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Wheat Production in the Panhandle of Texas

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The TEXAS AGRICULTURAL AND MECHANICAL COLLEGE SYSTEM

GIBB GILCHRIST, Chancellor

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DIGEST

This bulletin deals primarily with wheat production on the High Plains of the Panhandle of Texas. In spite of the hazards encountered in growing wheat, there has been a steady increase in total production in this area during the past 50 years. It is probable that wheat will continue to be the Panhandle's major cash crop.

Research in the development of wheat varieties and in cultural practices has reduced the risks involved in producing wheat. Much, however, remains to be done to stabilize production.

Wheat research in the Panhandle began with the establishment of experiment stations by the U. S. Department of Agriculture at Amarillo and Channing in 1903 and continued at these stations until 1916. Cooperative work on farms and with the Amarillo Chamber of Commerce on land provided by the Price Memorial College at Amarillo, was carried on from 1931 to 1938. Wheat research, much of it in cooperation with other field stations, has been conducted on the Amarillo Conservation Experiment Station since its establishment in 1938.

The Amarillo station is at Bushland 14 miles west of Amarillo, on U. S. Highway 66. The soil on the station is representative of much of the wheat-producing land in the Panhandle.

Wheat varieties grown in the Panhandle, which have been accepted by farmers, millers and bakers, include Westar, Comanche, Triumph and Wichita.

Crop rotations, stubble mulch farming, the use of good seed, planting at the right time, proper management of grazing, and the control of weeds, diseases and pests in wheat, will give more stable wheat production.

Wheat may be stored on the farm without loss in amount or grade, if proper precautions are taken.

These various phases of wheat production are discussed in this bulletin.

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Wheat Production in the Panhandle of Texas

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CROP PRODUCTION of the Panhandle of Northwest Texas is, for the most part, less than 50 years old. Before 1900, much of this area was largely unsettled or in large cattle ranches. Increases in acreage under cultivation and in population in recent years have been rapid.

In 1909, there were only 88,170 acres of wheat in the Panhandle. By 1915, this had increased to 550,000. Owing to the needs for wheat during World War I, large acreages of sod were plowed up. Wheat was grown on 2,424,700 acres by 1927. More than 5,000,000 Panhandle acres were seeded to wheat in 1949, with a production of 75,000,000 bushels.

Wheat production is one of the most important farming enterprises in the Texas Panhandle. The economic welfare of both the Panhandle farmer and the businessman depends in a large measure on the yields that farmers make and the price per bushel they receive. No less important is the part that wheat production in this area has in feeding the nation and the world.

The growth of the wheat industry in the Texas Panhandle, as in all parts of the wheat belt, was made possible by improvements in many phases of wheat production. The development of machinery capable of tilling, seeding and harvesting large acreages enabled farmers to increase the number of seeded acres. Improvements in land preparation and other cultural practices and methods have been important factors. The use of improved varieties, which are earlier in maturity and more disease resistant than older varieties, like Turkey, Kanred, Blackhull and even Tenmarq, is partially responsible for farmers being able to maintain and even increase the per-acre yield.

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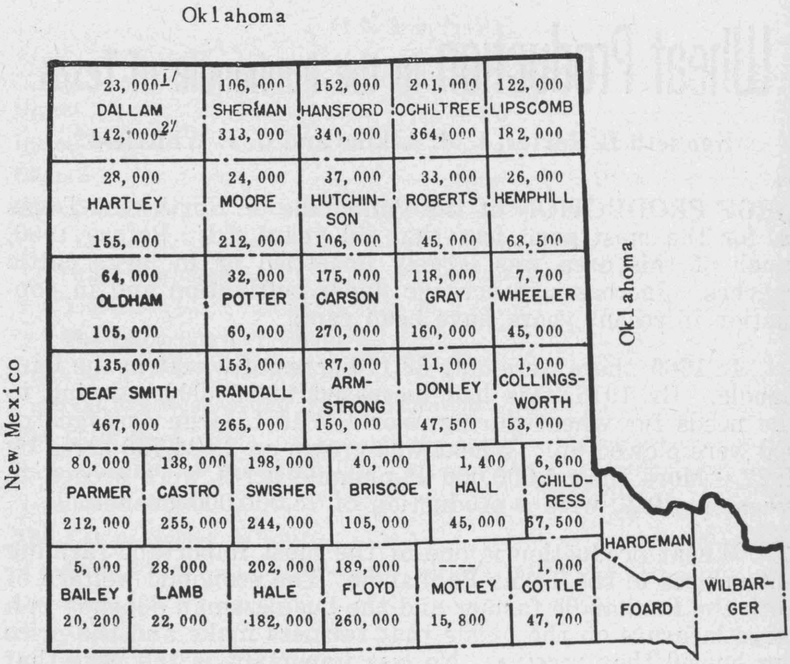

[1]First figure shows the 1927 seeded acreage.
[2]Second figure shows the 1949 seeded acreage.

Figure 1. Seeded acreage of winter wheat in the Panhandle of Texas by counties, 1927 and 1949. Estimates obtained from the Office of the Agricultural Statistician, Bureau of Agricultural Economics, U. S. Department of Agriculture, Austin, Texas.

This bulletin deals primarily with wheat production on the High Plains of the Panhandle of Texas, and recommendations given herein will be applicable primarily to that portion of the Texas Panhandle.

The number of seeded acres in 1927 and 1949 are given for each county of the Panhandle in Figure 1. Much of the increase in seeded acres during this period occurred after 1939. This is particularly true in the Rolling Plains counties of Wheeler, Donley, Collingsworth, Hall, Childress, Motley and Cottle. In these counties, over 75 percent of the increase occurred after 1939.

More detailed crop statistics of wheat production are given in Texas Station Circular 130.

CLIMATE

Drouth, wind and cold are the greatest contributors to the risk involved in producing wheat in the Panhandle. Sporadic outbreaks of insects and diseases are often associated with extremes in weather conditions, and add to the uncertainity of stable production. Hail damages wheat in scattered areas almost every year.

The variability of the climate of the Texas Panhandle is shown in Table 1. These data were obtained over the 58-year period, 1892-1950, by the U. S. Weather Bureau at Amarillo. Average annual precipitation varies from about 22 inches along the eastern edge of the Panhandle to about 18 inches along the western boundary. The average annual precipitation for the 13-year period, 1938-50, at the Amarillo station was 18.88 inches. Average temperatures, particularly during the winter, are slightly lower in the northern part of the Panhandle than they are at Amarillo.

VARIETIES

The first varieties grown in the Panhandle were the soft red winter wheats brought by immigrants from Central Texas and from other states. As recently as 1919, when the first wheat varietal survey was made by the U. S. Department of Agriculture, 57.6 percent of the wheat grown in Texas was of the soft red winter varieties. Today, hard red winter wheat varieties make up more than 95 percent of the Texas acreage.

The Turkey type wheats were brought to Kansas by Russian immigrants about 1873 and soon spread into North Texas. Selection work within the Turkey wheats resulted in the distribution of Kanred in 1917 by the Kansas Agricultural Experiment Station, Blackhull by Earl G. Clark of Sedgwick, Kans., a private plant breeder, and Cheyenne by the Nebraska Agricultural Experiment Station. Turkey also was one of the parents of Tenmarq (Turkey X Marquis) which was distributed by the Kansas Station about 1932. These hard wheat varieties were found to be well adapted to growing conditions in the Panhandle and contributed to the rapid spread in the wheat acreage.

