Bulletin 404 September, 1933

WHEAT PRODUCTION IN COLORADO 1926-1932

By D. W. Robertson, Alvin Kezer, J. F. Brandon, J. J. Curtis, Dwight Koonce and Wayne W. Austin

Harvesting Kanred Wheat on the Dryland of Eastern Colorado.

Colorado Agricultural College
Colorado Experiment Station
Fort Collins

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WHEAT PRODUCTION IN COLORADO

By D. W. ROBERTSON, ALVIN KEZER, J. F. BRANDON, J. J. CURTIS, DWIGHT KOONCE and WAYNE W. AUSTIN

SUMMARY[1]

In Colorado, about 19,000,000[2] bushels of wheat are produced annually. The average acreage sown to wheat for the 4-year period 1928-1931 is 1,307,250 acres. Over 70 percent of the total wheat produced in Colorado is produced without irrigation.

There are three localities in Colorado where variety tests with grain are being carried. The Fort Collins station is located in the north central part of the state. At this station, variety tests are carried under irrigation. The type of soil, elevation and climatic conditions make it fairly representative of the irrigated sections in Northeastern Colorado.

The Fort Lewis substation is located in the southwestern corner of the state in La Plata County, at an elevation of over 7,000 feet. On this farm grains are tested under irrigation. The elevation and climate make this farm a desirable place to test grains for high-altitude conditions.

The United States Dry Land Field Station at Akron is operated in cooperation with the Colorado Experiment Station. This station is located in the heart of the wheat belt of Colorado. Tests conducted there are on dryland and should give results which can be applied to similar conditions in that region.

In making recommendations for Colorado, one is confronted with varied conditions such as rainfall, altitude and length of frost-free season. Any recommendation should be applied only to conditions similar to those found at the various experimental farms and the districts they represent. Various local conditions and demands may make it advisable to deviate slightly from the recommendations.

Such an instance is that regarding summer fallow. In the Akron area, with a precipitation of about 17 inches, summer fallow is not the best practice. It may be a necessary practice to control weeds. Also in some areas corn and sorghums cannot be grown to advantage. In areas of low rainfall, the moisture stored in the fallow will increase yields to a greater relative extent than where 17 inches or more of moisture falls during the year.

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[1]This bulletin gives the results of experiments carried on by the Agronomy Section, Colorado Experiment Station, Fort Collins and Fort Lewis, and the Office of Cereal Crops and Diseases at Akron, cooperating with the Office of Dry Land Agriculture and the Colorado Experiment Station for the years 1926 to 1932, inclusive.

[2]Average of a 4-year period from 1928-1931, inclusive.

At Fort Collins, under irrigation, Kanred is still the best winter wheat to grow. Other varieties yield as high but do not outyield it sufficiently to recommend being grown in place of Kanred.

The highest-yielding hard red spring wheats were Komar and Ceres. Both of these wheats, however, are susceptible to loose smut and bunt and they are weaker-strawed varieties than Marquis.

Milling and baking tests showed Komar to be as good a bread wheat as Marquis.

Under irrigation, the highest-yielding winter wheats outyield the highest-yielding spring wheats by about 10 bushels.

At Fort Lewis, Kanred is recommended as the best high-altitude winter wheat tested.

Of the spring wheat varieties under irrigation, Dicklow proved to be the best soft white wheat and Komar the highest-yielding hard red spring wheat.

At Fort Lewis, the difference between the highest-yielding winter wheat and the highest-yielding spring wheat was about 10 percent in favor of the winter wheat.

The recommended date to plant winter wheat at Fort Lewis is about the middle of September.

On the dryland field station at Akron, Kanred and other Crimean types of wheat are the varieties best adapted to dryland conditions. While Tenmarq, C. I. 6936, yields well, its lack of winter hardiness is undesirable for conditions similar to those found at Akron.

The milling and baking tests show that Blackhull seems to have a type of protein which will not stand up to rough usage such as is encountered in a high-speed mechanical mixer. The quality of loaf when such a mixer is used is low when compared with that of Kanred. The winter hardiness of Blackhull, C. I. 6251, under Akron conditions, is much lower than that of Kanred.

Spring-wheat varieties should be sown as early in the spring as soil conditions permit. The seeding of spring wheat cannot be recommended for the drylands, except possibly as a catch crop where a feed crop is not wanted. Winter wheat, sown as late as the middle of October, usually will outyield spring wheat.

Of the spring wheats, Komar, a late-maturing variety at the United States Dry Land Field Station at Akron, outyielded all other varieties. Quality was the highest-yielding white wheat grown at the Akron Field Station.

Fallowing for either winter or spring wheat probably is not ordinarily justified in regions similar to the Akron station where there is a rainfall of 17 inches or above. Under such conditions fallow does not usually increase wheat yields over yields obtained on corn land sufficiently to justify the added cost. There are many

sections with a lower rainfall than 17 inches where fallowing is regularly justified. At Akron, seeding on corn land usually has hastened maturity, produced shorter straw and smaller yields of both straw and grain than seeding on fallow.

As a result of the various experiments with wheat, the following varieties appear to be best adapted, and are recommended for growing in Colorado under conditions similar to those found at the various experimental farms:

RECOMMENDED VARIETIES

Conditions similar to those at Ft. Collins (irrigated)

WINTER WHEAT	SPRING WHEAT
Kanred	Komar

Conditions similar to those at Ft. Lewis (altitude over 7,000 feet—irrigated)

WINTER WHEAT	SPRING WHEAT
Kanred	*Hard Red Spring*
	Komar
	Soft White Spring
	Dicklow

Conditions similar to those at Akron (dryland)

WINTER WHEAT	SPRING WHEAT
Kanred	Komar

PRODUCTION ON DRYLAND

Over 70 percent of the wheat produced in Colorado is produced without irrigation. Over 80 percent of the dryland wheat is winter wheat.

PREPARATION OF SOIL.—Several methods of preparation may be followed, depending on the rainfall and the type of soil. Where the rainfall is sufficient and the soil comparatively new, a rotation in which wheat follows corn may be used. The wheat can either be sown between the rows of corn with a small drill or the corn cut for forage and the wheat drilled in on corn stubble. Good results by the latter method have been obtained at Akron. Spring wheat can be drilled on cultivated corn stubble in the spring.

In many sections summer fallow gives better results, especially where the rainfall is light. Of course, extremely sandy land should never be broken up for non-irrigated farming. The so-called hard lands and the sandy loams can be handled so as to prevent blowing. The essential feature of such handling is to keep a "small cloddy" surface (Fig. 1) on the hard land, and to keep vegetable matter exposed on the surface of the sandy land. This may be accomplished by the use of the furrow drill. This drill ridges the soil and plants the seed much deeper than the ordinary drill. These ridges catch more snow and aid in preventing soil drifting. This drill has the

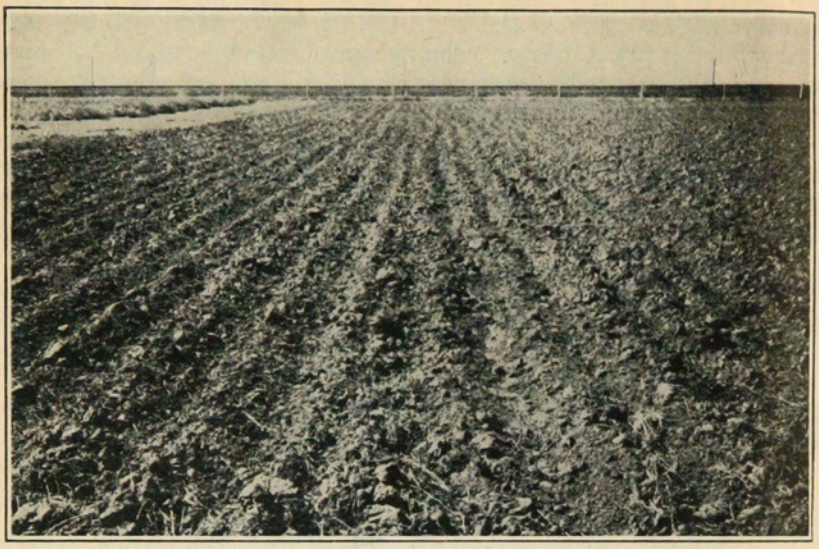


Fig. 1. Summer fallow showing a rough surface. Such a surface is desired for prevention of blowing.

added advantage of planting the wheat close to the moisture supply. The furrow drill seems to give better results the more severe the conditions.

Sometimes when blowing is severe it is necessary to cultivate or list strips thru the wheat at right angles to the direction of the prevailing winds, but ordinarily the furrow-drill seeding will give complete protection.

Bean land blows worse than almost any other cultivated field because the soil is usually clear of all vegetation and finely pulverized on the surface. If there are rains after the bean harvest, the surface should be cultivated when slightly moist so as to make a "small cloddy" surface, otherwise bean lands will blow severely. If the weather conditions are dry, it may be necessary to cross list such lands to prevent blowing. Where cross listing is done at the right time, and in advance of the wind, there will be little damage. Once the soil starts to blow, it takes more work and a much rougher surface to prevent damage. As a general rule, do not seed bean land to winter wheat.

Summer fallow has its disadvantages. Crops grown on summer fallow have to stand the costs of cultivation the first year and taxes for 2 years. This, in many places makes summer fallow very costly. Cheaper means of summer fallowing should be used where possible. In some sections of Northeastern Colorado the following method of summer fallowing has been used with success:

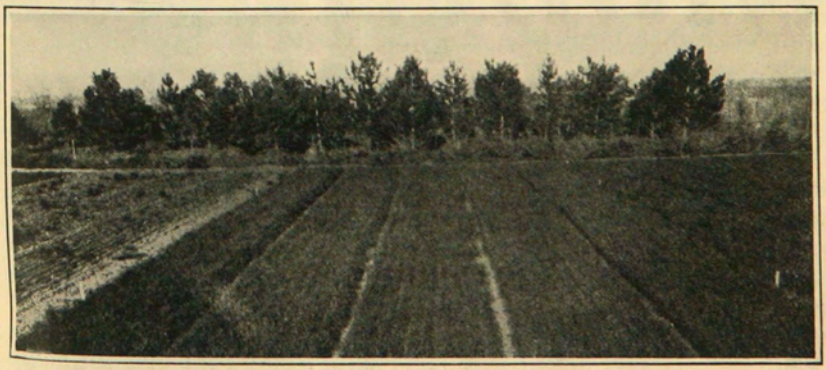
The ground is listed in the fall after the crop has been removed, or in the early spring. Any method which will prevent weed growth in the fall will aid in conserving moisture. When the weeds commence to come out of the ground in the late spring the lister is used to break out the ridges. The usual outfit for this work consists of a three-row lister. The ridges are then broken down in different ways, depending upon seasonal conditions. Sometimes one harrowing is given to kill small weeds. Sometimes the land is disked, but the disk is used as sparingly as possible because it pulverizes the surface too much. One of the best tools is the duckfoot or field cultivator. This tool leaves the surface of the ground slightly ridged and in a cloddy condition.

Results at the Akron station[1] have shown that the small grains, either fall or spring sown, do not do as well after sorghum as after corn. Where possible, sorghum land should be seeded to some row crop that is planted late in the spring.

RATE AND DATE OF SEEDING.—The earliest winter wheat can be planted in the fall the better, provided there is sufficient moisture to maintain fall growth, so that the wheat will not be killed by fall drouth. Results at Akron have shown that the highest yields are obtained with wheat sown between September 6 and September 21. Good yields are obtained with plantings as late as October 11. Spring wheat is sown as early in the spring as practicable. Generally, conditions are favorable for seeding in the latter part of March.

Akron data show little difference between the 2 and 6-peck rates for winter wheat. The yields from the lighter seedings, however, have been the lowest most often. In all years, the better yields were from the seedings heavier than 2 pecks to the acre. There

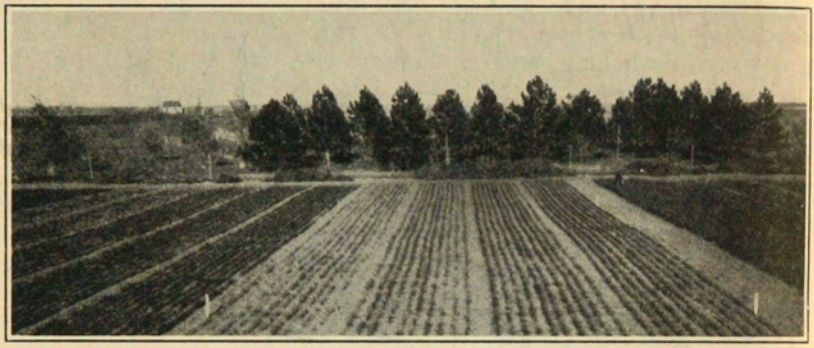
[1]Brandon, J. F. Crop Rotation and Cultural Methods at the Akron (Colorado) Field Station, U. S. D. A. Bul. 1304—1925.



