made on samples of wheat from the fertilization and irrigation tests in 1923. The results are given in Table XII.

The effect of applications of nitrogenous fertilizers on the protein-content of wheat is very evident, since the table above shows an average increase in protein-content of 2.2 percent for the wheat receiving nitrogenous fertilizer over that which did not receive such fertilizer. The effect of the nitrogen was considerably more pronounced when applied in the form of commercial fertilizer than in animal manure. This increase in protein-content is a highly important factor from the milling standpoint since lack of quality in Arizona wheat has made it less desirable than some other wheats for bread-flour purposes. In these tests, the increases in yield and protein-content have more than paid for the fertilizers used. How far such a practice may be adapted to commercial production remains to be seen.

TABLE XII.—EFFECT OF NITROGENOUS FERTILIZERS AND TIME OF IRRIGATION ON PROTEIN-CONTENT OF EARLY BAART WHEAT.

Treatment	Yield	Protein content
	Pounds	Percent
No nitrogenous fertilizers used:		
Check (1) Fertility test	1,753	10.88
Check (2) Fertility test	1,760	11.89
200 lbs superphosphate, Fertility test	1,770	11.86
Irrigation at early-bloom stage	2,157	11.50
Ordinary irrigation	2,190	11.49
Irrigation in hard-dough stage	2,143	10.64
Average percent protein	—	11.38
Nitrogenous fertilizers used:		
Ordinary irrigation plus 150 lbs. of nitrate of soda	2,368	14.45
Irrigation in hard-dough stage plus 150 lbs. of nitrate of soda	2,363	14.24
Commercial fertilizer (with 236 lbs. of nitrate of soda) Fertility test	2,428	13.49
5 tons barnyard manure (fertility test)	2,330	12.20
Average percent protein	—	13.60

Some terminal buyers and millers in certain producing areas have been paying premiums for high protein wheats of the Hard Red Spring and Hard Red Winter classes for a number of years. In some seasons, the average protein-content is very low which results in very high premiums for those lots of wheat testing high in protein. In other years when the quality of the general crop is good, the premiums may be lacking etnirely. The wide variations in the premiums in a given season or part of a season are due to the fact that purchases of high protein wheats are made on order of mills primarily and that the protein-content

as such is not an integral part of the grade. The average price-differential for high protein lots of Hard Red Spring and Hard Red Winter wheats is from 7 to 10 cents per bushel for each per-cent of protein over 12 percent.

While premiums are not being paid for high protein lots of the white wheats on the basis of protein-content, it is evident that the amount of protein is a definite factor in determining the milling and baking value of such wheats and that such value varies in a more or less direct proportion to the protein-content. Since such a difference in actual value does exist, this difference should be reflected in the prices paid to farmers for wheat.

EFFECT OF PRECEDING CROPS ON THE YIELDS OF SMALL GRAINS

Some of the most accurate information concerning the effect of preceding crops on the yields of small grains was obtained as a result of a test to determine the relative effect of corn and hegari on the soil, using Beardless barley as an indicator crop. Seven borders were set aside for this purpose of which four were planted to corn and three to hegari. All of the land was given a heavy application of straw in the spring of 1924, and during June of each year, prior to planting the corn and hegari, all the borders with the exception of one devoted to each crop received an application of 7½ tons of manure per acre. The barley yields for the 3 years are given in Table XIII.

Thus it will be seen that hegari was much more detrimental to the yield of the barley crop that followed than was corn, and that while an annual application of approximately 7 tons of manure per acre caused marked increases in yields, it did not entirely overcome the deleterious effect of the hegari crop. The comparative effects of the two crops were even more noticeable in the straw yields than in the grain yields of the barley. The manured corn borders produced an average straw yield for the first 2 years of the test of 3,617 pounds as compared with 2,758 pounds for the manured hegari borders. The average yield of straw on the unmanured corn plot was 1,699 pounds as compared with 1,174 pounds per acre for the corresponding hegari plot.