Research with small grains was started in the Panhandle by the U. S. Department of Agriculture in 1903 on the experimental stations at Amarillo and Channing, and continued until 1916. Cooperative work on farms and with the Amarillo Chamber of Commerce on land provided by the Price Memor-

Table 1.—Average and extremes in precipitation, temperatures and wind movement at Amarillo, and average precipitation at other locations

Location	No. yrs. record	Annual	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
							AMARILLO							
Precipitation, inches	58													
Average		20.99	0.51	0.71	0.71	1.83	2.79	2.84	2.84	3.08	2.30	1.66	0.92	0.80
Highest recorded		39.75	2.51	2.93	4.06	5.47	9.14	9.76	7.32	6.76	6.42	7.64	5.09	3.77
Year		1923	1939	1903	1922	1900	1902	1923	1950	1906	1923	1941	1905	1943
Lowest recorded		11.15	0.0	0.0	T	T	.07	.05	.12	.15	.05	T	0.0	0.0
Year		1910	1923	1930	1893	1929	1927	1933	1946	1938	1910	1950	1894	1908
Temperatures	58													
Average daily		54.6	33.1	36.1	45.3	53.8	62.1	71.4	75.9	74.6	67.8	55.8	43.8	35.5
Av. daily maximum		67.1	45.5	48.9	59.0	67.3	74.6	83.8	87.8	86.6	80.0	68.2	56.3	47.1
Highest recorded			83	84.0	96.0	94.0	100.0	107	106	106	102	95	86	83
Year			1927	1904	1907	1910	1925	1939	1940	1944	1947	1934	1934	1939
Av. daily minimum		42.1	20.8	23.3	31.6	40.4	49.6	58.9	64.0	62.6	55.5	43.3	31.2	23.9
Lowest recorded			–11	–16	– 3	13	26	38	51	48	32	15	4	– 6
Year			1912	1899	1948	1920	1907	1917	1905	1915	1926	1917	1906	1924
Wind	58													
Av. hourly speed		12.5	12.1	12.9	14.1	14.5	13.4	13.1	11.3	10.7	12.0	12.2	11.7	11.4
Fastest mile			61.0	58.0	72.0	61.0	84	63.0	66.0	65	50.0	68.0	53.0	59.0
							AVERAGE PRECIPITATION OTHER LOCATIONS							
Clovis, New Mexico	39	18.71	0.35	0.41	0.69	1.39	2.47	2.72	2.44	2.94	2.36	1.83	0.51	0.60
Dalhart, Texas	12	18.01	0.31	0.36	0.71	1.69	2.68	2.81	2.36	2.61	1.62	1.66	0.67	0.53
Amarillo Station, Bushland, Texas	13	18.88	0.57	0.43	0.39	1.25	3.19	2.76	2.32	2.54	1.87	2.07	0.76	0.73
Plainview, Texas	57	21.29	0.50	0.65	0.75	1.78	2.72	3.02	3.11	2.57	2.43	1.99	1.01	0.76
Spearman, Texas	28	21.26	0.63	0.76	1.37	2.02	3.22	3.30	2.20	2.38	2.00	1.67	0.97	0.74
Shamrock, Texas	20	22.94	0.69	0.87	1.08	2.52	4.16	2.99	1.38	2.18	2.45	2.41	1.06	1.15

Frost data — Amarillo

Average first frost............November 1
Average last frost.............April 14
Earliest frost.....................October 16, 1903
Latest frost........................May 7, 1915

Average length of growing season.............................200 days
Longest growing season ....249 days (1934)
Shortest growing season ....166 days (1917)

ial College at Amarillo was carried on from 1931 to 1938. Variety testing was conducted in as many as 11 counties some seasons and a nursery of breeding material was grown at Amarillo.

With the establishment of the Amarillo Conservation Experiment Station in 1938, which is cooperative between the Soil Conservation Service of the U. S. Department of Agriculture and the Texas Agricultural Experiment Station, small grain work in the Panhandle was transferred to the Amarillo station. The development of our present wheat varieties and others soon to be released is the result of a coordinated program of research by these two agencies with the Division of Cereal Crops and Diseases, Bureau of Plant Industry, Soils and Agriculture Engineering, U. S. Department of Agriculture. An intensive breeding program is carried on at Amarillo, at the Denton station and on the Main Station Farm at College Station and additional tests are conducted at other stations and locations in Texas.

The breeding, testing, increase and distribution of new varieties of small grain requires the combined efforts of many people. Not only must a new strain of wheat being considered for distribution be able to produce as good or better yields of grain than established varieties, but it must be resistant to diseases, lodging and shattering, be adapted to the harvesting methods employed, and have good milling and baking characteristics.

Modern methods of developing new varieties consist usually of crossing the best adapted commercial varieties of an area with another variety that possess one or more other desirable characteristics such as rust resistance, smut resistance, high quality and high test weight. After the cross is made, the hybrid must be grown through several segregating generations before true breeding strains can be selected for trial. Hundreds and even thousands of strains may be selected before the desired combination of characters is obtained Many crosses fail to produce a new variety. New selections must be carried through many years of trial at several locations. It usually requires from 10 to 15 years to develop a new variety.

The small grain research program in Texas has been instrumental in developing or testing several new varieties of wheat that now occupy large arcearges in Texas. Through the early work at Amarillo and on farms in this area, Tenmarq was introduced to Texas farmers. In 1944, Tenmarq occupied more than 30 percent of the wheat acreage in the

State. Its popularity has declined in recent years. Westar was developed by the Denton and Amarillo stations and is rapidly becoming the most popular variety in Texas, occupying 26 percent of the wheat acreage in 1949. Comanche and Wichita, developed in the cooperative regional small grain program, also occupy large acreages. Other new varieties will be made available as they are developed in this and other states.

Figure 2 shows the acreage of the major wheat varieties of Texas from 1919 through 1949, as determined by surveys made by the U. S. Department of Agriculture and reported in USDA Circular 861.

Commercial Varieties

Varieties which have been accepted by farmers, millers and bakers include Westar, Comanche, Triumph and Wichita. A description of these and other varieties follows.

Westar is a white chaff, bearded variety developed from a cross of (Kanred X Hard Federation 25007) X Tenmarq. The early breeding work was done at the Denton station. The stations at Amarillo, Iowa Park, Chillicothe and Spur cooperated in testing the new strain. Westar has been distributed by the Amarillo station since 1944.

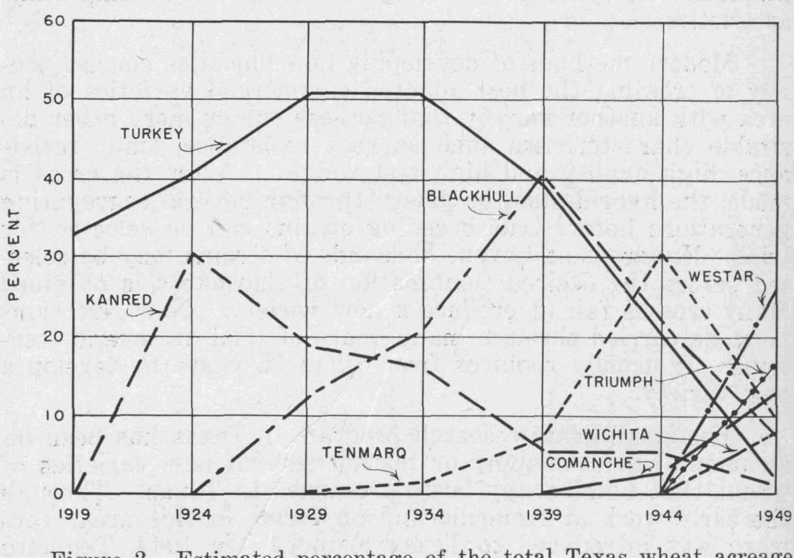

Figure 2. Estimated percentage of the total Texas wheat acreage occupied by eight varieties, 1919 and 1949.