2 pecks 3 pecks 4 pecks 5 pecks 6 pecks

Fig. 2. Rate and date of seeding on fallow at Akron. Seeded August 19, 1926.

seems to be enough information to justify the assertion that the more severe conditions become, the greater amount of seed must be used. With favorable conditions good results may be obtained with light seedings. Under certain conditions good yields may be obtained from seeding less than 2 pecks.



2 pecks 3 pecks 4 pecks 5 pecks

Fig. 3. Rate and date of seeding on fallow at Akron. Seeded November 2, 1926.

PRODUCTION UNDER IRRIGATION

Spring wheat is grown mostly on irrigated land. On the heavier lands, if soil moisture conditions are good, the soil should be prepared by fall plowing. If the soil is dry in the fall, plowing had better be put off until spring. If the spring grain follows beets or potatoes, any fall plowing will necessarily be late. Spring plowing should be done as early as possible. The plow should be followed immediately by the disk and harrow. The land should be leveled prior to seeding. The object of leveling is to produce a surface of uniform grade in order to help the easy distribution of water. The usual rate of seeding for spring wheat on irrigated land is 90 pounds per acre.

In Northeastern Colorado it is seldom necessary to "irrigate up" small grain. In the Arkansas Valley, often in the San Luis Valley, and in some western slope localities, natural precipitation is so uncertain that it is necessary to "irrigate up." On the tighter soils, where it is necessary to irrigate crops up, the land should be irrigated, then disked, leveled, planted and harrowed as soon as cultivation is possible. On the college farm, good results have been obtained in getting a uniform stand by using a light packer instead of the harrow after planting. On light, sandy soils, it is better to plant and irrigate after planting because sandy soils dry out on the surface rather quickly. If there is moisture enough in the soil to keep the crop growing, there is no need of irrigation until the time

the crop commences to head. The crop should not be allowed to suffer from water, even if it is necessary to irrigate prior to heading. On the tighter lands in Northern Colorado one irrigation for small grains is usually amply sufficient. On the sandier land, two or more irrigations distributed thruout the growing season may be necessary to produce the same results. In these sections where it is necessary to irrigate crops up, two irrigations on the tighter lands are sufficient and usually three irrigations on the sandier lands. If the crop is growing rather vigorously, showing no need of water, the heaviest seed production can be obtained by irrigating when the grain is heading. Wheat should have sufficient moisture to insure vigorous growth and bring the plant to heading. One good irrigation at heading will insure a crop with the normal rainfall on the tighter lands of Northern Colorado. Little or nothing is gained by irrigating after the grain is in the milk and often losses are caused by delayed ripening and lodging.

Winter wheat grown under irrigation should be seeded at about 60 pounds per acre. Winter wheat should be sown in September in order to take advantage of all the fall moisture possible. Spring wheat, ordinarily, should not be sown after April 20. Wheat sown later than this may mature and give a good yield but the danger of rust attack increases with a retardation of ripening.

If the grain is harvested with a binder, which is the usual practice under irrigation, the sheaves should be placed in small round

Fig. 4. Field of Marquis wheat near Fort Collins.

shocks of about eight sheaves and capped. This enables the straw to cure and produces a better quality of grain. Grain in uncapped shocks will bleach out under the usual prevailing weather conditions at this time of the year.

TREATMENT OF SEED

Wheat smut (bunt) is prevalent in Colorado. Accordingly, all seed should be treated before planting. Some varieties are more susceptible to bunt attack than others. So far, none of the varieties recommended are entirely immune to bunt.

COPPER CARBONATE TREATMENT FOR COVERED SMUT.—Colorado Extension Bulletin 306-A, "Smuts in Colorado Grains," describes the copper carbonate treatment which is generally recommended.

"Wheat, to be used for seed, should first be carefully cleaned to remove weed seed, dirt and unbroken smut balls. Do not use badly smutted wheat for seed. Dust the wheat with copper carbonate at the rate of 2 to 4 ounces of dust for each bushel of seed. One heaping tablespoonful of copper carbonate weighs about 1 ounce and is a fairly good measure to use. A complete covering of the seed with the copper carbonate dust must be secured to give results."

A good covering may be obtained by thoroly mixing the grain and the recommended amount of dust in an air-tight mixer of the barrel or steel-drum type. This type of mixer raises a part of the wheat and dips it back into the center of the pile. In this way, the seed is coated with copper carbonate.

WHEAT-PRODUCING AREAS

There is considerable variation in the climate of Colorado. Extremes in both temperature and rainfall are frequent. In some sections less than 10 inches of moisture fall in a year. In other areas, the precipitation is 20 inches or more. In the wheat-growing sections, the rainfall varies from 10 to 20 inches, and the altitude from below 4,000 to above 7,000 feet. The wheat-growing sections of Colorado can be divided into two general areas, the irrigated and the non-irrigated. The irrigated sections comprise those areas lying along the various water courses where the natural rainfall is supplemented. Irrigated farming produces about 30 percent[1] of the total wheat production of the state.

The following counties lead in dryland wheat production: Logan, Baca, Weld, Phillips and Yuma. In the irrigated sections, Weld, Boulder, Larimer, Adams and Jefferson Counties are the leading producers. Considerable amounts are also produced in the San Luis Valley and the San Juan Basin.

[1]Colorado Yearbooks from 1928 to 1931, inclusive.

LOCATION OF EXPERIMENTAL FARMS

There are three station farms in Colorado where variety tests with grain are being carried. The central station is located at Fort Collins in the north central part of the state. At this station, varietal tests are carried under irrigation. The type of soil, elevation and climatic conditions make it fairly representative of the irrigated sections in the northeastern part of the state.

The Fort Lewis farm is located in the southwestern corner of the state in La Plata County. The elevation of the station is over 7,000 feet. At this station, grains are tested under irrigation. The elevation and climate make this station a desirable place to test grains for high-altitude conditions.

The United States Dry Land Field Station, located at Akron, Colorado, is operated in cooperation with the United States Department of Agriculture. This station is located in the heart of the Colorado wheat-belt. Tests conducted here should apply to crops grown under similar conditions on the plains.

VARIETAL EXPERIMENTS WITH WHEAT ON DRYLAND

By J. J. CURTIS, J. F. BRANDON and D. W. ROBERTSON

Investigations with wheat have been conducted at the United States Dry Land Field Station, Akron,[1] Colorado, since 1908.

The results reported in this bulletin cover the period from 1926 to 1932.[2] These experiments were conducted wholly on dryland. The data obtained are believed to be generally applicable not only to nearly all dryland sections in the plains area of Colorado, but to adjacent portions of Western Kansas, Southwestern Nebraska and Southeastern Wyoming.

LOCATION AND DESCRIPTION OF THE STATION.—The United States Dry Land Field Station is located about 4.5 miles from Akron, Washington County, Colorado. The station contains about 382 acres. Three hundred fifteen acres are owned by the Colorado Agricultural Experiment Station, and the rest by the U. S. Department of Agriculture, Bureau of Plant Industry.

SOIL.—The soil of the farm is variable in texture and is slightly rolling. It is a naturally fertile, sandy loam locally called "hard

[1]United States Dry Land Field Station, Akron, Colorado, is operated by the Division of Dry Land Agricultural Investigations of the United States Department of Agriculture, with the Colorado Agricultural College cooperating. The cereal experiments were conducted by the Division of Cereal Crops and Diseases in cooperation with the office named from 1907 to 1924.

[2]J. F. Brandon, Superintendent of the United States Dry Land Station, and D. W. Robertson, Associate Agronomist at the Colorado Experiment Station, carried the work from 1924 to September, 1930. J. J. Curtis, Junior Agronomist, Office of Cereal Crops and Diseases, has been in charge of the work since September, 1930.

land." It differs from the so-called "soft land" in that it is less sandy in nature.

CLIMATIC CONDITIONS.—The climatic conditions at Akron are similar to those of other parts of Eastern Colorado. The nature and distribution of the precipitation are often limiting factors in crop production. Occasionally injury from frost, low winter temperature, soil blowing or hail, cause serious crop losses. The following quotation regarding the climate is taken from Bulletin 371 of the Colorado Experiment Station:

The average annual precipitation at the Akron Field Station during these 20 years (1908 to 1927), has been approximately 18 inches, of which more than 13 inches have been received during the months of April to September. Usually the period of greatest precipitation has been from April 1 to June 10. The distribution is important, since high correlation exists between crop yields and the amount of rainfall received during the latter part of May and the first 10 days of June.

The records show the average annual wind velocity to be between 6 and 7 miles an hour. The highest monthly velocities usually occur in March, April and May. During July and August the atmosphere is generally comparatively quiet. Hot winds are almost unknown at Akron. The nights are cool the year round. While winter temperatures are often low, they are not as low as in many other parts of the Great Plains. The summer temperatures at Akron usually are mild, due to the elevation, about 4,500 feet above sea level. The average frost-free period has been about 142 days. Evaporation records from a free water surface show an average evaporation from April 1 to September 30, inclusive, of approximately 43 inches. This is more than three times the average concurrent precipitation. This emphasizes the need for careful moisture conservation.

Table 1.—Seasonal Precipitation, Evaporation, Ratio of Precipitation to Evaporation, the Dates of Last Spring and First Autumn Frost and the Frost-Free Period in Days for the 7-Year Period, 1926 to 1932, inclusive, at the Akron Field Station.

Year	Seasonal precipitation, inches	April to Sept.		Frost Dates		Frost-free period, days
		Evaporation, inches	Ratio precipitation to evaporation	Last spring	First autumn	
1926	17.62	44.366	1:2.52	April 25	Sept. 24	152
1927	16.53	40.429	1:2.45	May 10	Sept. 26	139
1928	12.51	43.161	1:3.45	April 27	Sept. 21	146
1929	15.54	40.075	1:2.58	May 2	Oct. 22	172
1930	16.82	33.348*	1:2.29	May 17	Sept. 25	130
1931	7.45	47.296*	1:7.16	May 21	Oct. 13	145
1932	13.13	49.177	1:3.74	April 29	Oct. 3	157
7-yr. Av.	14.23	42.55	1:3.46	May 6	Oct. 2	149
25-yr. Av.	....	....	....	May 11	Sept. 28	140

*Evaporation for May to September, inclusive.

The climatic data for the period from 1926 to 1932 are given in Table 1. The evaporation remains about the same as for the previous 18 years. The precipitation during the growing season,

April to September, was exceedingly low in 1931. The first killing frost was somewhat earlier than for the previous 18-year period. The average for this period was September 30. The general trend of these records show that average conditions have prevailed at Akron for the past 7 years.

PRECIPITATION.—The rainfall data for the 7-year period, 1926 to 1932, are given in Table 2. The rainfall in 1926, 1927, 1929 and 1930 was above average. In 1928, the precipitation was below the average. The spring months of this year were low in moisture. The seasonal precipitation, however, was only slightly below average. The season of 1931 was exceedingly dry and most of the reserve moisture in the subsoil was used up. The precipitation in 1932 was 17.21 inches, which is slightly below average for the 25-year period, 1908 to 1932. The rainfall during the growing season was high, but due to the very dry season in 1931, the reserve moisture was low and this had its effect in decreasing crop production.

Table 2.—Monthly, Annual and Seasonal Precipitation for the 7-Year Period from 1926 to 1932, Inclusive, at the Akron Field Station.

	1926	1927	1928	1929	1930	1931	1932	Av. for 7 yrs.	Av. for 25 yrs.
January	.41	.17	.13	.07	.07	.01	.27	.16	.31
February ...	.05	.29	.17	.34	T	.71	.25	.26	.44
March	.36	2.41	.32	.32	.17	.95	.60	.73	.78
April	.18	2.27	.17	3.43	2.28	.84	1.93	1.59	2.14
May	3.77	1.46	3.52	1.19	5.52	1.38	2.91	2.82	2.71
June	1.42	5.16	5.39	1.15	1.61	2.20	2.80	2.82	2.33
July	6.46	3.00	3.14	4.44	3.54	1.49	4.17	3.75	2.79
August	5.07	3.74	.25	2.66	3.48	1.04	1.27	2.50	2.14
September ..	.72	.90	.04	2.67	.39	.50	.05	.75	1.41
October	1.03	.14	1.75	2.76	.83	.61	.49	1.09	1.10
November ...	.41	.64	.49	.49	1.05	.11	.19	.48	.55
December ...	.28	.22	T	.09	.09	.90	.21	.26	.64
Annual 20.16		20.40	15.37	19.61	19.03	10.74	15.14	17.21	17.35
Seasonal, Apr.-Sept.	17.62	16.53	12.51	15.54	16.82	7.45	13.13	14.23	....

EXPERIMENTAL METHODS.—The winter-wheat plats are replicated four times—two plats on summer fallow and two on corn land. The yield is determined from the average of all four plats. The plats are 8 rods long and 6 feet wide with a 16-inch alley between them. The plats contain one-fifty-fifth (1/55) of an acre. Since the plats draw some moisture and plant food from the alleys, it seems fair to consider the area one-fiftieth of an acre when computing yields, altho the actual size is slightly less.