EFFECT OF STORAGE ON WEIGHT OF SMALL GRAIN

Experiments were commenced following the small-grain harvest of 1923 to determine the effect of storage on the weight of small grain. Weighed sacks of one variety each of wheat, barley,

and oats were stored in the grain bins on the Salt River Valley Experiment Farm. The work was continued during the following 2 years and during the last year four varieties of barley and four of wheat were included. The average weights for the barley and wheat at the different weighing periods are given in Table XIV. Weights were taken on June 9 and July 9 and about the middle of each succeeding month with the exception of April for which no figures are available.

TABLE XIII.— EFFECT OF CORN AND SORGHUM ON YIELDS OF BEARDLESS BARLEY.

Previous crop	1925	1926	1927	Average
	Pounds	Pounds	Pounds	Pounds
Corn	2,769	3,356	2,573	2,899
Corn	3,157	3,405	2,770	3,111
Corn	2,774	3,309	2,741	2,941
Hegari	2,824	3,025	2,112	2,654
Hegari	3,047	3,1..	2,256	2,828
Hegari (no manure)	1,822	1,151	715	1,229
Corn (no manure)	2,675	1,454	1,435	1,855
Average barley yield on manured corn borders	—	—	—	2,984
Average barley yield on manured hegari borders	—	—	—	2,741

The results for the previous years were very much the same although in 1923-1924 the maximum increase was somewhat higher than that recorded here while the weight at the end of the year was practically identical with that at the beginning of the test. It is readily apparent, however, that the weight of the grain is at its lowest during the 4 or 5 months following harvest and that it increases during the winter months, again decreasing with the higher temperatures and lower humidity of spring and early summer. Weights are highest following a period of rainy or damp weather during the winter when the lowest temperatures prevail. Since the bulk of the small grain is usually

TABLE XIV.—EFFECT OF STORAGE ON WEIGHT OF SMALL GRAIN.

	June	July	August	September	October	November	December	January	February	March	May
	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds
Four varieties of barley	100.00	99.88	100.61	101.19	101.76	101.93	102.18	102.41	101.87	101.50	101.75
Four varieties of wheat	100.00	100.17	100.28	100.55	101.59	101.65	101.87	102.16	101.73	101.64	101.57

sold shortly after harvest, the farmer loses on account of the very dry condition of the grain. The difference in weight shortly after harvest and that 5 or 6 months later amounts to approximately 50 pounds per acre when the acre-yield is about a ton of grain. Wheat sold directly from the combine, however, may have a moisture content higher than it would have a week or so later. The moisture content at harvesting time depends on the maturity and condition of the grain.

SUMMARY

1. Small grains are third in importance among the general field crops of Arizona and are exceeded in acreage and value by both cotton and alfalfa.

2. Early Baart wheat, Common Six-Row barley, and Texas Red oats have given the highest average yields in variety tests and field trials.

3. Rye, speltz, and emmer have not given yields sufficiently large to justify the general planting of these crops.

4. Date-of-planting tests with Early Baart and Marquis wheats indicate that the former variety gives the highest yields from late December and early January plantings, while the latter yields highest when planted late in November.

5. Early-winter plantings of barley and oats gave higher yields than late-winter plantings of these grains.

6. Rust injury is considerably less on early-planted than on late-planted wheats.

7. Wheat seeded at the rate of 75 pounds per acre gave the highest yields in a 3-year test. Barley and oats are usually planted at somewhat heavier rates than is wheat.

8. Applications of nitrogen in the form of commercial fertilizers increased wheat yields more than did barnyard manure, and both showed considerable increases over the check plots. No increases were obtained from applications of phosphoric fertilizers.

9. Wheat from plots receiving nitrogenous fertilizers in 1923 had an average protein-content of 13.60 percent as compared with 11.38 percent protein-content for wheat receiving no nitrogenous fertilizer.

10. A 3-year test of the effect of corn and hegari on succeeding crops showed that Beardless barley following hegari produced much lower yields of both grain and straw than it did following corn.

11. Stored grain increased in weight between 2 and 3 percent following winter rainy periods as compared with weights taken shortly after threshing. These increases gradually disappeared with the increased temperature and lower humidity of spring and early summer.