Outstanding characteristics of Westar include high yield, high test weight, good milling and baking characteristics, and resistance to some races of leaf (orange or red) rust. Westar is highly susceptible to stem (black) rust. In general appearance, it is similar to Tenmarq and Comanche. Under Panhandle conditions, it matures about the same time as Comanche, 3 days earlier than Tenmarq and 5 days earlier than Turkey. Westar averages about the same height as Tenmarq, has a strong straw and stands well for combine harvesting. While not as winter-hardy as Turkey, it is equal to Comanche and Wichita, and is considered sufficiently hardy for Texas conditions.

Comanche is a white chaff, bearded, mid-season variety possessing fairly strong straw and producing grain of a good test weight. It is resistant to the races of bunt present in the Panhandle and to some races of leaf rust.

Comanche was developed by the Kansas Station from a cross of Oro X Tenmarq. Comanche has about the same maturity as Westar. Both Comanche and Westar usually produce grain of better test weight than Tenmarq. Comanche's excellent milling and baking characteristics have made it popular with millers and bakers. Comanche was distributed in Texas in 1942 by the Chillicothe station.

Wichita is a bearded variety of about the same maturity as Early Blackhull but has more desirable milling and baking characteristics. The chaff of Wichita may be black in seasons favorable for color development.

Wichita was developed by the Kansas Station from a cross between Tenmarq and Early Blackhull. It is about 10 days earlier than Tenmarq and 7 days earlier than Comanche and Westar. Like Early Blackhull, it is susceptible to leaf rust, stem rust and smut but, owing to its early maturity, it usually escapes serious rust injury. Wichita usually lodges less than Early Blackhull, but has weaker straw than Comanche or Westar. Under some conditions, it will shatter some in the field. Wichita is less desirable in quality than Comanche and Westar and should not replace acreages of those varieties.

Triumph is a white chaff, bearded, early-maturing wheat developed by Joseph Danne of El Reno, Oklahoma. It is equally as early as Wichita and Early Blackhull. As it is shorter, lodges less and yields well, it has become popular on farms in Texas, Oklahoma and Kansas. The quality of Triumph is acceptable but not outstanding. Triumph, like Wichita, has little or no resistance to disease but has slightly shorter and stronger straw than Wichita. Triumph also is known as Early Triumph, Early Danne and Early Premium.

Tenmarq is a white chaff, bearded variety developed from a cross of Turkey and Marquis (a spring wheat) by the Kansas Station. Tenmarq was the first hard red winter wheat developed by selecting from the progeny of a cross of two or more varieties of wheat. Varieties developed prior to Tenmarq were either introductions or were selections from Turkey. Tenmarq has little resistance to disease and is about 3 days later than Westar. It has excellent milling and baking characteristics. Although it has produced satisfactory yields in the Panhandle, its low test weight and late maturity have caused it to be largely replaced by the more recently distributed varieties.

Blackhull is a black chaff, bearded variety, although in some years the black chaff color may not be well developed. It is a selection from Turkey made by Earl G. Clark in 1912. It is 2 to 3 days later than Westar. Blackhull has little resistance to disease and is particularly susceptible to leaf rust. It has moderately weak straw and poor milling and baking characteristics. Blackhull, like Tenmarq, has been largely replaced by newer varieties.

Kanred is a white chaff, bearded, late-maturing variety. It is a selection from Turkey which was distributed by the Kansas Station in 1917. It has little resistance to disease and has weak straw. Kanred is a good quality variety. It is now grown on a very small acreage.

Turkey, a white chaff, bearded variety, was introduced by Russian immigrants who settled near Newton, Kansas, about 1873. It was the most widely grown variety on the Great Plains until about 1940. Turkey is either a parent or grandparent of all the hard red winter wheat varieties now grown in the area. Turkey is about 5 days later in maturity than Westar. It has little resistance to disease but is a good quality variety. Its susceptibility to lodging and diseases, and its lateness of maturity have caused it to be replaced by improved varieties.

Pawnee is a white chaff, bearded, mid-season variety developed from a cross of Kawvale and Tenmarq by the Kansas and Nebraska Stations. It matures about the same time as Westar, has strong straw and yields well. It is resistant to the hessian fly and to loose smut and is moderately resistant to leaf rust. It often shatters badly and is less desirable in baking quality than Comanche and Westar.

Red Chief and *Chiefkan* are beardless wheats which were developed by Earl G. Clark. They mature slightly later than Comanche and Westar, produce grain of high test weight, yield well and have good field characteristics. However, they are undesirable in milling and baking characteristics.

Superhard Blackhull is similar in appearance to Blackhull, but is of inferior baking quality.

Other Varieties

Several new varieties have been distributed recently by experiment stations and a private plant breeder. Some have been tested since 1947 and others during a shorter period. They require further testing before they can be evaluated fully.

Blue Jacket is a late-maturing Blackhull type wheat developed by Earl G. Clark. It is a black chaff, bearded wheat having high test weight and good yielding ability. It is somewhat inferior to Blackhull in milling and baking characteristics.

Quanah is a white chaff, bearded selection from a compound cross of Comanche and two rust resistant soft winter wheats made at the Denton station, and was distributed in 1949. Quanah is resistant to many races of stem rust, leaf rust and stinking smut. It is similar to Comanche in appearance and milling and baking characteristics. It is very susceptible to loose smut. Quanah is recommended for Central Texas. Tests at Amarillo and Spur from 1947 through 1951 indicate that Quanah is too winter-tender for growing in the Panhandle.

Apache is a bearded selection from the cross Cheyenne X Early Blackhull. The selection was made at the Fort Hays Experiment Station, Hays, Kansas, from hybrid material which origniated at the U. S. Southern Great Plains Field Station, Woodward, Oklahoma. Apache was tested in uniform trials in Nebraska, Kansas, Oklahoma, Colorado and Texas from 1945 through 1947 and in New Mexico in 1948 and 1949. It was distributed in 1949 to farmers of northeastern New Mexico by the New Mexico Station at Clovis.

Apache is intermediate in maturity between Wichita and Comanche. It yielded about the same as Westar at the Amarillo station during the years it was tested. Apache is not equal to Wichita in quality.

Kiowa is a bearded variety developed from the cross Chiefkan X Oro-Tenmarq by the Fort Hays Experiment Station. It is about a day earlier than Comanche in maturity, has strong straw, good test weight and produced satisfactory yields at Amarillo. Kiowa is less desirable than Comanche in milling and baking characteristics, and is very susceptible to both loose smut and rust. It does not appear to be superior to Comanche for Texas conditions.

Ponca is a white chaff, bearded, mid-season variety, recently named and released by the Kansas and Oklahoma Stations. It is a selection from the cross Kawvale-Marquillo X Kawvale-Tenmarq. It has more resistance to the hessian fly than Pawnee and is recommended especially for those areas where this fly causes serious damage to the wheat crop. Ponca is similar to Pawnee in many respects but is better in milling and baking characteristics. It has more resistance to leaf rust than Pawnee. Additional tests are needed, but it seems doubtful that Ponca is any better adapted to the conditions of the Texas Panhandle than the present commercial varieties.

New Chief, Red Jacket and *Kansas Queen,* a soft wheat, are varieties distributed by Earl G. Clark about 1950. These wheats are included in experimental tests in Texas, but they have not been under trial long enough to evaluate them. Soft wheat varieties such as Kansas Queen, are not suitable to the needs of the trade and no variety should be grown unless it is known to possess good milling and baking characteristics.