The spring-wheat test has been carried in small nursery plats since 1927. The tests were made on summer fallow. The supplementary spring-wheat variety test was carried on summer fallow. The plats were one-fiftieth (1/50) acre in size and were grown in

duplicate. Only the early maturing varieties were harvested in 1931. A hailstorm on July 19 damaged the later-maturing varieties.

The winter-wheat variety tests are sown at the rate of 3 pecks per acre. Spring wheat is sown at the rate of 4 pecks. Winter wheat is generally sown in September. During the past 7 years the seeding date has varied between September 17 and 29. Spring wheat has been sown as early in the spring as practicable. Generally, conditions are favorable for seeding in the latter part of March. The crop records at the Akron Field Station show that any delay in the seeding of spring grain after the first part of April is to be avoided, if possible, because the chances for favorable yields of spring grain decrease as the seeding date is delayed.

EXPERIMENTAL RESULTS.—Winter wheat is the most important crop in the dryland sections of Colorado. From 80 to 85 percent of the total winter-wheat crop of the state is produced on drylands. The crop is especially important in the northeastern part of the state where the United States Dry Land Field Station is located. For that reason, the experiments with winter wheat have been far more extensive than those with all other crops, altho both winter and spring varieties have been included in the experiments at Akron. The experiments with spring wheat have ranked second in importance.

WINTER WHEAT.—The winter-wheat variety tests have been conducted for the past 24 years. This bulletin reports the results over the past 7 years. In 1926 the yields were exceedingly low due to adverse climatic conditions. The annual precipitation for 1925 was below average and the rainfall in the early spring of 1926 was exceedingly low. After having been injured by the winds of the early spring, April rains would have been especially welcome to this test. However, April passed with but 0.18 of an inch of rainfall, and relief from the drouth was not had until the middle of May. The rains the middle of May were only sufficient for immediate needs, and soon after the first of June, winter wheat began to suffer for moisture. Wheat was just breaking into head when a severe hail the night of June 15 completed the damage of a very adverse early spring.

In 1932, the spring was very dry and due to the dry season of 1931, there was no reserve moisture stored in the subsoil. However, the seasonal rainfall made up somewhat for the lack of stored water and fair yields were obtained on fallow but those on corn land were low.

The yield data are given in Table 3 for the 7-year period—1926 to 1932, inclusive. Of the varieties tested for 7 years, Kanred Selection .0166, C. I. 10099 and Tenmarq, C. I. 6939, yielded slightly higher than the Kharkof, C. I. 1583 check. Several other Crimean

Table 3.—Yields of Winter Wheat at the Akron Field Station for Varying Periods from 1926 to 1932, Inclusive.

Variety	C. I. No.	YIELD, BUSHELS PER ACRE							Years Grown	Average	Kharkof Percentage
		1926	1927	1928	1929	1930	1931	1932			
Alton	1438	0.9	15.4	23.8	6.3	15.6	9.6	5.3	7	11.0	75.76
Blackhull	6251	2.1	16.1	34.6	9.7	19.5	10.1	9.5	7	14.5	100.10
Kanred	5146	1.3	15.9	36.7	9.2	20.1	8.8	8.0	7	14.3	98.52
Kanred Sel. .0166	10099	0.9	14.9	39.7	9.8	22.7	9.4	8.0	7	15.1	103.84
Kharkof	1583	1.6	17.6	36.2	8.6	21.6	10.3	5.6	7	14.5	100.00
Kharkof	1442	1.5	...	...	...	...	9.2	7.2	3	6.0	102.29
Pesterboden Sel.	8266	1.3	21.2	34.3	8.3	19.7	10.3	7.2	7	14.6	100.79
Tenmarq	6936	1.3	22.5	35.0	9.0	20.7	9.2	8.7	7	15.2	104.83
Turkey Sel. 159	10100	1.5	16.8	36.0	9.9	21.3	10.6	7.4	7	14.8	101.97
Minturki	6155	2.0	15.0	27.6	...	...	...	4.9	4	12.4	81.15
Kharkof, Hays No. 2	6686	..	...	40.2	8.1	21.3	10.6	6.5	5	17.3	105.35
Nebraska No. 6	6249	..	...	39.1	8.3	20.1	10.8	6.7	5	17.0	103.28
Nebraska No. 60	6250	..	...	39.1	7.5	17.9	9.4	6.6	5	16.1	97.81
Newturk	6935	..	...	34.1	7.6	18.2	9.3	6.8	5	15.2	92.35
Oro	8220	..	...	38.2	8.8	18.8	9.8	7.2	5	16.6	100.61
Minhardi x Minturki	8034	..	...	...	6.9	17.2	9.1	4.7	4	9.5	82.21
Yogo	8033	..	...	...	7.0	22.7	9.7	8.4	4	12.0	103.69
Early Blackhull	8856	..	...	...	...	22.1	7.4	9.8	3	13.1	104.80
Quivira	8886	..	...	...	...	19.9	8.5	7.1	3	11.8	94.67
Cheyenne	8885	..	...	...	...	17.5	10.3	7.2	3	11.7	93.33
Turkey Sel. (Nebr.)	10016	..	...	...	...	...	...	9.3	1	9.3	....
Alton Sel. D 7112 G	...	1.6	...	...	...	...	...	...	1	1.6	....
Alton Sel. B 7166 G	...	1.2	...	...	...	...	...	...	1	1.2	....
Alton Sel. D 730 G	...	1.4	...	...	...	...	...	...	1	1.4	....
Kharkof (Hays, Kan.)	1442	1.3	...	...	...	...	...	...	1	1.3	....
K by N. Sel. 166 B14-3	...	1.8	...	...	...	...	...	...	1	1.8	....
K by N. Sel. 166 B4-2	...	1.8	...	...	...	...	...	...	1	1.8	....
Sherman	4430	1.1	...	...	...	...	...	...	1	1.1	....
Turkey	1571	1.5	...	...	...	...	...	...	1	1.5	....
Hussar	4843	1.3	17.8	26.5	...	...	...	...	3	15.2	82.31
Kanmark	6937	1.0	19.2	33.7	8.3	...	...	...	4	15.5	97.19
Kanred Selc. 1499 Kd	...	1.2	16.2	36.2	9.6	...	...	...	4	15.8	98.75
Marquis x Kanred	10009	0.8	14.7	32.2	7.8	...	...	...	4	13.8	86.72
Marquis x Kanred	10008	1.5	23.6	31.3	9.1	19.8	9.6	...	6	15.8	98.96
Superhard	8054	..	17.4	35.9	7.8	...	...	...	3	20.4	97.92
Regal	7364	..	...	35.1	6.0	14.7	...	...	3	18.6	84.04
Ridit	6703	..	...	...	7.2	15.0	...	...	2	11.1	73.51
Colo. Mutant 556	...	..	...	...	7.2	18.4	7.5	...	3	11.0	81.73

types equal the yield of the Kharkof check. Blackhull, C. I. 6251 yielded well, having a 1.5 percent higher yield than Kanred over this 7-year period; however, over a longer period—1920 to 1932—Kanred has outyielded Blackhull by 7 percent. This yield does not surpass Kanred sufficiently to justify the recommendation of this variety in place of Kanred or other Crimean wheats. Several other varieties have been grown for shorter periods. Kharkof Hays No. 2, C. I. 6686, Nebraska 6, C. I. 6249, Nebraska 60, C. I. 6250, Newturk, C. I. 6935 and Oro, C. I. 8220, have been grown for the past 5 years (1928 to 1932). Kharkof, Hays No. 2, C. I. 6686, was the highest-yielding variety of the wheats tested for this 5-year period. Other varieties have been tested for a shorter period but need further tests before recommendations can be made. Seventeen varieties have been dropped from the test because of low yield.

AGRONOMIC DATA.—The summary of the agronomic data is found in Table 4. It will be noted that all of the varieties are shorter in straw length than those grown under irrigation. However, they are of sufficient length to be harvested with machinery. When we consider the date of heading, we find that Kanred, C. I. 5146, Kharkof, C. I. 1583, Kanred Sel. .0166, C. I. 10099 and Tenmarq, C. I. 6939, all head within a few days of each other, on the average. When we rank the varieties tested for 5 years only, from earliest heading to latest, we have the following sequence: Nebraska No. 6, C. I. 6259, Oro, C. I. 8220, Kharkof, C. I. 6686, Newturk, C. I. 6935, and Nebraska No. 60, C. I. 6250. All of the varieties which yield well under Akron conditions are more or less early heading varieties.

MILLING AND BAKING TESTS.—The following varieties have been tested for milling and baking quality: Pesterboden Sel., C. I. 8266, Marquis x Kanred, C. I. 10009, Kanmark, C. I. 6937, Kharkof, C. I. 1583, Marquis x Kanred, C. I. 10008, Blackhull, C. I. 6251, Kanred C. I. 5146, Tenmarq, C. I. 6936, Super Blackhull, C. I. 8054, Turkey Sel. 159, C. I. 10100 and Colorado 556. The tests in 1927, 1928 and 1929 were conducted by Dr. C. O. Swanson of the Department of Milling Industry, Kansas Agricultural College, Manhattan, Kansas. A high-speed mechanical mixer was used in this test. The tests in 1930 and 1931 were made by the Bureau of Plant Industry, in co-operation with the Bureau of Agricultural Economics, United States Department of Agriculture, Washington, D. C.

Table 4.—Agronomic Data on Winter-Wheat Varieties Grown at Akron, Colorado, for Varying Periods from 1926 to 1932, Inclusive.

Variety	C. I. Number	Date Headed	Maturity	Straw Length	Years Grown
Alton	1438	6/17	7/26	28	7
Blackhull	6251	6/15	7/13	29	7
Kanred	5146	6/14	7/15	26	7
Kanred Sel. .0166	10099	6/14	7/15	28	7
Kharkof	1583	6/15	7/18	28	7
Kharkof	1442	6/20	7/15	26	3
Pesterboden Sel.	8266	6/16	7/14	28	7
Tenmarq	6939	6/14	7/13	28	7
Turkey Sel. 159	10100	6/15	7/14	29	7
Minturki	6155	6/20	7/23	33	4
Kharkof (Hays No. 2)	6686	6/17	7/14	27	5
Nebraska No. 6	6249	6/16	7/14	26	5
Nebraska No. 60	6250	6/19	7/14	26	5
Newturk	6935	6/18	7/13	27	5
Oro	8220	6/16	7/13	27	5
Minhardi x Minturki	8034	6/21	7/15	26	4
Yogo	8033	6/17	7/12	25	4
Early Blackhull	8856	6/9	7/8	30	3
Quivira	8886	6/11	7/8	29	3
Cheyenne	8885	6/17	7/12	25	3
Turkey Sel. (Nebr.)	10016	6/22	7/18	24	1
Hussar	4843	6/14	7/20	34	3
Kanmark	6937	6/15	7/19	29	4
Kanred Sel. 1499 Kd.	...	6/13	7/17	27	4
Marquis x Kanred	10009	6/16	7/19	29	4
Marquis x Kanred	10008	6/15	7/16	30	6
Superhard	8054	6/14	7/11	30	3
Regal	7364	6/15	7/17	30	3
Ridit	6703	6/19	7/10	31	2
Colo. Mutant 556	...	6/17	7/10	25	3

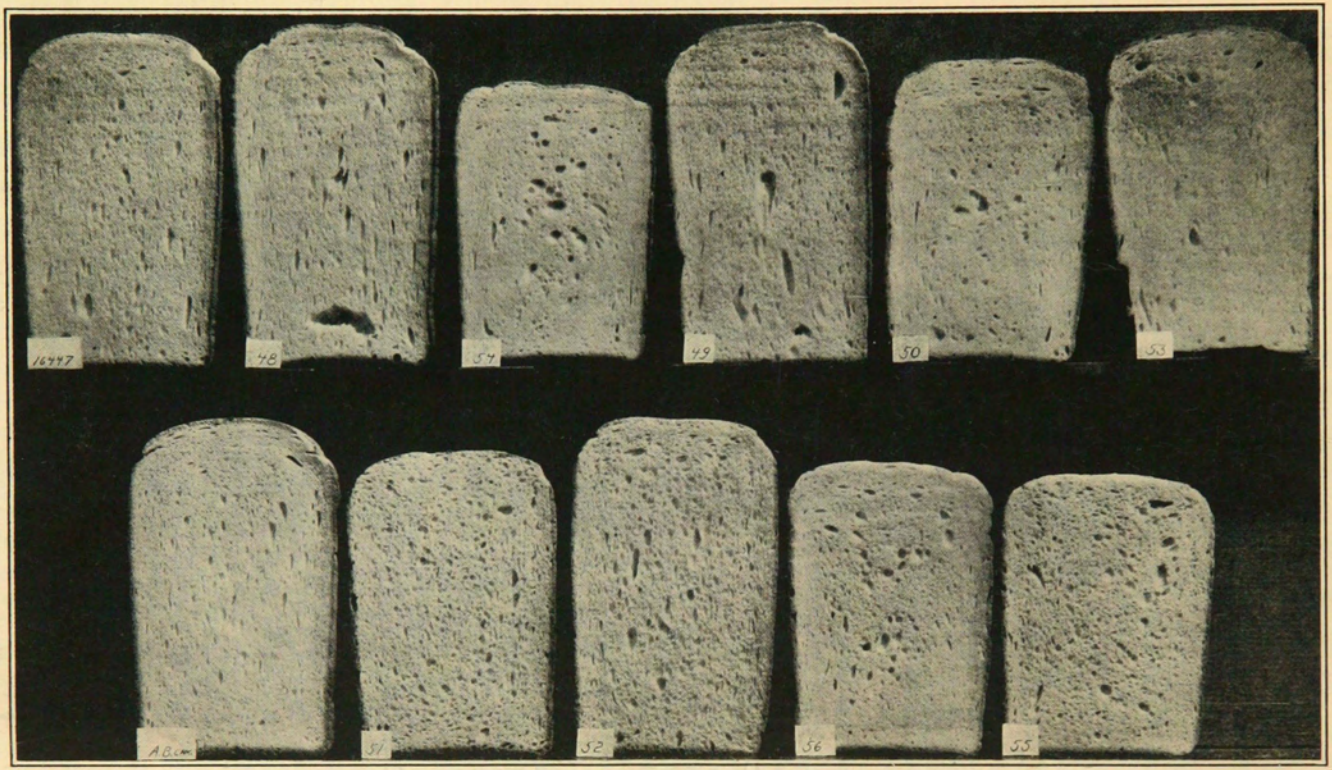


Fig. 5. Samples of bread baked from the 1930 crop.

16447=1656-48, 48=Komar, 54=6898, 49=1656-85, 50=Ceres, 53=Marquis No. 1, 51=Pilcraw, 52=Onas, 56=Texas Red, 55=Early Baart.

Table 5.—Milling and Baking* Tests of Winter Wheat Grown at the Akron Station for Varying Periods from 1927 to 1929.

Variety	C. I. No.	Year	Test Weight	Flour Yield Percentage	Protein in Wheat Percentage	Absorption Percentage	Loaf Volume C. C.	Texture Percentage	Color Percentage
Pesterboden Sel.	8266	1927	55.2	68.3	....	70	2100	97	97
		1928	59.0	68.8	15.50	72	1935	96	95
		1929	57.8	67.3	18.15	78	1415	90	99
		Average	57.3	68.1	16.83	73.3	1817	94.3	97
Kharkof	1583	1927	51.4	66.8	....	73	2065	97	97
		1928	58.5	65.8	14.65	79	1785	97	99
		1929	57.5	62.3	18.60	78	1625	90	99
		Average	55.8	65.0	16.63	76.7	1828	94.7	98.3
Marquis x Kanred	10008	1927	55.9	69.8	....	75	2030	89	95
		1928	59.3	68.5	15.75	79	1995	97	97
		1929	59.0	67.3	17.80	75	1570	90	98
		Average	58.1	68.5	16.78	76.3	1865	92	96.7
Blackhull	6251	1927	60.2	68.8	....	73	1730	87	97
		1928	60.2	67.3	14.55	71	1580	80	90
		1929	56.6	65.0	17.35	74	1585	90	99
		Average	59.3	67.0	15.95	72.7	1632	85.7	95.3
Kanred	5146	1927	55.1	70.5	....	73	2030	94	94
		1928	59.7	67.5	15.25	87	1875	97	97
		1929	57.1	65.0	15.10	81	1765	91	99
		Average	57.3	67.7	15.18	80.3	1890	94	96.7
Kanmark	6937	1927	56.7	67.5	....	72	2130	97	97
		1928	59.9	67.5	15.00	76	2075	99	99
Marquis x Kanred	10009	1927	56.2	69.3	....	69	2105	95	96
		1928	59.3	68.5	15.35	75	2150	99	99
Tenmarq	6936	1928	60.3	67.5	14.80	84	1990	99	99
		1929	55.3	66.0	17.60	74	1720	91	98
Superhard	8054	1928	60.8	67.3	14.50	85	1740	90	84
		1929	57.5	66.3	17.10	78	1550	90	99
Turkey Sel. 159	10100	1929	58.5	66.5	18.90	79	1560	90	99
Colorado 559	...	1929	56.2	62.0	18.85	79	1595	90	99

*Tests made by the Department of Milling Industry. Kansas State Agricultural College, Manhattan, Kansas.

Table 5 gives the results obtained with the high-speed mixing machine. Under this treatment some varieties do not stand up, indicating a lack of quality in the protein complex. Kanred, C. I. 5146, has a high absorption percentage, volume of loaf indicating light bread and good texture and color. Kharkof, C. I. 1583, shows the same characteristics. Pesterboden Sel., C. I. 8266, is a little low in absorption percentage, but has good quality of loaf. Blackhull is lowest in all the characters tested for baking quality. The loaf volume is particularly low.

Several other varieties were tested for shorter periods. Colorado 556, Kanmark, C. I. 6937, Marquis x Kanred, C. I. 10009, Marquis x Kanred, C. I. 10008, and Superhard, C. I. 8054, have been dropped from the varietal test because of low yield. Tenmarq, C. I. 6936, was tested in 1928 and 1929, and when compared with Kanred, C. I. 5146, showed slightly better baking quality. Turkey Sel. 159, C. I. 10100, was only tested for 1 year.

The results of the tests made in 1930 and 1931 are given in Table 6.

In the tests of 1930 and 1931, it will be noted that the volume of loaf is lower, smaller amounts of dough being used. Blackhull, C. I. 6251, in this test gives a better-quality loaf but gives a slightly lower straight flour yield than Kanred, C. I. 5146. Several of the newer varieties show up well in milling and baking qualities. Yogo, C. I. 8033, has a good quality loaf, but the flour yield is slightly lower than Kanred, C. I. 5146. Turkey Selection 159, C. I. 10100, shows good quality and ranks well with the other Crimean types of wheat grown in the test. Quivira, C. I. 8886, and Tenmarq, C. I. 6936, are also good milling wheats. However, the straight flour yield of Quivira is low. Further tests, however, are necessary before many of the wheats tested can be eliminated on milling and baking quality.

COMPARISON OF FALLOW AND CORN LAND.—When we consider the yields of some of the better-yielding varieties of wheat on summer fallow and on corn land, we find that the summer fallow outyielded the corn land by about 9.5 bushels. When fallow is used, each wheat crop must bear almost the entire expense of soil preparation, interest on land, the interest and depreciation on equipment for 2 years, and the cost of seeding and harvest for 1 year. When wheat is grown after corn, the wheat crop carries a lower charge for soil preparation, an equal charge for seeding, at least no greater for harvesting, and interest and depreciation for 1 year only. In determining the best method of preparation for winter wheat one should consider the yield of both wheat and corn. When the corn value is added to that from the wheat grown on the corn land, the disadvantage or advantage of the fallow system for conditions similar to those at Akron may be determined.

Table 6.—Milling and Baking Tests of Winter Wheats Grown at Akron in 1930 and 1931.

Variety	C. I. No.	Year	Wt. per Measured Bushel	Straight Flour Percentage	Water Absorption	Volume of Loaf, C. C.	Weight of Loaf, gm.	Color of Crumb	(a) AACC Score
Kanred	5146	1930	57.4	75.5	58	393	137	50 Cr Gr	J2
		1931	57.5	70.0	58	475	143	65 Cr	J2
Alton	1438	1930	57.5	74.0	58	430	139	70 Cr Gr	J2
		1931	58.9	70.9	58	440	142	65 Cr Gr	J2
Blackhull	6251	1930	55.8	72.9	58	500	134	70 Cr Gr	J3.5
		1931	58.1	69.5	58	472.5	143	75 Cr	J3
Early Blackhull	8856	1930	56.1	72.7	58	480	134	80 Cr	J3.5
		1931	58.8	70.0	58	427.5	141	75 Cr Gr	J2
Yogo	8033	1930	53.4	72.6	61	498	139	70 Cr Gr	L3
		1931	56.1	69.9	58	500	140	70 Cr	J2.5
Minhardi x Minturki	8034	1930	55.4	75.3	55	518	140	75 Cr	J3.5
		1931	57.1	72.8	58	572.5	140	75 Cr	J2.5
Nebraska No. 6	6249	1930	59.5	75.5	58	405	136	65 Cr Gr	J2.5
		1931	57.6	68.8	58	457.5	145.5	75 Cr	J2.5
Minturki	6155	1931	56.6	63.1	58	452.5	140.5	65 Cr	J2
Kharkof	1442	1931	57.4	66.7	62	452.5	147	75 Cr	J2
Kharkof	6686	1931	57.3	68.2	59	482.5	144.5	70 Cr	J3
Kharkof	1583	1931	57.6	63.2	61	422.5	145	70 Cr	J2
Newturk	6935	1931	57.1	70.9	60	510	144	60 Cr Gr	J2
Cheyenne	8885	1931	59.0	73.8	58	477.5	141.5	75 Cr Gr	L.B.
Nebraska No. 60	6250	1931	57.8	69.9	60	505	145	70 Cr	M3
Pesterboden Sel.	8266	1931	57.8	70.9	63	520	147.5	75 Cr	J2.5
Oro	8220	1931	57.5	70.0	58	565	138	75 Cr	M3.0
Turkey Sel. 159	10100	1931	55.7	70.3	63	495	148	70 Cr	J2
Kanred Sel. 0166	10099	1931	56.7	69.7	60.5	527.5	145	75 Cr	J2.5
Tenmarq	6936	1931	55.3	64.3	58	540	140	75 Cr	L2.5
Quivira	8886	1931	57.1	71.2	58	520	142	70 Cr Gr	J2

(a) Blish, M. J. Report of Committee on Standardization of Experimental Baking Test. Cereal Chem. Vol. V, pp. 277-294.
(a) Harrel, C. G., 1929. Report of Committee on Standardization of Experimental Baking Test. Cereal Chem. Vol. VI, pp. 249-258.

CONCLUSION FOR WINTER WHEAT.—Kanred, C. I. 5146, and the other Crimean types of wheat are the varieties adapted to Akron conditions. While Tenmarq, C. I. 6936, yields well, its non-hardy quality is undesirable for conditions similar to those found at Akron. Blackhull, C. I. 6251, seems to have a type of protein which will not stand up to rough usage such as is encountered in a high-speed dough mixer. The quality of loaf when such a mixer is used is low when compared with that of Kanred, C. I. 5146. The winter hardiness of Blackhull, C. I. 6251, under Akron conditions is much lower than that of Kanred, C. I. 5146, and is also lower than Tenmarq, C. I. 6936.

SPRING-WHEAT VARIETIES.—Spring wheat, as a general rule, will not yield as well as winter wheat on the drylands of Eastern Colorado. Variety tests with spring wheat have been carried for the past 7 years at the Akron Field Station. Several varieties have been tested for the entire period. The 1931 results are omitted because a hail storm destroyed the plats on July 19. The yield in 1926 was obtained from one-fiftieth-acre plats—two on fallow and two on corn land. The yields were exceedingly low due to unfavorable weather conditions. The yields in the remainder of the tests were obtained from small nursery plats replicated 4 times (5 plats). When we examine the yield of the varieties tested for 5 years or longer, we find that Komar, C. I. 8004, and Quality, C. I. 6607, are the two highest yielders. Komar was the highest-yielding variety in the test. Ceres, C. I. 6900, also yielded well but yielded considerably less than Komar. The highest-yielding white spring wheat was Quality, C. I. 6607. The highest-yielding Durum wheat was Akrona, C. I. 6881. An additional test with spring wheat was started in 1930. Several of the better-yielding varieties were sown in one-fiftieth-acre plats in duplicate on summer fallow. In 1931, only the early maturing varieties were harvested before the hail storm of July 19. The remaining plats were damaged by hail but were later harvested and yields taken. When we compare the yields of the different varieties with Peliss, we find that Komar is the highest yielding variety. In the calculation of average yields the hailed plats were not used. Quality again yielded well but was closely followed by Hard Federation, C. I. 4733, another white wheat.

CONCLUSIONS FOR SPRING WHEAT AT AKRON.—Komar, C. I. 8004, a late-maturing variety, at the Akron Field Station outyielded all other varieties.

Akrona, C. I. 6881, was the highest-yielding Durum wheat.

Quality, C. I. 6607, was the highest-yielding white wheat grown at the Akron Field Station.

Table 7.—Yields of Winter Wheat Grown on Duplicate Plats on Both Fallow and Corn Land at the Akron Field Station for the 7-Year Period 1926 to 1932.