Yields

Many plant characters influence the yield of wheat. Plant or variety characteristics, such as earliness or disease resistance, will exert a greater influence on yield in some years than in others. Therefore, more accurate comparisons of the yielding ability of varieties can be obtained over a series of years than in a single year or a short period of years.

Small grain variety tests were conducted on farms in the Texas Panhandle from 1931 to 1938 in cooperation with county agricultural agents. Tenmarq, Kanred, Blackhull and Turkey were grown in all tests. Tenmarq produced the highest average yield, although it was not much higher than that of Blackhull and Kanred. The soft wheat varieties, Kawvale and Denton, produced lower yields in these tests than the hard red winter wheat varieties with the exception of Early Blackhull.

Yields of varieties in dryland tests on the Amarillo station during 8 years from 1940 through 1951 are shown in Table 2. Yields for 1945 and 1951, in which hail severely

Table 2.—Yield, test weight and plant height of wheat varieties in dryland tests on fallow at the Amarillo Conservation Experiment Station, 1940-50

Variety	Bushels per acre												
	1940	1941	1942	1943	1944	1947	1948	1949	1950	1940-50 Av.	1947-50 Av.	Test weight, pounds	Plant height, inches
Chiefkan	6.7	29.7	23.1	15.3	38.1	21.6	14.1	40.1[1]	0	21.0	19.0	60.0	29
Westar	6.4	34.8	18.8	16.8	36.7	22.1	11.1	35.9	0	20.3	17.3	58.7	27
Pawnee	4.7	33.4	18.5	13.3	37.4	19.8	12.7	41.0	0	20.1	18.4	58.0	24
Red Chief	5.8[1]	28.4	18.2	13.3	34.7	21.5	13.3	39.7	0	19.4	18.6	60.0	29
Comanche	4.8	28.7	19.5	14.9	35.0	17.4	12.3	39.3	0	19.1	17.3	57.9	26
Tenmarq	6.0	26.1	18.5	14.2	34.1	23.5	10.3	37.4	0	18.9	17.8	57.3	27
Blackhull	6.4	19.6	20.2	15.7	36.1	21.8	13.2	36.9	0	18.9	18.0	58.3	27
Kanred	5.3	24.1	17.0	13.3	34.6	22.8	12.4	39.1	0	18.7	18.6	58.0	29
Wichita	4.5	26.4	19.4	13.7	33.4	18.9	10.9	36.9	0	18.2	16.7	59.0	24
Turkey	5.0	20.8	16.9	13.3	34.1	22.3	12.6	36.1	0	17.9	17.8	57.8	29
Early Blackhull	3.9	18.6	21.3	10.8	32.6	18.2	10.9	38.0	0	17.1	16.8	58.3	25
Triumph						17.6	13.3	37.1	0		17.0	59.0	24
Quanah						15.5	10.6	37.7	0		16.0	57.0	26
Kiowa						18.8	13.3	38.8	0		17.7	60.0	26
Blue Jacket						21.2	12.3	40.0	0		18.4	60.0	31
Ponca						19.3	11.6	37.5[1]	0		17.2	59.0	26

[1]Calculated yield.

damaged the tests, are not given. Yields in 1946 were not obtained because of poor stands and drouth. The crop was destroyed by greenbugs in 1950.

The varieties which produced the highest yields on dryland have also been among the higher yielders in irrigated tests at Amarillo and Hereford. Irrigation of wheat in the Panhandle is generally a practice of supplementing the natural rainfall and is not an intensive irrigation of the crop. The irrigated tests were conducted on this basis.

Probably the main advantage the improved varieties have over older varieties, like Turkey, Kanred and Blackhull, is their earlier maturity. Medium-maturity varieties such as Comanche and Westar have higher average yields than either the early or late-maturing varieties.

Chiefkan was the highest yielding variety during the 8 seasons for which records are available. Westar ranked second and Pawnee third. Chiefkan, however, is of poor quality and is grown very little commercially at present. Westar is superior in quality to Pawnee and shatters less. The test weight of Westar has averaged higher than any other good quality variety.

The Importance of Quality

Wheat varieties differ greatly in milling and baking characteristics. For this reason, millers are careful to use only varieties or a blend of varieties which will produce the kind of flour required to meet the needs of the baker to whom they sell. Many terminal elevators and mills now classify the wheat they receive as to the percentage of good and inferior varieties that make up a shipment. Wheat with an appreciable amount of poor quality varieties often moves into the feed or export channel. If a variety is grown on a large scale and fails to meet the needs of the trade, then the wheat in the area where this variety predominates may be discriminated against at the terminal market.

The choice of a wheat variety should be based on its quality as well as on its performance in the field. Fortunately, the Panhandle farmer has available to him varieties of approved quality which will yield as high as those having poor quality. Therefore, the growing of high quality varieties, such as Westar, Comanche, Wichita and Triumph, will be advantageous to the farmer.

PLACE OF WHEAT IN THE ROTATION

The continuous growing of one crop undoubtedly reduces the inherent fertility of the soil and makes production less stable than would a cropping system in which wheat is rotated with other crops or fallow. Cropping systems for the Panhandle are probably more restricted than they are in areas of higher rainfall. However, the use of adapted crops, such as wheat and sorghum, in rotation with fallow, will aid in stabilizing crop production.

Yields of wheat and grain sorghum in a wheat-sorghum-fallow rotation are compared in Table 3 with yields of continuous wheat and sorghum. For the 10-year period, 1942-51, wheat in rotation yielded 46.7 percent more than continuous wheat, and sorghum in rotation yielded 44.5 percent more than continuous sorghum. Since only two crops, one of wheat and one of sorghum, can be produced in a wheat-sorghum-fallow rotation during a 3-year period, the total grain production is slightly less than the amount produced by continuous cropping. This difference is more than offset however, by the fewer seeding and harvesting operations required in the rotation system.

Table 3.—Average yield of wheat and sorghum grown in a wheat-sorghum-fallow rotation and continuous wheat and sorghum in tests at the Amarillo Conservation Experiment Station, 1942-51

Year	Continuous wheat	Continuous sorghum	Wheat-sorghum-fallow rotation Wheat	Wheat-sorghum-fallow rotation Sorghum
		Bushels per acre		
1942	20.1	13.6	19.1	20.7
1943	7.6	12.7	6.7	13.1
1944	26.0	37.1	38.8	43.7
1945	5.6	.0	17.6	4.3
1946	8.2	.0	6.4	4.0
1947	27.0	18.2	34.6	23.8
1948	2.4	24.4	19.6	43.0
1949	20.2	38.9	28.9	51.2
1950	.0	16.4	.0	27.6
1951	5.1	20.7	7.4	31.1
Average	12.2	18.2	17.9	26.3

Crop rotation is desirable as a means of controlling weeds, insects, plant diseases, to reduce erosion by both wind and water, and to improve the physical condition and productivity of the soil through the growing of legumes and grasses. Hairy vetch, Austrian Winter peas and the clovers, can be grown, although definite rotations including these and other legumes have not been developed for this area. The use of legumes and other crops in a rotation with wheat will necessitate the use of more livestock, if economical utilization is to be made of these crops.

CULTURAL PRACTICES ON THE AMARILLO STATION

Farmers are becoming increasingly aware of the value of leaving crop residue on the surface as an aid in reducing runoff, evaporation, wind and water erosion, and in improving the physical condition of the soil. In years when wheat fails to produce enough cover for protection against erosion, plant residue will prevent much damage to small plants. Snow will be retained on the land by plant residue and may maintain stands until additional moisture is received. Stubble-mulch farming may be accomplished in varying degrees with the use of any of several types of field cultivators and sweep-type plows now commercially available. This practice appears to be valuable in wheat production in the Panhandle. Farmers have found some difficulty in changing to a system of stubble-mulch farming but most of it will be overcome with experience.

Table 4.—Yields of continuous wheat and wheat on fallow obtained on differently tilled plots, Amarillo Conservation Experiment Station, 1942-49[1]

Tillage practice	Bushels per acre								
	1942	1943	1944	1945	1946	1947	1948	1949	Ave.
				CONTINUOUS WHEAT					
Moldboard plow	20.3	4.2	19.7	4.4	1.8	31.8	5.6	23.2	13.9
Oneway plow	20.1	6.0	24.5	6.3	2.6	28.4	4.6	21.5	14.2
Subtillage[2]	19.1	7.1	26.4	6.9	6.0	34.3	6.2	19.4	15.7
				WHEAT ON FALLOW					
Oneway plow		11.9	28.4	16.7	8.5	33.1	13.9	36.0	21.2
Subtillage		14.6	28.4	20.4	13.9	36.8	15.7	38.4	24.0
Delayed subtillage[3]		12.9	30.3	23.3	15.4	36.2	15.6	36.1	24.3

[1]Tables reproduced from USDA Circular No. 860.
[2]Subtillage refers to cultivation with a sweep-type plow, which leaves residue on the surface and provides a stubble mulch.
[3]Subtillage in which the first operation was delayed until about April 1.

Table 4 indicates that yields can be maintained and even increased by the use of a sweep-type plow or other subtillage implements. These implements leave nearly all of the plant residue on the surface. A good discussion of stubble-mulch farming in this area is given in Texas Station Bulletin 711 (available only in libraries) and in U. S. Department of Agriculture Circular 860.

Delayed fallow, a system in which the land is not cultivated until the spring following the harvesting of the wheat, produced as high yields as those grown on fallow in which cultivation to control weeds began shortly after the harvesting of the crop. Delayed fallow reduces the expenses of fallowing and tends to preserve the crop residue during the fallowing period.

Proper land management, seedbed preparation, seeding, grazing and the use of improved varieties reduce the risks due to adverse weather conditions. Farm operations are planned on the basis of average precipitation, temperatures and other climatic conditions. However, the years which vary from the average are more common and contribute the most to the uncertainties of farming in the Panhandle.

Farming operations in the production of wheat and other crops should include those practices best suited to meet the adverse conditions as well as those of the so-called normal year.

USE GOOD SEED

The use of recleaned, good quality seed of a recommended adapted variety, which are free from weed seed and other foreign matter, is of prime importance. Wheat seed should have a germination of at least 90 percent. All planting seed should be treated with copper carbonate, Ceresan M or some other approved fungicide.

Seed from fields having even a low infestation of noxious weeds such as bindweed, or of annual grasses such as goat grass, should not be saved for planting purposes. Farmers should insist that custom combines be thoroughly cleaned before moving into their fields.

The certification of field seeds in Texas is handled by the State Department of Agriculture at Austin, Texas. Certified seed guarantees the purchaser of the variety wanted and that he is obtaining seed reasonably free from disease and free of noxious weeds.

While it probably is not essential or economical to purchase certified seed for the entire acreage each year, some certified seed should be used. By planting a seed block on fallowed land, sufficient seed may be grown to plant the entire acreage the following year. By careful planning of the planting and harvesting operations, farmers can provide themselves with high quality seed at a minimum cost.

RATE AND DATE OF SEEDING

Thirty pounds of seed per acre is the most common and probably the optimum rate of seeding wheat in the Panhandle. Twenty pounds may be sufficient for early September seedings but, 30 pounds will insure better stands. Slightly higher rates, 35 to 45 pounds per acre, are desirable on sandy soils, or for November seeding on heavier soils.

Most wheat in the Panhandle is seeded between August 20 and October 15. If moisture conditions are favorable, much of the acreage will be seeded by September 15.

The increased use of wheat for grazing has tended to advance the seeding date. August and early September seedlings usually will provide more grazing for livestock and produce a better cover for protection against blowing, but there are several disadvantages to early seeding. Early-seeded wheat may deplete the soil of most of the available moisture during the fall and winter and make it largely dependent on spring rainfall to produce a crop. Early-seeded wheat is frequently damaged more by root diseases and fall infection of rust than late-seeded wheat. Early-seeded wheat provides food for the early increase of insects such as greenbugs, cutworms and wireworms. Western wheat mosaic, which possibly may be transmitted by one or more species of insects or by other means, has been more severe in August-seeded wheat than in that seeded the latter part of September.

Date-of-seeding tests indicate that the most desirable seeding date is from September 20 to October 10.

GRAZING OF WHEAT

Grazing of wheat has become a profitable part of its production in the Texas Panhandle, Figure 3. The influence of grazing on the yield of grain is, therefore, an important factor in determining the most economical utilization of the crop.

Studies were conducted from 1946 through 1951 at the Amarillo Station to determine the effect of clipping and grazing on the yield of four popular varieties. Data on clipping were obtained in 1946 and 1947 and by grazing with cattle in 1949, as shown in Tables 5 and 6. The data indicate that moderate grazing during the fall and winter does not seriously reduce the yield of grain. However, if grazing is continued past March 1, grain yields are reduced in proportion to the lateness of grazing and the earliness of the variety. Wheat

Table 5.—Average yield of four varieties of wheat following grazing and clipping of forage on dates shown, at the Amarillo Conservation Experiment Station, 1946-47

Variety	Grazed moderately with livestock Nov. 8—Dec. 11 and Feb. 4—March 1	1946, BUSHELS PER ACRE — Dates clipped in imitation of livestock grazing[1]: November 5 and January 28	January 28 and March 7	November 5 and April 2	March 7 and April 2	April 2	Unclipped check plot
Westar	8.3	25.9	20.2	5.7	4.2	4.2	22.8
Comanche	8.8	21.3	13.0	10.9	5.2	4.2	20.7
Tenmarq	9.5	22.8	15.0	8.8	3.6	5.2	18.7
Blackhull	10.6	14.0	7.8	8.6	4.2	5.2	6.2
Average	9.3	21.0	14.0	8.5	4.3	4.7	17.1
Average yield in percent of unclipped check plot	54.3	122.8	81.9	49.7	25.1	27.4	

1947, BUSHELS PER ACRE — Dates clipped in imitation of livestock grazing[1]

Variety	Dec. 15	Dec. 15 and Jan. 15	Dec. 15 and Feb. 15	Jan. 15 and Feb. 15	Dec. 15 and Mar. 15	Feb. 15 and Mar. 15	Mar. 15 and Apr. 1	Apr. 1 and Apr. 15	Apr. 15 and May 1	All dates Dec. 15 May 1	Unclipped check plot
Westar	19.9	20.1	21.0	20.0	19.9	18.0	18.0	11.4	2.7	2.2	20.4
Comanche	12.4	14.0	12.0	13.2	8.2	11.4	10.2	7.8	2.2	2.9	15.0
Tenmarq	18.9	20.9	20.4	19.4	17.6	20.4	12.8	10.8	1.7	1.2	20.1
Blackhull	15.7	16.1	14.3	15.2	13.6	13.2	11.1	8.0	2.4	2.1	16.8
Average	16.7	17.8	16.9	17.0	14.8	15.8	13.0	9.5	2.3	2.1	18.1
Average yield in percent of unclipped check plot	92.3	98.3	93.4	94.0	81.8	87.3	71.8	52.3	12.7	11.6	

[1]Plots were clipped off at the surface with power hand clippers on the dates indicated.