Name	C. I. No.	BUSHELS PER ACRE							
		1926	1927	1928	1929	1930	1931	1932	7-yr. Av.
Fallow									
Blackhull	6251	2.7	18.2	45.0	13.2	19.6	16.2	17.7	18.9
Kanred	5146	1.9	19.8	48.2	14.4	19.5	14.8	14.8	19.1
Kanred Sel. .0166	10099	1.3	18.5	49.5	14.8	21.7	15.8	14.8	19.5
Kharkof	1583	2.2	21.5	49.0	13.6	24.0	16.2	10.2	19.5
Tenmarq	6936	1.8	27.3	48.6	13.8	20.2	14.7	16.3	20.4
Turkey Sel. 159	10100	2.0	19.1	46.6	15.4	22.1	17.3	13.4	19.4
									116.8
									19.5 Av.
Corn Land									
Blackhull	6251	1.5	13.9	24.1	6.2	19.4	4.1	1.3	10.1
Kanred	5146	.7	11.9	25.1	4.0	20.6	2.8	1.2	9.5
Kanred Sel. .0166	10099	.6	11.3	29.9	4.6	23.8	3.1	1.2	10.6
Kharkof	1583	1.1	13.7	23.4	3.6	19.0	4.4	1.1	9.5
Tenmarq	6936	.7	17.7	21.3	4.2	21.3	3.8	1.2	10.0
Turkey Sel. 159	10100	1.1	14.5	25.3	4.5	20.4	3.9	1.5	10.2
									59.9
									10.0 Av.

Table 8.—Spring-Wheat Variety Tests Conducted at the Akron Field Station for Varying Periods from 1926 to 1932, Inclusive.

Variety	C. I. No.	YIELD, BUSHELS PER ACRE						Years Grown	Average	Peliss Percentage
		1926 (a)	1927 (b)	1928 (b)	1929 (b)	1930 (b)	1932			
Akrona	6881	0.1	19.2	18.9	8.9	7.8	6.0	6	10.2±0.38	105.55
Kubanka	1440	0.2	18.8	13.8	10.0	8.7	5.6	6	9.5±0.36	98.96
Quality	6607	0.9	12.8	19.5	12.5	12.4	10.0	6	11.4±0.43	118.02
Prelude	4323	0.7	(c)14.4	15.4	11.4	13.4	6.1	6	10.2±0.39	106.41
Converse	4141	1.0	12.7	17.4	13.2	9.0	6.0	6	9.9±0.37	102.77
Peliss	1584	0.3	13.8	15.6	12.7	8.1	7.2	6	9.6±0.36	100.00
Hard Federation	4733	1.1	12.6	10.1	14.0	...	...	4	9.5±0.40	89.15
Marquis	3641	1.0	13.8	9.6	8.1	6.3	3.1	6	7.0±0.26	72.62
Kota	6248	0.7	7.8	13.6	11.9	...	...	4	8.5±0.36	80.19
Vernal	3686	0.4	12.1	12.1	3.0	...	...	4	6.9±0.29	65.09
Komar 1656-84	8004	..	19.4	20.7	16.9	11.2	8.7	5	15.3±0.58	151.79
Ceres	6900	..	17.2	17.0	13.1	10.6	6.4	5	12.9±0.49	112.02
Garnet	8181	..	15.9	14.7	9.8	...	...	3	13.5±0.57	95.96
Red Mediterranean	....	..	14.5	15.2	12.8	11.6	9.5	5	12.7±0.48	110.80
Reliance	7370	..	14.5	14.7	11.9	...	...	3	13.7±0.58	97.62
Otis	....	..	8.9	15.5	13.0	...	...	3	12.5±0.53	88.84
Marquillo	6887	..	...	(d)10.8	10.0	6.8	5.1	4	8.2±0.37	75.00
Probable error in percent	....	..	7.50	6.36	7.87	5.63	12.70	..	.....	....

(a) 1/50-acre plats—2 on fallow and 2 on corn land.
(b) Nursery plats—replicated 4 times.
(c) Average of 4 plats.
(d) Average of 3 plats.
1931—Hail destroyed plats.

Table 9.—Supplemental Spring-Wheat Varietal Tests at Akron Field Station Grown on Fallow on Duplicate One-Fiftieth-Acre Plats for the Years 1930, 1931 and 1932.

Variety	C. I. No.	1930	1931	1932	Years Grown	Average	Prelude Percentage
Prelude	4323	9.6	10.8	23.8	3	14.7	100.00
Quality	6607	5.6	14.4	29.5	3	16.5	111.99
Hard Federation	4733	6.5	14.4	27.9	3	16.3	110.41
1656-85	8385	12.1	2.6 (a)	32.4	2	22.3	128.61
Komar	8004	8.4	3.1 (a)	34.3	2	21.4	123.41
1656-48	10014	10.9	3.8 (a)	30.8	2	20.9	120.52
Ceres	6900	4.6	3.1 (a)	30.6	2	17.6	101.73
Converse	4141	5.0	2.0 (a)	29.7	2	17.4	100.29
Akrona	6881	5.0	2.9 (a)	26.4	2	15.7	90.75

(a) Damaged at least 60 percent by hail on July 19.

VARIETAL EXPERIMENTS AT FORT COLLINS, UNDER IRRIGATION

D. W. ROBERTSON, ALVIN KEZER AND WAYNE AUSTIN

CLIMATE.—The climate at Fort Collins is suitable for the production of small grains. Sufficient rainfall is obtained in average years to start a fall-sown winter-wheat crop and carry it thru successfully until spring irrigation can be applied. With few exceptions, sufficient rainfall comes in the months of March and April to start a spring-wheat crop. Table 10 gives the rainfall for the years 1926 to 1932, inclusive.

Table 10.—Monthly Rainfall at the Colorado Experiment Station, Fort Collins, for the Years 1926-1932, Inclusive.

Month	1926	1927	1928	1929	1930	1931	1932
January	0.25	0.04	0.26	0.21	0.45	0.00	0.08
February	0.28	0.40	0.52	0.70	0.07	1.26	0.48
March	1.54	1.87	1.38	1.78	0.70	0.41	1.09
April	2.88	2.77	1.02	2.37	0.58	1.07	0.71
May	1.67	0.83	3.01	1.08	3.92	2.94	2.65
June	1.66	1.95	2.95	0.64	1.50	1.46	1.26
July	0.71	1.96	0.79	0.46	1.04	0.05	2.08
August	0.76	1.52	0.27	2.35	5.88	0.75	3.29
September	1.01	1.10	0.09	2.13	0.16	0.51	0.01
October	1.00	1.05	1.50	0.99	0.36	1.00	0.34
November	0.36	1.00	1.15	0.93	0.70	0.63	0.34
December	0.83	0.25	0.06	0.09	0.14	0.18	0.49
Total	12.95	14.74	13.00	13.73	15.50	10.26	12.82

Note:—The monthly rainfall for 1929 was obtained from Mr. R. E. Trimble, Meteorologist. The records of January, February, March, October, November and December are also furnished by Mr. Trimble. The records for the other months are obtained on the experiment station farm. They differ slightly from the United States records for Fort Collins. The difference is due to local showers in the summer. The U. S. Weather Bureau station is on the college campus about 1 mile west of the experimental farm.

Winter wheat over-winters with little killing in this section. But some damage is done in the spring by dry winds and dry soil which often reduces the stands of some of the less-hardy varieties.

RAINFALL.—During the entire period of the test, 1926 to 1932, only 1 year exceeded the average in precipitation. In this year, 1930, a heavy period of rainfall in August came too late to be of any value to the wheat crop. The dry year of 1931 showed its effect in 1932 when the reserve moisture in the subsoil was low. Irrigation water was applied to the winter-wheat crop only in 1931 and 1932. The spring-wheat crop was irrigated once each year during the period of the experiment. As a rule, the winter-wheat crop will mature on fallow without irrigation under Fort Collins conditions.

TREATMENT OF PLATS.—All of the plats are replicated. They were irrigated at as near heading as possible. The plats were sown on summer fallow. While this gave results slightly different from farm conditions, it gave comparative tests. Previous tests have shown that in order to control weeds and get comparative yields, summer fallow was necessary.

CARE OF GRAIN.—The threshed grain from the plats is cleaned and weighed. The yield per acre is determined from the cleaned-grain weight. Probable errors are calculated by the deviation from the mean method.[1] Ten nursery plats of each variety are grown.

TIME AND RATE OF SEEDING.—The winter-wheat plats are planted about September 10. Spring wheat is planted from March 20 to April 10. An attempt is made to plant it as soon after March 20 as possible. The rates of seeding are 60 pounds per acre for winter wheat and 90 pounds per acre for spring wheat.

EXPERIMENTAL RESULTS

In a previous publication,[2] the results of the wheat variety tests up to 1925 are discussed.

The data in this bulletin deal with the results for the period from 1926 to 1932. Table 11 gives the yield data of the winter-wheat varieties grown at Fort Collins during this period.

Of the varieties tested for 3 years or more which are still being grown in 1932, only three outyielded Kanred. None of them, however, outyielded Kanred sufficiently to recommend replacing it as an irrigated winter wheat. Several varieties have been dropped from the test. Superhard did not yield sufficiently high to recommend its use under irrigation. It yielded 93.6 percent while Kanred yielded 100 percent for the same years. The early maturing Turkey strain from Akron yielded 7.5 percent less than Kanred.

Several new varieties were introduced in 1932, but have not been tested long enough to determine their yielding ability.

Table 12 gives the agronomic data on the winter-wheat varieties grown in the test at Fort Collins. Several varieties show indications of having weak straw. The length of straw varies slightly from 40 inches to 54 inches. The date of heading, if taken as an indication of maturity, shows Mutant, Colorado No. 348 and Tenmarq to be the earlier-maturing varieties tested for 5 years or more. Several of the Old Beardless Turkey selections are early but need testing for a longer period.

[1]Hayes, H. K., and Garber, R. J. "Breeding Crop Plants" (Second Edition. 1927)—pp. 81-84.

[2]Kezer, A., et al. "Colorado Wheat Varieties," Colo. Exp. Sta. Bul. 329.

Variety	C. I. No.	YIELD, BUSHELS PER ACRE							Average	Yield in Percentage Kanred
		1926	1927	1928	1929	1930	1931	1932		
Fultz Mediterranean Selection	...	75.9	76.5	66.4	55.8	60.7	44.9	53.6	62.7±0.61	97.3
Kanmark	6937	...	...	70.1	57.4	74.2	50.5	36.1	57.7±0.71	93.8
Kanred	5146	70.7	73.2	62.2	61.8	74.4	54.3	54.5	64.4±0.63	100.0
Kansas Selection P 1068-6-18	...	71.7	80.2	66.8	56.6	70.7	56.4	52.6	65.0±0.64	100.9
Marquis x Kanred	10008	...	...	66.3	55.7	65.7	44.5	...	58.0±0.70	91.9
Marquis x Kanred	10009	...	...	64.1	61.2	72.7	50.6	46.4	59.0±0.73	96.0
Mutant Colo. 348	...	77.5	75.6	71.1	54.7	77.2	58.8	52.1	66.7±0.65	103.5
Nebraska No. 60	6250	...	...	62.5	54.7	73.8	56.0	53.5	60.1±0.74	97.8
Pesterboden Selection	8266	...	...	61.1	54.6	66.9	56.0	48.6	57.4±0.71	93.5
Tenmarq	6936	...	...	75.6	56.6	71.8	51.0	58.0	62.6±0.77	101.9
Early Blackhull	8856	...	...	...	...	...	...	44.9	44.9±1.13	82.4
Oro	8220	...	...	...	...	...	...	51.4	51.4±1.30	94.3
Quivira	8886	...	...	...	...	...	...	54.3	54.3±1.37	99.6
Kharkof Hays No. 2	6686	...	...	...	...	...	...	47.4	47.4±1.19	87.0
Kanred Sel. 0166	10099	...	...	...	...	...	...	52.8	52.8±1.33	96.9
Cheyenne	8885	...	...	...	...	...	...	54.5	54.5±1.37	100.0
Old Beardless Turkey 16	...	...	...	...	...	...	...	41.9	41.9±1.06	76.9
Old Beardless Turkey 17	...	...	...	...	...	...	...	52.8	52.8±1.33	96.9
Old Beardless Turkey 18	...	...	...	...	...	...	...	51.3	51.3±1.29	94.1
Old Beardless Turkey 19	...	...	...	...	...	...	...	54.7	54.7±1.38	100.4
Old Beardless Turkey 20	...	...	...	...	...	...	...	53.3	53.3±1.34	97.8
Turkey Sel. Colo. 351	11375	...	...	...	...	...	...	49.5	49.5±1.25	90.8
Marquis	...	...	...	...	...	...	...	47.8	47.8±1.20	87.7
Mutant 556	...	84.7	72.0	68.2	60.2	71.0	49.7	...	67.6±0.71	102.3
Superhard	8054	...	69.0	62.4	52.0	70.0	51.5	...	61.0±0.73	93.6
Turkey Sel. 159	10100	...	...	58.3	54.7	63.7	51.6	...	57.1±0.80	90.3
Ridit	6703	...	...	...	52.2	65.0	41.9	...	53.0±0.95	83.5
Blackhull	6251	72.9	71.0	61.7	55.5	...	...	...	65.3±0.82	97.5
Kanred	5146	68.3	72.9	70.0	58.4	...	...	...	67.4±0.85	100.6
Turkey 192	...	64.3	67.3	57.9	58.3	...	...	...	62.0±0.78	92.5
Kharkof	1583	63.9	72.1	61.5	...	...	...	...	65.8±0.74	95.8
Hybrid 180	...	76.0	66.2	69.6	...	...	...	...	70.6±0.80	102.8
Hybrid 188	...	73.2	63.5	...	...	...	...	...	68.4±1.04	102.8
Hybrid 190	...	69.1	81.5	67.1	...	...	...	...	72.6±0.82	105.6
Kanred Selection	...	70.2	75.6	57.6	...	...	...	...	67.8±0.77	98.7
Minturki	6155	63.3	70.7	56.4	...	...	...	...	63.5±0.72	92.4
Turkey Selection	...	61.6	69.2	56.1	...	...	...	...	62.3±0.70	90.7
P. E. Percentage	...	2.21	2.09	1.48	3.75	2.35	3.12	2.52	.....	...