Table 6.—Yields obtained for five varieties of wheat heavily grazed for the periods shown, compared with ungrazed plots of the same varieties, Amarillo Conservation Experiment Station, 1949

	Bushels per acre			
Variety	Grazed Dec. 7 to April 1	Grazed Feb. 1 to March17	Not grazed	Grazed plots Percent of plots not grazed
Westar	35.5	32.5	39.3	86.5
Comanche	35.0	33.0	38.3	88.8
Red Chief	36.4	36.2	41.6	87.3
Quanah	28.3	28.4	36.8	77.2
Wichita	28.2	27.8	34.3	81.6
Average	32.7	31.6	38.1	84.5
Average yield in percent of ungrazed plots	85.8	83.9		

grazed from December 7, 1949 to April 1, 1950, yielded slightly more than wheat grazed only from February 1 to March 17, 1950. The slight variation in yield between wheat grazed during the different periods is probably due to the fact that both test areas were able to make maximum recovery because of the very favorable rainfall and temperature conditions that existed.

Livestock should be removed by March 15 from mid-season varieties such as Comanche and Westar, and by March 1 from early-maturing varieties such as Wichita and Triumph.

Wheat that was heavily-grazed during the 1950 and 1951 seasons appeared to have fewer greenbugs than did the wheat that was not grazed. However, when cattle were removed

Figure 3. Grazing wheat on the Amarillo Conservation Experiment Station.

from closely-grazed wheat, new plant growth was severely damaged by greenbugs. Greenbugs killed the 1950 crop and no yield differences were obtained. Wheat partially recovered from the greenbug attack in 1951 and ungrazed wheat yielded 3.2 bushels per acre, as compared with 1.8 and 2.3 bushels for wheat plots grazed to February 1 and March 15, respectively.

The use of wheat in a year-round grazing program is discussed in Texas Station Bulletin 717.

THE USE OF SPRING WHEATS

Spring wheat is not adapted to the Panhandle, although, under favorable conditions, it may produce a satisfactory yield. The poor yields obtained with spring wheat in this area may be due in part to the unfavorable spring planting conditions that usually exist. The late maturity of spring wheat causes it to encounter high temperatures and hot winds during the heading and ripening period.

Spring-seeded barley and particularly grain sorghums are much better adapted to the conditions of the Panhandle than is spring wheat.

WEEDS IN WHEAT

The more serious weeds in wheat in the Panhandle include goat grass or joint grass, little barley and cheat, which are weedy annual grasses; and bindweed and blueweed, which are broadleaf perennials. Goat grass, little barley and cheat are best controlled by rotating wheat with cultivated crops and fallow. Bindweed and blueweed need more intensive control measures. Broadleaf annual weeds, which are a serious pest in wheat in the spring of some years, may be controlled with 2,4-D.

Numerous tests have been conducted to determine the proper dates and rates of application of 2,4-D on wheat. In general, the recommendations given by W. M. Phillips in Contribution No. 61, Ft. Hays Experiment Station, Hays, Kansas, are in agreement with those of other stations. The following recommendations are from that publication:

> "Winter wheat should be sprayed after the crop is fully tillered and before it reaches the boot stage. Damage from 2,4-D is most likely to occur during the boot and heading stages. Rates of 1/4 to 1/3

pound 2,4-D acid equivalent as an ester, or 1/2 to 2/3 pound 2,4-D acid equivalent as an amine, or sodium salt usually will be sufficient for annual weed control if applied before the wheat reaches the boot stage.

"Spraying a short time before harvest should be regarded as an emergency measure rather than a recommended practice. Large weeds present at this time are diffcult to kill and often results are not satisfactory. Only the ester formulations at rates of 2/3 to 1 pound 2,4-D acid should be used on these large weeds.

"Wheat may be seriously injured by fall applications of 2,4-D so fall treatments are not recommended."

Cotton and a number of other crop plants are very susceptible to 2,4-D. Even if a considerable distance from a spray application of 2,4-D, cotton may be severely damaged by the drifting spray. The use of 2,4-D and similar weed control chemicals is regulated by law in some Texas counties, particularly those having sizable cotton acreages. Farmers should be fully acquainted with these regulations before making applications of 2,4-D.

DISEASES

The cool, dry climate of the Panhandle is less favorable for many diseases of wheat than are the more humid areas of the State. The wheat rusts, septoria leaf blotch, septoria glume blotch, black chaff, basal glume rot, Helminthosporium leaf spot and mildew are favored by humid, warm weather and frequent showers. These diseases may be of economic importance in wet seasons but often are of minor importance in this area.

The soil-borne diseases, such as the root and foot rots, are important and probably cause more damage than is recognized. The seed-borne diseases, stinking smut and loose smut, may cause important losses but can be controlled by proper seed treatment.

Smuts

Two types of smut are found in wheat in the Panhandle. Both are fungus diseases caused by microscopic, parasitic

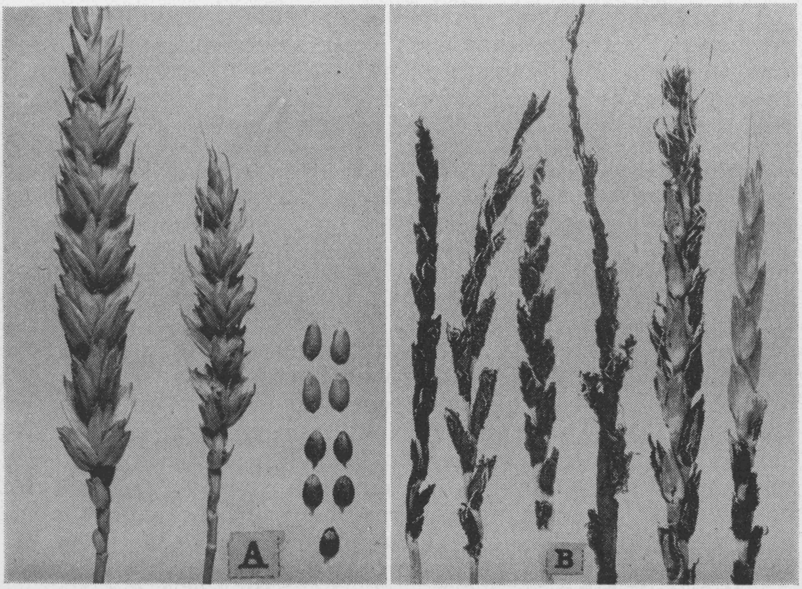

Figure 4. (A) A normal wheat head, left, compared with the head of a plant infected with stinking smut or bunt. Normal grain, upper, is compared with the smut balls, lower, which replace the grain in bunt-infected plants. (B) Heads of plants infected with loose smut. Note the central stem of the head, fourth from left, from which the spores of loose smut have been washed or blown off. These pictures are used through the courtesy of J. G. Dickson, professor of plant pathology, University of Wisconsin, and USDA agent in cereal investigations.

plants that grow and reproduce at the expense of the wheat plant. They produce tiny black spores in the wheat head instead of the normal grain.

Figure 4 shows specimens of loose smut, heads of wheat infected with bunt and normal heads and grain.

Bunt or stinking smut is spread from one crop to the next by means of the black spores produced in the smut ball that replaces the seed of wheat. These spores are scattered in the threshing process and lodge in the crevices of the kernel and in the hairs at the brush end. When this smut-contaminated seed is sown in moist, cool soil, the smut spore germinates and the fungus penetrates the young seedlings. The parasite grows within the wheat plant during the season, finally producing a mass of spores which replaces the seed in the head. This not only reduces the yield of grain in proportion to the number of smutted heads present, but the odor permeates the entire lot of wheat seed so that it is unfit for milling and baking into bread without costly washing and processing. Growers generally are familiar with these smut balls and the foul-smelling odor of the grain. The presence of smut balls or a smutty odor is cause for grading the wheat as smutty and this grade brings a lower price on the market.

Comanche, Kiowa and Quanah are resistant to the common races of bunt present in Texas. All other commercial varieties now grown are susceptible.

Seed treatment for the control of bunt is inexpensive and should be practiced every year. Copper carbonate dust was formerly used very extensively for this purpose. Several new commercial compounds are available and satisfactory. These include Ceresan M, New Improved Ceresan, Aagrano, Agrox and other volatile organic mercury dusts. One of the most commonly used compounds is New Improved Ceresan or Ceresan M at one-half ounce per bushel. It may be applied as a dust or a slurry. The dust or slurry must be well distributed on the seed. The mixing of these dusts with the wheat in the drill box is not advisable, as complete coverage is seldom obtained.

Information on seed treatment and methods of applying the fungicide are given in USDA Miscellaneous Publication 219, "Treat Seed Grain."

Loose smut is more noticeable in the field before harvest as the entire head, except the central stem (rachis), is destroyed by the fungus. The black spores are scattered by the wind and may be blown at flowering time into the open florets of healthy plants. Here the spores germinate and the fungus enters the ovary of the wheat seed. The infected seed matures normally and cannot be distinguished from non-infected seed. The fungus remains dormant until the seed germinates, then it invades the plant tissues, grows upward as the plant matures and finally replaces the floral parts with a mass of smut spores.

The loose smut fungus cannot be controlled by surface seed disinfectants such as Ceresan M and others. It can be controlled by a rather complicated treatment in hot water where the seed are subjected to a sufficiently high temperature to kill the fungus within it, but not high enough to injure the seed. This process is rather difficult to carry out unless adequate facilities are available.

Instructions for treating seed with hot water may be found in USDA Miscellaneous Publication 219, mentioned previously.

Rusts

The rusts, like the smuts, are fungus diseases which attack the wheat plant but, unlike the smuts, they are not seed borne. Two types of rust are important in Texas. Leaf rust attacks the leaves and leaf sheathes, causing small, round, salmon red pustules which are filled with tiny red spores. As the plant matures or the food supply in the leaf is reduced, these pustules produce black or over-wintering spores and the pustule appears as a tiny black dot on the leaf. Stem rust, commonly called black stem rust, attacks all parts of the plant above ground but is most damaging on the stems. This rust also has a red or infectious stage. It is during this stage that damage is done to the plant. The black or over-wintering stage appears later.

Leaf rust is present in varying amounts each year. It may cause damage in the fall by reducing the vigor of the plant and the pasture value of the field, or it may infect the plant during the spring and yields will be reduced in proportion to the amount of infection. Leaf rust usually influences the yield by reducing the number of kernels per head and the size of the grains rather than through shriveling of the grain, as is characteristic of stem rust. Fortunately, some of the new and more popular varieties are moderately resistant to leaf rust. Westar, Comanche, Quanah and Pawnee are much more resistant than Turkey and Blackhull.

Both rusts are favored by warm, humid weather with frequent showers. The only practical control method is the use of resistant varieties.

Figure 5 shows leaves infected with leaf rust in comparison with normal leaves.

Stem rust is destructive in Panhandle wheat only during occasional seasons. Under favorable conditions, it may cause very serious losses in yield and in the quality of grain. Damage results from the stem rust organism taking food and water from the host plant. This results in marked shriveling of the grain and breaking over of the stem, with an accompanying increase in the cost of harvesting. None of the varieties grown on or recommended for the Panhandle is resistant to stem rust. Breeding experiments are in progress to develop resistant varieties, but this work has been hampered by the repeated appearance of new races of stem rust.

Figure 6 shows stems and leaves of wheat damaged by stem rust.

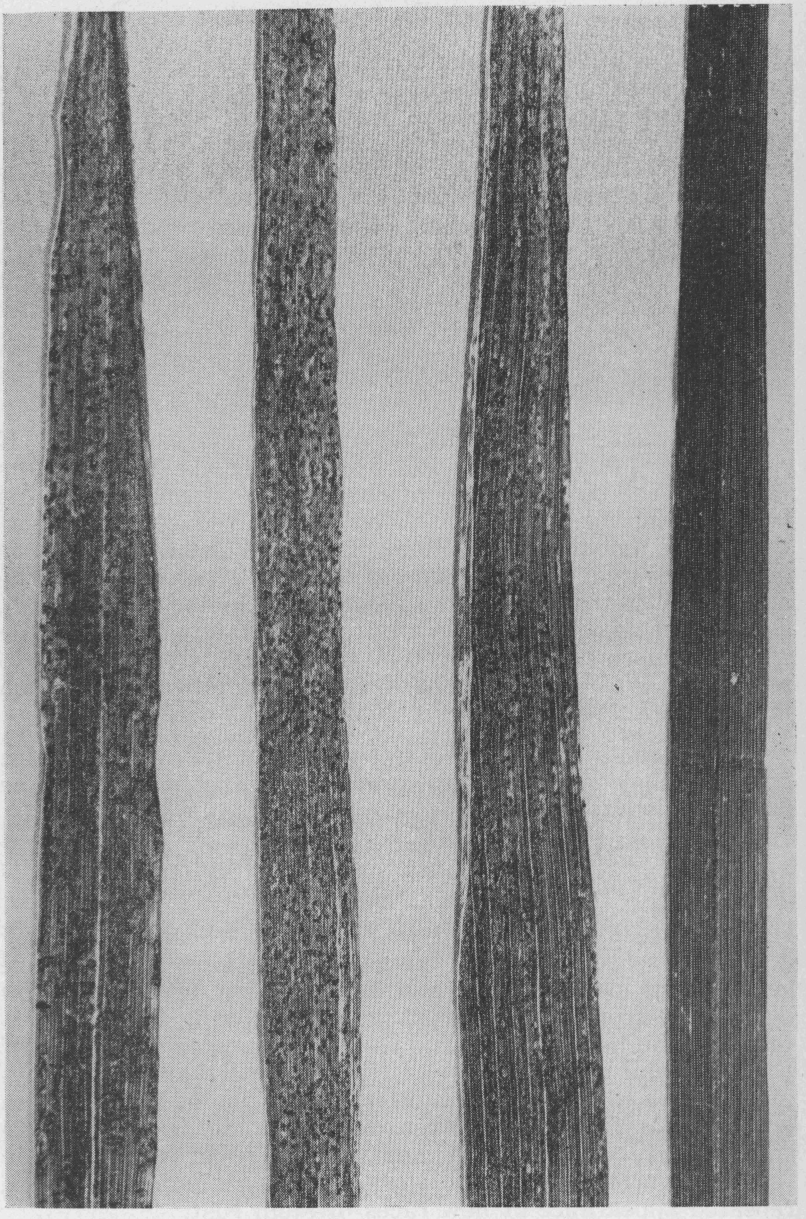

Figure 5. The first three leaves from the left show specimens of leaf rust of wheat. An uninfected or normal leaf is on the right.