Table 12.—Agronomic Data on Winter-Wheat Varieties at Fort Collins, 1926-1932.

Variety	C. I. No.	Date Headed	Maturity	Straw Length	Straw Strength	Years Grown
Fultz Mediterranean Sel.....	...	6/10	7/20	49	weak	7
Kanmark	6937	6/10	7/21	47	medium	5
Kanred	5146	6/10	7/21	46	weak	7
Kansas Sel. P 1068-6-18....	...	6/10	7/21	47	weak	7
Marquis x Kanred.....10008		6/12	7/23	48	weak	4
Marquis x Kanred.....10009		6/10	7/21	48	weak	5
Mutant Colo. 348.....	...	6/9	7/21	48	stiff	7
Nebraska No. 60.....	6250	6/14	7/24	48	weak	5
Pesterboden Selection.....	8266	6/13	7/22	48	weak	5
Tenmarq	6936	6/19	7/21	48	medium	5
Early Blackhull	8856	5/31	7/18	41	stiff	1
Oro	8220	6/13	7/24	49	stiff	1
Quivira	8886	6/5	7/20	45	stiff	1
Kharkof Hays No. 2.....	6686	6/13	7/22	48	medium	1
Kanred Selection 0166.....10099		6/13	7/22	49	weak	1
Cheyenne.....	8885	6/12	7/22	46	stiff	1
Old Beardless Turkey 16...	...	6/6	7/18	42	stiff	1
Old Beardless Turkey 17...	...	6/6	7/18	42	stiff	1
Old Beardless Turkey 18...	...	6/6	7/18	42	stiff	1
Old Beardless Turkey 19...	...	6/2	7/18	40	stiff	1
Old Beardless Turkey 20...	...	6/6	7/18	42	stiff	1
Turkey Colo. 351.....	...	6/12	7/19	46	stiff	1
Marquis	...	6/11	7/22	43	stiff	1
Mutant 556.....	...	6/9	7/20	47	stiff	6
Superhard	8054	6/6	7/21	47	weak	5
Turkey 159.....10100		6/12	7/20	50	weak	4
Ridit	6703	6/12	7/20	45	stiff	3
Blackhull	6251	6/6	7/23	52	medium	4
Kanred	5146	6/9	7/24	49	medium	4
Turkey Red 192.....	...	6/12	7/26	50	weak	4
Kharkof	1583	6/11	7/25	50	weak	3
Hybrid 180.....	...	6/5	7/22	51	stiff	3
Hybrid 188.....	...	6/9	7/29	54	weak	2
Hybrid 189.....	...	6/8	7/24	52	medium	3
Kanred Selection.....	...	6/7	7/25	49	weak	3
Minturki	6155	6/12	7/25	51	medium	3
Turkey Selection.....	...	6/10	7/25	49	weak	3

CONCLUSION AT FORT COLLINS.—Under irrigated conditions similar to those found at Fort Collins, Kanred is still the best winter wheat to grow. Other varieties yield as high but none outyield it sufficiently to recommend them in place of Kanred.

SPRING WHEAT

Spring wheats yield well under irrigated conditions at Fort Collins. Table 13 gives the yields of the different varieties grown for various periods from 1926 to 1932.

Several new varieties have yielded well. When we consider the varieties which have been grown for 5 years or more, we find that Komar is the highest-yielding variety. In the last column of

Variety	C. I. No.	YIELD, BUSHELS PER ACRE 1926	1927	1928	1929	1930	1931	1932	Years Grown	Average	Ceres Percentage
Ceres	6900	57.0	44.4	41.2	40.7	55.7	33.4	41.7	7	44.9±0.43	100.00
N.D. 1656 Marquis x Kota	6898	63.0	45.5	48.0	48.9	61.6	39.9	46.3	7	50.5±0.48	112.45
1656-85 Marquis x Kota	8385	...	...	...	...	64.1	45.8	47.9	3	52.6±0.70	120.64
1656-48 Marquis x Kota	10014	...	...	...	...	63.0	38.0	43.9	3	48.3±0.64	110.78
Komar 1656-84	8004	...	48.3	45.7	46.7	63.0	40.6	47.7	6	48.7±0.51	113.57
Baart	1697	...	38.9	41.6	45.9	63.1	...	48.3	5	47.6±0.49	106.30
Marquillo	6887	...	36.1	49.0	39.9	52.0	28.5	36.0	6	40.3±0.42	93.93
Marquis No. 1	...	58.7	37.1	46.1	40.5	52.3	31.2	38.1	7	43.4±0.42	96.78
Marquis No. 2	...	54.2	36.5	35.1	24.9	54.4	33.5	38.5	7	39.6±0.38	88.22
Mindum	5296	62.8	49.3	64.7	46.0	58.7	35.9	46.5	7	52.0±0.50	115.85
Onas	6221	57.4	31.5	50.8	47.5	62.3	35.2	42.1	7	46.7±0.45	104.04
Red Bobs No. 222	...	...	35.4	43.6	39.3	54.2	36.0	38.3	6	41.1±0.43	95.99
Reliance	7370	...	...	...	...	...	40.4	46.2	2	43.3±0.70	115.31
Texas Red	...	60.0	44.0	48.6	45.7	58.4	34.1	49.8	7	48.7±0.47	108.44
Pilcraw	10036	...	...	...	...	65.4	34.2	40.1	3	46.6±0.62	106.80
F. C. 1104[1]	...	...	...	...	...	...	...	44.6	1	44.6±0.78	106.95
F. C. 1105	...	...	...	...	...	...	...	47.1	1	47.1±0.83	112.95
F. C. 1106	...	...	...	...	...	...	...	42.2	1	42.2±0.74	101.20
F. C. 1107	...	...	...	...	...	...	...	42.5	1	42.5±0.75	101.92
Hard Federation Sel.	...	...	...	...	38.1	52.4	31.8	...	3	40.8±0.60	94.22
Marquis (Bulk Selection)	...	...	...	...	41.1	51.9	32.5	...	3	41.8±0.61	96.69
Red Bobs F. C. 1091	...	...	...	...	40.8	52.8	35.1	...	3	42.9±0.63	99.15
Reward	8182	...	...	...	35.3	46.2	24.5	...	3	35.3±0.52	81.59
Axminster	8195	57.9	40.1	47.9	43.5	53.3	...	...	5	48.5±0.57	101.55
Defiance	...	45.3	17.9	20.7	44.6	45.1	...	...	5	34.7±0.41	72.64
Kubanka	1440	55.0	42.4	45.0	43.8	51.9	...	...	5	47.6±0.57	99.62
Supreme	8026	...	32.8	43.9	40.3	50.3	...	...	4	41.8±0.56	91.92
Early Java	...	...	37.1	43.2	22.9	...	...	...	3	34.4±0.55	81.71
Garnet	8181	53.4	40.3	39.6	41.0	...	...	...	4	43.6±0.59	95.09
Redsask	6794	57.0	38.4	45.4	38.2	...	...	...	4	44.8±0.60	97.65
Renfrew	8197	...	34.0	36.7	33.8	...	...	...	3	34.8±0.56	82.74
Arnautka	1493	56.5	46.4	56.9	...	...	...	...	3	53.3±0.84	112.06
Dicklow	3663	36.0	...	21.5	...	...	...	...	2	28.8±0.53	58.55
Federation	4734	52.1	26.6	40.8	...	...	...	...	3	39.8±0.63	83.80
Ghirka	1517	49.4	31.0	32.6	...	...	...	...	3	37.7±0.60	79.24
Kota	5878	48.3	25.8	36.3	...	...	...	...	3	36.8±0.58	77.42
Preston	3081	59.1	35.5	22.5	...	...	...	...	3	39.0±0.62	82.12
Quality	6607	51.2	33.2	45.4	...	...	...	...	3	43.3±0.68	91.02
Marquis No. 3	...	57.2	33.9	43.1	...	...	...	...	3	44.7±0.71	94.11
Red Bobs Col. 239	...	56.5	31.4	41.4	...	...	...	...	3	43.1±0.68	90.67
Red Russian	...	48.5	27.1	31.8	...	...	...	...	3	35.8±0.57	75.32
Sevier	6247	40.6	10.7	28.2	...	...	...	...	3	26.5±0.42	55.75
Probable error in percentage.	...	2.38	3.03	2.77	2.55	2.30	2.73	1.76	..	.....	....

Table 13 the yields are calculated in percentage of Ceres. Komar outyielded Ceres by 15.57 percent in a 6-year test. Mindum, a durum wheat, also yielded well. Marquis dropped in yield to less than that of Ceres. Several new varieties show promise but require further testing before recommendations can be made. Twenty-three varieties have been dropped from the test since 1926 but 19 new ones have been added. Some of the latter have also been discarded because they failed to yield under Fort Collins conditions.

The agronomic data of the different varieties are given in Table 14.

Table 14.—Agronomic Data on Spring Wheat Grown at Fort Collins, 1926-1932.

Variety	Date Headed	Maturity	Straw Length	Straw Strength
Ceres	6/21	7/31	46	stiff
N. D. 1656	6/20	7/29	48	medium
1656-85 Marquis x Kota	6/18	7/26	49	medium
1656-48 Marquis x Kota	6/20	7/26	49	medium
Komar	6/21	7/29	47	stiff
Baart	6/17	7/31	47	weak
Marquillo	6/20	7/28	43	stiff
Marquis No. 1	6/22	7/30	47	stiff
Marquis No. 2	6/22	7/30	47	stiff
Mindum	6/21	8/1	53	medium
Onas	6/19	7/31	42	stiff
Red Bobs No. 222	6/18	7/27	46	stiff
Reliance	6/22	7/30	44	stiff
Texas Red	6/21	8/2	50	weak
Pilcraw	6/21	7/30	46	stiff
F. C. 1104	6/17	7/25	44	stiff
F. C. 1105	6/18	7/25	44	medium
F. C. 1106	6/18	7/27	43	stiff
F. C. 1107	6/19	7/27	45	stiff
Hard Federation Selection	6/18	7/25	41	stiff
Marquis (Bulk)	6/23	7/29	45	stiff
Red Bobs F. C. 1091	6/20	7/29	47	stiff
Reward	6/16	7/25	43	stiff
Axminster	6/23	7/31	49	stiff
Defiance	6/29	8/6	50	medium
Kubanka	6/22	8/2	52	weak
Supreme	6/21	7/30	47	stiff
Early Java	6/18	8/1	47	weak
Garnet	6/17	7/27	44	medium
Redsask	6/19	8/1	48	stiff
Renfrew	6/28	8/4	50	stiff
Arnautka	6/21	8/3	53	medium
Dicklow	6/27	8/5	54	stiff
Federation	6/19	7/31	42	stiff
Ghirka	6/24	8/3	49	weak
Kota	6/24	8/2	49	weak
Preston	6/24	8/1	48	stiff
Quality	6/15	7/29	45	medium
Marquis No. 3	6/22	8/1	49	stiff
Red Bobs Col. 239	6/18	8/1	48	stiff
Red Russian	6/23	8/3	49	weak
Sevier	6/24	8/3	45	weak

Fig. 6. Field of Komar foundation stock grown at Fort Collins in 1932.

Several of the better-yielding varieties show fairly stiff straw. However, some show a tendency to lodge. Both 1656-85 and 1656-48 are inclined to go down. Komar is not as stiff-strawed a variety as Marquis and may go down with irrigation.

Komar is also susceptible to loose smut which may become a drawback to the growing of this variety commercially if great care is not taken in obtaining seed from sources where infection is light.

MILLING AND BAKING RESULTS.—The milling and baking tests were made by Dr. C. O. Swanson of the Department of Milling Industry, Kansas Agricultural College, Manhattan, Kansas. Several of the varieties tested have been dropped due to low yield. Others have only been tested for 1 year. Of the varieties tested for the entire 4 years, we find that Komar is the highest-yielding wheat and compared well with Marquis, a hard red wheat of known high milling and baking quality. It had the highest average loaf volume and was second in water absorption. It also had good color. N. D. 1656 also showed excellent milling and baking quality. Ceres was slightly off in color of loaf in 1930. Of the soft wheats, Baart was low in quality thruout.

Table 15.—Milling and Baking Data on Spring Wheat Grown at Fort Collins, Colorado.

Variety	Year	Test Weight	Flour Yield	Protein Percentage	Absorption Percentage	Loaf Volume	Texture Percentage	Color Percentage
Komar	1927	58.6	71.3	....	76	2100	97	97
	1928	59.4	67.3	16.00	81	2035	99	99
	1929	62.2	69.5	15.35	81	2060	97	98
	1930	59.5	67.5	16.65	70	2030	98	OK
	Av.	59.9	68.9	16.00	71	2056	97.8	98
N.D. 1656 Marquis x Kota.	1927	59.9	71.0	....	79	2075	95	96
	1928	60.0	65.0	16.95	81	2025	99	99
	1929	62.2	70.0	16.60	83	1620	90	99
	1930	60.0	70.0	17.65	68	2010	97	OK
	Av.	60.5	69.0	17.07	78.2	1932	95.2	98
Texas Red....	1927	60.2	70.0	....	69	1895	90	96
	1928	59.4	67.5	14.60	79	1830	96	95
	1929	61.1	68.0	16.60	75	1685	90	99
	1930	59.9	67.5	16.40	66	1710	92	Grayish
	Av.	60.2	68.0	15.87	72.25	1780	92	96.7
Baart	1927	58.0	68.8	....	63	1980	92	97
	1928	60.1	66.0	13.05	75	1970	97	99
	1929	62.2	69.5	15.20	73	1595	88	98
	1930	60.1	68.8	15.20	62	1635	84	Poor, creamy
	Av.	60.1	68.3	14.48	68.3	1795	90.2	98
Onas	1927	50.6	65.3	....	71	2040	94	96
	1928	55.2	65.0	10.70	75	1925	98	97
	1929	58.0	67.0	12.90	69	1890	91	95
	1930	55.8	68.8	13.65	62	1990	88	Poor, creamy
	Av.	54.9	66.5	12.42	69.2	1961	92.8	96
Ceres	1927	60.7	72.5	....	76	2070	97	96
	1928	60.4	67.5	15.70	76	2040	99	99
	1929	62.0	70.0	16.00	79	1710	90	99
	1930	60.3	67.0	17.40	70	1720	92	Grayish
	Av.	60.8	69.2	16.37	75.2	1885	94.5	98
Marquis No. 1.	1927	58.5	70.0	....	71	2140	98	97
	1928	60.5	67.5	14.90	81	2150	99	99
	1929	61.7	69.0	15.65	76	1675	90	99
	1930	59.1	71.0	17.00	68	1870	93	OK
	Av.	59.95	69.4	15.85	74	1959	95	98
Axminster ...	1927	58.8	72.0	....	75	1835	87	93
	1928	61.3	67.3	14.35	76	1970	98	97
	1929	61.2	69.3	16.05	76	1570	90	99
Marquillo	1927	55.4	72.5	....	68	2030	96	96
	1928	58.8	68.5	15.25	75	2100	99	97
	1929	60.1	69.8	15.65	74	1710	91	95
Redsask	1927	57.2	70.0	....	72	2160	98	97
	1928	59.6	68.0	13.00	76	2000	99	97
	1929	61.1	67.5	13.65	75	2070	98	98
Garnet	1927	58.2	70.5	....	78	1960	92	96
	1928	59.0	66.0	13.55	75	1930	99	97
	1929	61.6	66.8	14.40	76	1690	91	95

Table 15 (continued).—Milling and Baking Data on Spring Wheat Grown at Fort Collins, Colorado.

Variety	Year	Test Weight	Flour Yield	Protein Percentage	Absorption Percentage	Loaf Volume	Texture Percentage	Color Percentage
Early Java...	1927	58.7	68.0	....	68	1940	89	97
	1928	60.6	65.7	16.05	75	1830	94	96
	1929	61.4	66.8	16.40	71	1575	90	99
1656-48 Marquis x Kota..	1930	59.9	68.8	16.90	70	1970	97	OK
1656-85 Marquis x Kota..	1930	59.6	66.5	17.15	70	1630	92	OK
Pilcraw	1930	55.3	69.3	14.05	60	1785	86	Poor, creamy
Quality	1927	57.8	72.5	....	76	1850	88	96

(A high-speed mechanical mixer was used in making the baking tests.)

COMPARISON OF WINTER AND SPRING WHEAT UNDER IRRIGATION

Table 16 gives the yields of the two highest-yielding winter wheats and the two highest-yielding hard red spring wheats grown at Fort Collins.

Table 16.—Comparative Yields of Spring and Winter Wheats at Fort Collins from 1928 to 1932.

Variety	C. I. No.	YIELD, BUSHELS PER ACRE 1928	1929	1930	1931	1932	Average
Winter Wheat							
Kanred	5146	62.2	61.8	74.4	54.3	54.5	61.4
Tenmarq	6936	75.6	56.6	71.8	51.0	58.0	62.6
Spring Wheat							
Komar	8004	45.7	46.7	63.0	40.6	47.7	48.7
Ceres	6900	41.2	40.7	55.7	33.4	41.7	42.5

The winter wheats outyielded the spring wheats every year. Evidently under Fort Collins conditions, winter wheat yields better than spring wheat when conditions favor its planting in the fall.

VARIETAL EXPERIMENTS AT FORT LEWIS UNDER IRRIGATION AT AN ALTITUDE OF 7,600 FEET

By DWIGHT KOONCE

The Fort Lewis Substation is located in the San Juan Basin, in the southwestern part of the state. The work at the substation is carried on in cooperation with the Fort Lewis School of the Colorado Agricultural College. The school is located 12 miles west of Durango and 4 miles south of Hesperus, Colorado. The land used for the experimental plats is a short distance from the school campus. It is bench land and is part of the old bed of the La Plata River. The slope of the land is southeast towards the river. The soil is a dark loam, shallow and underlaid by coarse gravel. A 2-year rotation of small grain and peas is followed, with the exception of winter wheat, which is planted on fallow. Part of the land is manured and all is fall plowed.

CLIMATIC CONDITIONS.—The growing season is short, due to the altitude, which is 7,610 feet. The average frost-free period for the past 10 years is 107 days. Table 17 gives the dates of the last killing frost in the spring, the first killing frost in the fall, and the frost-free periods of the 10 years from 1923 to 1932, inclusive.

Table 17.—Frost-Free Periods, 1923-1932, Inclusive.

Year	Last killing frost	First killing frost	Frost-free period, days
1923	June 20	Sept. 19	91
1924	June 19	Sept. 12	85
1925	June 12	Sept. 14	94
1926	May 14	Sept. 29	138
1927	June 3	Sept. 28	117
1928	May 18	Sept. 14	119
1929	May 29	Sept. 9	103
1930	June 1	Sept. 23	114
1931	May 31	Sept. 21	113
1932	June 8	Sept. 10	94
Average	June 3	Sept. 18	107

PRECIPITATION.—The annual rainfall ranges from 15.62 to 24.91 inches. The rainfall was low during the growing season (April to July) of 1928, 1930 and 1932. The winter precipitation was low in 1926 and 1929. The precipitation is highest during the months of July, August and September. May and June are generally low in rainfall, especially June. Table 18 gives the monthly, the mean monthly and the annual precipitation at Fort Lewis for the 7-year period of 1926 to 1932, inclusive.

Table 18.—Precipitation in Inches at Fort Lewis Substation from 1926 to 1932, Inclusive.

Year	1926	1927	1928	1929	1930	1931	1932	7-year Mo. Average
January	.40	.15	.51	1.24	2.61	.15	.74	.83
February	.39	4.29	1.70	1.74	.74	2.45	3.23	2.08
March	.54	1.31	1.53	.95	1.15	1.03	.98	1.07
April	3.58	.53	.37	1.21	1.31	1.82	1.22	1.43
May	2.87	.60	1.26	.68	.89	.50	.84	1.09
June	.14	3.05	.02	.00	.35	2.03	.83	.92
July	2.14	1.85	2.12	4.13	2.76	3.20	2.97	2.74
August	.76	3.31	1.51	3.91	3.08	1.14	4.05	2.54
September	2.17	6.26	.63	3.34	.50	2.22	1.30	2.35
October	.85	.81	2.97	1.19	.32	2.09—	1.56	1.40
November	.60	1.15	2.89	.20	1.91	3.64	T	1.48
December	1.54	1.60	1.14	.18	T	2.35	1.81	1.23
Total	15.98	24.91	16.65	18.77	15.62	22.62	19.53	19.15
April-July, incl.	8.73	6.03	3.77	6.02	5.31	7.55	5.86	6.18

IRRIGATION.—The furrow method of irrigation is used for both grain and rowed crops. This is necessary because of the steep slope of the land. Small heads of water must be used to prevent excessive erosion. The soil is shallow and has limited storage capacity for soil moisture. This makes frequent irrigations necessary. The grain crops are usually irrigated three times.

METHODS OF CONDUCTING EXPERIMENTS.—The varieties are grown in 3-rod row plats and are replicated nine times (10 plats). Part of each plat is harvested by hand, dried under cover, then threshed. All yields are the averages of 10 plats.

DATE OF SEEDING.—Date-of-seeding tests have been conducted for a 3-year period. The varieties used were Turkey Red and Beardless Turkey. These two varieties were planted at weekly intervals, in single plats, beginning the last of August and ending the first part of October. The data obtained indicate that the proper time to plant winter wheat is about the middle of September in this section and altitude.

In the variety tests the winter wheat is sown as near September 20 as possible. The spring wheat tests are sown as soon as the land can be prepared. The average date is about April 20.

EXPERIMENTAL DATA.—Twenty-six varieties of winter wheat have been tested at varying periods from 1926 to 1932, inclusive. Five of these have been dropped on account of their inability to yield under high-altitude conditions. Of the varieties tested for 4 years or longer, Hybrid 190 has given the best yields. Of the commercial varieties tested, Montana 36 shows a slight increase in yield when compared with Kanred. A strain of Marquis which has been planted

Table 19.—Yields of Winter Wheat Grown at the Fort Lewis Substation for Varying Periods from 1926 to 1932, Inclusive.

Variety	C. I. No.	YIELDS IN BUSHELS PER ACRE						Years Grown	Average	Percentage Kanred
		1926	1927	1928	1930*	1931	1932			
Kanred	5146	31.0	45.9	58.2	61.8	64.7	83.3	6	57.5±0.89	100.00
Turkey Red	...	32.7	43.8	64.2	62.4	63.3	82.8	6	58.2±0.90	101.25
Marquis (Fall)	...	35.8	34.1	53.4	67.4	77.3	82.9	6	58.5±0.91	101.74
Montana No. 36	5549	...	...	60.6	67.4	65.4	82.8	4	69.1±1.33	103.06
Iobred	6934	...	...	46.6	55.3	56.5	70.3	4	57.2±1.10	84.39
Blackhull	6251	...	...	55.6	52.7	69.9	74.5	4	63.2±1.22	94.29
Superhard	8054	...	...	53.6	44.7	66.7	76.1	4	60.3±1.16	89.96
Nebraska No. 60	6250	...	...	58.6	55.1	61.4	77.2	4	63.1±1.22	94.14
Hybrid 189	...	...	...	63.2	68.5	70.8	79.9	4	70.6±1.36	105.37
Hybrid 190	...	...	...	58.7	71.6	81.2	75.7	4	71.8±1.39	107.16
Iowa 1946	6676	34.7	50.4	57.2	...	...	...	3	47.4±0.98	105.33
Pesterboden Sel.	8266	...	...	...	54.9	59.0	74.8	3	62.9±1.54	89.94
Kanmark	6937	...	...	...	57.1	67.0	72.6	3	65.6±1.61	93.76
Mutant 556	...	...	...	...	55.9	70.8	79.3	3	68.7±1.68	98.19
Tenmarq	6936	...	...	...	59.7	71.9	81.3	3	71.0±1.74	101.48
Beardless Turkey	...	28.6	39.2	...	...	...	...	2	33.9±0.87	88.17
Minturki	6155	34.3	41.6	...	...	...	...	2	38.0±0.98	98.70
Minhardi	5149	39.5	48.4	...	...	...	...	2	44.0±1.13	114.30
Local Selection	...	...	...	...	46.0	63.2	...	2	54.6±1.71	86.32
Kanred Sel. 0166	10099	...	...	...	...	...	76.6	1	76.6±2.17	91.96
Kharkof Hays No. 2	6686	...	...	...	...	...	74.5	1	74.5±2.11	89.44
Early Blackhull	8856	...	...	...	...	...	69.7	1	69.7±1.97	83.67
Oro	8220	...	...	...	...	...	79.9	1	79.9±2.26	95.92
Cheyenne	8885	...	...	...	...	...	89.1	1	89.1±2.52	106.96
Turkey Sel.	11375	...	...	...	...	...	78.5	1	78.5±2.22	94.24
Quivira	8886	...	...	...	...	...	73.0	1	73.0±2.07	87.64
Probable error in percentage	...	3.72	3.54	3.48	5.61	2.84	2.34	..	.....	....

No yields in 1929 due to severe hail damage.
*Average of 6 plats.

in the fall at Fort Lewis for about 10 years has yielded as well as Kanred for the 7-year period. Several other varieties show promise but require further testing before their adaptability can be determined.

AGRONOMIC DATA.—Table 20 gives the agronomic data for the period of the experimental tests. The stiffness of straw is recorded in percentage.

Marquis has the stiffest straw, with Hybrid 190 second. The date of maturity varies slightly. When the date of heading is considered, Blackhull and Superhard head a little earlier than the other varieties.

Table 20.—Agronomic Data on Winter Wheat Grown at the Fort Lewis Substation, 1926-1932, Inclusive.

Variety	C. I. No.	Date Headed	Date Maturity	Straw Length	Straw Strength Percentage	Years Averaged
Kanred	5146	6/23	8/1	36	49	6
Turkey Red	...	6/24	7/31	36	45	6
Marquis (Fall)	...	6/21	8/1	38	80	6
Montana No. 36	5549	6/23	8/2	37	50	4
Iobred	6934	6/23	8/2	38	77	4
Blackhull	6251	6/18	8/1	37	72	4
Superhard	8054	6/18	8/1	38	82	4
Nebraska No. 60	6250	6/23	8/2	37	55	4
Hybrid 189	...	6/22	8/1	37	64	4
Hybrid 190	...	6/21	8/2	37	67	4
Iowa 1946	6676	8/23	8/1	39	76	3
Pesterboden Sel	8266	6/22	8/1	36	73	3
Kanmark	6937	6/20	8/1	36	72	3
Mutant 556	...	6/21	8/1	36	87	3
Tenmarq	6936	6/20	7/31	37	74	3
Local Selection	...	6/21	7/29	36	52	2
Kanred Sel. .0166	10099	6/23	8/4	39	86	1
Kharkof Hays No. 2	6686	6/24	8/4	39	89	1
Early Blackhull	8856	6/13	8/2	41	94	1
Oro	8220	6/23	8/4	40	96	1
Cheyenne	8885	6/24	8/5	40	91	1
Turkey Sel	11375	6/25	8/5	39	85	1
Quivira	8886	6/15	8/1	41	95	1

DISCUSSION.—Several varieties slightly outyield Kanred. Hybrid 190 has been found to be non-winter-hardy at Akron and if snow covering were light this variety would probably winter-kill severely. This variety as grown at Fort Lewis is not pure and there is not a supply of seed available. Montana 36 and Marquis only slightly outyield Kanred. It is not advisable to recommend any other variety in preference to Kanred.

Table 21.—Yields of Spring Wheat Grown at the Fort Lewis Substation for Varying Periods from 1926-1932, Inclusive.

Variety	C. I. No.	YIELDS IN BUSHELS 1926	1927	1928	1930	1931	1932	Years Grown	Average	Marquis Percentage
Dicklow	3663	...	...	61.1	59.8	62.7	52.5	4	59.0±0.94	116.82
Defiance	...	56.6	60.0	48.8	54.6	53.1	43.7	6	52.8±0.71	102.42
Baart	1697	...	...	...	49.7	66.8	50.0	3	55.5±0.99	106.25
Sevier	6247	...	57.9	48.9	45.1	48.3	...	4	50.1±0.83	98.23
Kubanka	1440	48.5	47.0	45.5	39.2	56.7	47.0	6	47.3±0.64	91.79
Marquis	3641	58.0	49.2	45.4	48.8	60.4	...	5	52.4±0.80	100.00
Preston	3081	55.0	50.7	53.4	60.6	64.9	55.6	6	56.7±0.77	109.99
Ceres	6900	49.6	50.1	41.0	45.5	60.8	52.6	6	49.9±0.67	96.86
Garnet	8181	48.4	49.5	45.2	47.0	...	...	4	47.5±0.85	94.39
N.D. 1656 Marquis x Kota	6898	...	48.5	40.5	50.3	57.3	50.0	5	49.3±0.70	98.13
Marquillo	6887	...	47.2	43.1	51.0	62.4	49.2	5	50.6±0.72	100.64
Kota	5878	...	43.6	37.6	36.2	45.3	...	4	40.7±0.67	79.83
Quality	6607	...	48.5	44.3	44.8	55.3	...	4	48.2±0.80	94.65
Kitchener	4800	52.9	51.8	46.6	...	...	...	3	50.4±1.02	99.15
Ghirka	1517	48.2	49.0	48.0	...	...	...	3	48.4±0.98	95.15
Bobs	2826	51.7	52.7	49.6	...	...	...	3	51.3±1.04	100.92
Red Bobs	6255	...	...	44.8	49.8	64.3	...	3	53.0±1.02	102.78
Reward	8182	...	...	36.8	39.6	56.0	...	3	44.1±0.85	85.64
Marquis No. 1	...	...	...	...	48.7	60.7	46.3	3	55.9±0.92	99.36
Komar	8004	...	...	...	56.8	64.7	53.5	3	58.3±1.04	111.68
Marquis	...	...	...	...	...	...	47.5	1	47.5±1.24	100.00
1656-85 Marquis x Kota	8385	...	...	...	...	...	49.6	1	49.6±1.29	104.42
1656-48 Marquis x Kota	10014	...	...	...	...	...	52.5	1	52.5±1.37	110.53
F. C. 1104	...	...	...	...	...	...	53.4	1	53.4±1.39	112.42
F. C. 1105	...	...	...	...	...	...	52.0	1	52.0±1.35	109.47
F. C. 1106	...	...	...	...	...	...	56.1	1	56.1±1.46	118.11
F. C. 1107	...	...	...	...	...	...	53.2	1	53.2±1.38	112.00
Probable error in percentage	...	3.85	3.20	3.42	3.82	2.68	2.60	..	.....	....

No yields in 1929 due to severe hail damage.

SPRING WHEAT.—Twenty-seven varieties of spring wheat have been tested at the Fort Lewis Substation, for varying periods from 1926 to 1932. Ten of these varieties have been dropped as unsuitable for Fort Lewis conditions. Eighteen new varieties have been introduced since the last report on yields for the period prior to 1926.[1] Of the eight varieties which have been in the tests for 5 years or more, Dicklow, a soft white wheat, yielded highest. Komar, a new introduction tested for the last 3 years, has outyielded Marquis by over 10 percent for the same period. This variety shows promise as a hard red spring wheat. However, Komar has a tendency to lodge and is susceptible to loose smut. Several of the newer introductions show promise but require further testing before their adaptability can be determined.

AGRONOMIC DATA.—All the spring-wheat varieties grown at Fort Lewis have fairly long straw. Dicklow has a medium-length straw and stands up well. Dicklow matures about 10 days later than Komar. Komar has a fairly long straw and is inclined to lodge.

Table 22.—Six-Year Comparisons of Winter and Spring-Wheat Yields at the Fort Lewis Substation, 1926-32.

Variety	1926	1927	1928	1930	1931	1932	Kanred Percentage
Kanred	31.0	45.9	58.2	61.8	64.7	83.3	100.00
Highest winter-wheat yield	43.7	50.4	64.2	71.6	81.2	89.1	116.03
Marquis	38.0	49.2	45.2	48.8	60.4	47.5	89.62
Dicklow	...	...	61.1	59.8	62.7	52.5	88.10
Defiance	56.6	60.0	48.8	54.6	53.1	43.7	94.75
Highest hard red spring	58.0	52.7	53.4	60.6	64.9	56.1	101.56

COMPARISON OF WINTER AND SPRING-WHEAT YIELDS.—Table 22 gives the yields of Kanred, Marquis, Dicklow and Defiance. The highest yield of winter wheat and hard red spring wheat for each year is also recorded in Table 22. The results are similar to those found at Fort Collins. The winter-wheat varieties outyield the spring wheats by about 10 percent, at the Fort Lewis Substation.

CONCLUSIONS.—Kanred is recommended as the variety of winter wheat to grow under irrigated conditions. Dicklow, a soft white spring wheat, is recommended where a soft wheat is desired. Komar is the highest-yielding hard red spring wheat.

[1]Kezer, A. et al. Colorado Wheat Varieties. Colo. Exp. Sta. Bul. 329.

COMPARISON OF YIELDING ABILITY OF SEVERAL WINTER WHEATS GROWN AT AKRON AND FORT COLLINS

Several wheats have been grown on summer fallow under dryland conditions at Akron and under irrigation at Fort Collins. At Akron, their ability to yield under adverse conditions was tested severely in the years 1926, 1929, 1930, 1931 and 1932. The year 1928 was an exceedingly favorable year for wheat production on fallow at Akron. A 20-inch total precipitation was obtained in 1927 and no doubt part of this was stored for the use of the crop in 1928. The years 1927 and 1930—both years of average precipitation—gave good crop yields. The crops at Fort Collins all gave good yields since the rainfall could be supplemented by irrigation when necessary. The Fort Collins conditions can be taken as exceedingly favorable as far as moisture is concerned and will be used in the comparisons. The yields vary at Fort Collins but all of them are high when compared with the Akron yields. Kanred gives the highest yield at Fort Collins (exceedingly favorable conditions). In the unfavorable years, 1929-1931, at Akron, Marquis x Kanred, C. I. 10008, Pesterboden Sel., C. I. 8266, and Turkey Selection, C. I. 10100, all outyielded Kanred by 4 percent or over. When we add the yields of the favorable year, 1928, to the Akron yields, Pesterboden Sel., C. I. 8266, equals Kanred but Turkey Selection still outyields it by over 4 percent. But Turkey Selection does not respond to favorable moisture conditions to the same extent as Kanred, only yielding 90.3 percent as well in a 4-year test. The advantage gained in the unfavorable years is overcome by the failure to respond to favorable years. Over a longer period of years the advantage to be gained in higher yield in favorable years must be considered with the lower yields of unfavorable years in order to determine the adaptability of winter wheat under dryland conditions in Colorado. The data presented give a slight indication of what might be expected but further results are necessary before final conclusions can be drawn. However, an early maturing, high-yielding wheat, under severe conditions at Akron, may not be the best average wheat for Akron conditions when a longer period than 4 years has been used in testing it.

Table 23.—Yields of Winter Wheat Grown at Fort Collins and Akron on Fallow for Varying Periods.

Variety	C. I. No.	Station	YIELD, BUSHELS PER ACRE 1928	1929	1930	1931	1932	3-year Total 1929-1931	Kanred Percentage	4-year Total 1928-1931	Kanred Percentage
Kanred	5146	Ft. Collins	62.2	61.8	74.4	54.3	54.5	190.5	100	252.7	100
		Akron	48.2	14.4	19.5	14.8	14.8	48.7	100	96.9	100
Marquis x Kanred	10008	Ft. Collins	66.3	55.7	65.7	44.5	...	165.9	87.1	232.2	91.8
		Akron	41.8	14.1	21.7	15.3	...	51.1	104.9	92.9	95.9
Nebraska 60	6250	Ft. Collins	62.5	54.7	73.8	56.0	53.5	184.5	96.8	247.0	97.7
		Akron	47.0	11.7	19.8	13.9	12.0	45.4	93.2	92.4	95.3
Pesterboden Sel.	8266	Ft. Collins	61.1	54.6	66.9	56.0	48.6	177.5	93.2	238.6	94.4
		Akron	45.3	14.1	21.7	15.8	12.8	51.6	105.9	96.9	100.0
Turkey Sel.	10100	Ft. Collins	58.3	54.7	63.7	51.6	...	170.0	89.2	228.3	90.3
		Akron	46.6	15.4	22.1	17.3	...	54.8	112.5	101.4	104.6

DESCRIPTION OF BETTER VARIETIES

KANRED.—Kanred is a winter wheat with an awned head. The glumes are awned and white. The straw is rather weak and is white in color. The kernels are dark red, medium long and hard. This wheat can be distinguished from Turkey when in the head. The beaks of the outer glumes are from 3 to 25 mm. long, while those of Turkey are from 3 to 8 mm. long. Clark, Martin and Ball[1] make the following statement regarding Kanred:

> Kanred is very similar to Turkey, but is slightly more winter hardy and slightly earlier and can be distinguished from that variety by its larger beaks on the outer glumes and by its resistance to some forms of both leaf and stem rust.

KOMAR.[2]—Komar is a bearded white glumed wheat. The beaks on the glume are from 2 to 3 mm. long. The kernels are midlong, and are red in color. The straw is slightly weak under irrigated conditions. The milling and baking qualities are good. It is susceptible to loose and covered smut.

Komar (No. Dakota Ns. No. 1656-84, C. I. No. 8004) was produced from a hybrid between Marquis (female) and Kota (male). The cross was made in 1918 by L. R. Waldron, plant breeder, North Dakota Agricultural Experiment Station. The selection from which Komar descended was made in 1923.

DICKLOW.—Dicklow is a soft white spring wheat. The head has short awnlets and a claevate tip. The grain is white and the straw is stiff. It is a late-maturing variety, requiring about the same period to develop as Defiance, Colorado 50.

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[1]For detailed descriptions see references, Classification of American Wheat Varieties. J. Allen Clark, John H. Martin, and C. R. Ball. U. S. Department of Agriculture Bul. No. 1074.

[2]Clark, J. Allen. Registration of Improved Wheat Varieties VI. Jour. Amer. Soc. Agro., Vol. 23:1011-1012, 1931.