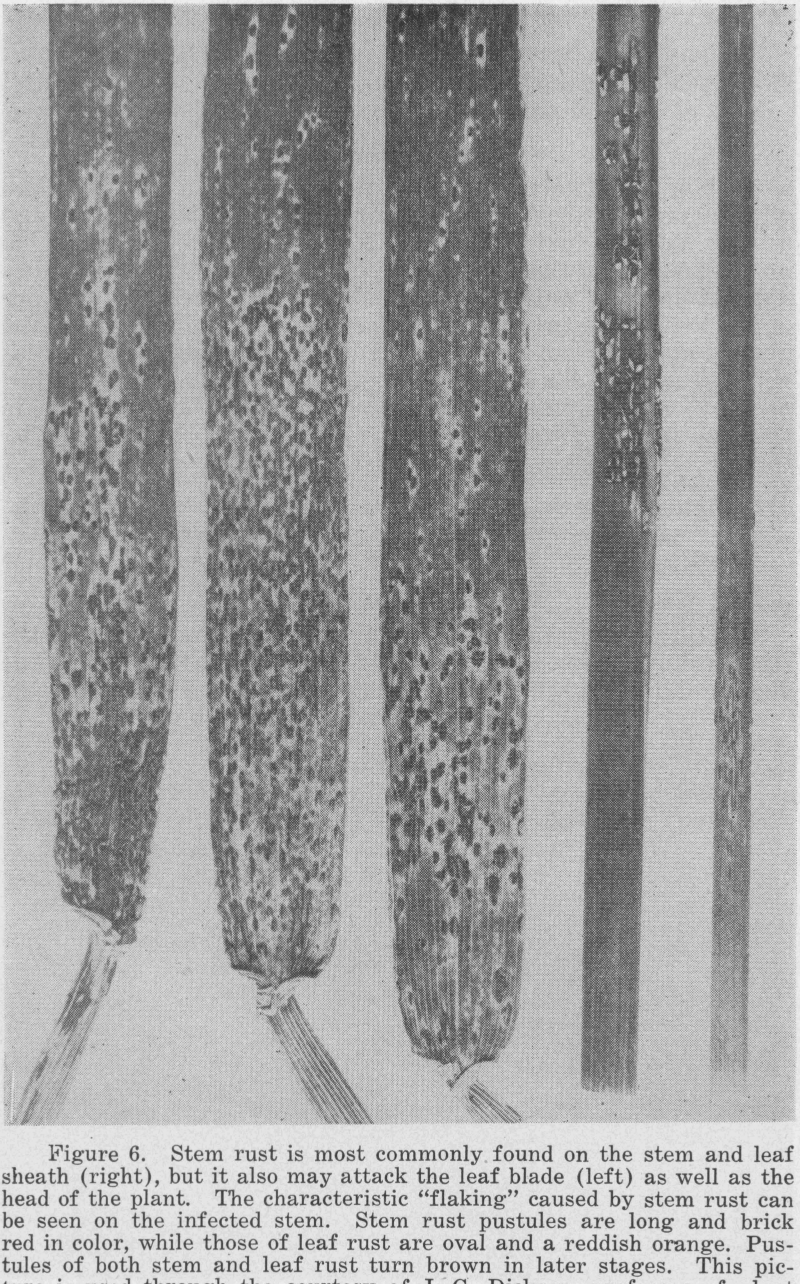

Figure 6. Stem rust is most commonly found on the stem and leaf sheath (right), but it also may attack the leaf blade (left) as well as the head of the plant. The characteristic "flaking" caused by stem rust can be seen on the infected stem. Stem rust pustules are long and brick red in color, while those of leaf rust are oval and a reddish orange. Pustules of both stem and leaf rust turn brown in later stages. This picture is used through the courtesy of J. G. Dickson, professor of plant pathology, University of Wisconsin, and USDA agent in cereal investigations.

There is no practical means of control of stem rust other than breeding resistant varieties.

Septoria

There are two types or species of septoria and both are of some importance in the Panhandle. Septoria leaf blotch usually occurs during cool weather. It produces yellow to brown lesions on the leaf in which small black fruiting bodies appear later. Yields are reduced when considerable portions of the leaves are involved. Septoria glume blotch attacks the glumes and nodes of the plant, causing brown discolored areas which finally weaken the stem and cause lodging or, when present on the glumes, cause discoloration and reduction in the size of the grain. In very wet seasons, the damage by this disease is often confused with damage by stem rust.

Figure 7 shows a field of wheat which was seriously damaged by septoria, accompanied by minor damage by stem rust.

Western Wheat Mosaic

Western wheat mosaic is not a new disease, although the first serious outbreak in the Mid-West occurred in 1949. The disease damaged wheat in western Kansas, eastern Colorado,

Figure 7. Field of Early Blackhull wheat seriously damaged by the combined effects of septoria and stem rust near Childress in 1938.

Nebraska, South Dakota, Wyoming, Oklahoma, and a few fields in the northern part of the Texas Panhandle had symptoms of the disease or were severely damaged. It is caused by one or more viruses.

Western wheat mosaic and the 1949 epidemic in Kansas are described by Claude King and Hurley Fellows in the Department of Botany and Plant Pathology, Mimeographed Circular No. 4, Kansas State College, 1952. The following remarks are based on information given in the above mentioned circular:

In the early stages of western wheat mosaic, some of the leaves of the plant are yellow striped or mottled, or have both symptoms. These symptoms may appear at any stage of plant growth. As the plant develops, the older leaves turn completely yellow and may die while the younger leaves are yellow striped and mottled. Infected plants are short, often bunchy and prostrate. The severity of the disease is indicated by the degree of rotting of the crowns of the plants.

Early-seeded fields of wheat, particularly August plantings, were more seriously damaged than those seeded the latter part of September. Late-sown wheat was also damaged somewhat more than the September seedings. No differences in varietal reaction to the disease were observed.

It is thought that insects may transmit the disease, although experimental work at the Kansas Station over 2 years have not shown definitely which, if any insect, carried western wheat mosaic.

Other Diseases

There are several other diseases which have been important in certain seasons or in certain localities. The root-rotting type diseases, Pythium root rot, take-all, and Helminthosporium root rot, have been reported occasionally. Black chaff, basal glume rot, Helminthosporium leaf spot and mildew have caused damage in certain wet seasons but normally are not important.

COLD INJURY

Wheat may be damaged by sub-freezing temperatures at any time during the winter and spring.

Winter injury to wheat in the Panhandle may be caused by the occurrence of low temperatures when the plants are in distress from lack of moisture. In this area, winter-killing of wheat seldom occurs if soil moisture is adequate for normal winter growth. The extent of winter-killing seldom can be accurately determined until growth begins in the spring. Ice sheets, caused by freezing rain, may damage wheat by smothering if they remain on the field for an extended period.

Much of the injury to wheat in Texas is caused by sudden drops in temperature in the spring after a period of warm weather in which the plants have lost all or a portion of the hardiness they acquired during the winter. This freeze damage is usually evident a few days after the occurrence of low temperatures, but the extent of damage, or its influence on yield, may not be apparent until after the wheat has headed. Freeze damage of this type may cause the leaves to have a yellow, brown or burnt appearance, depending on the severity of the temperature or the condition of the plants. The tips of the leaves or all the foliage may be involved.

When low temperatures occur during the jointing stage, it may cause buckling at the joints and often these tillers are discolored and produce little grain. Blighted and partially sterile heads may result from freezing temperatures during the booting or heading stage. Drouth and hot winds at heading time can cause damage which appears much the same as cold injury.

Wheat has a remarkable ability to recover from cold injury during the winter and spring, if the crowns of the plants have not been injured and subsequent conditions are favorable for growth. The amount of damage and the opportunity for recovery are different in each instance, and depends on so many environmental factors that accurate predictions of damage to the crop are difficult.

PESTS

Wheat in the Texas Panhandle is subject to sporadic attacks from several species of insects and mites. The more important of these are greenbugs and other aphids, spider mites, armyworms, cutworms, wireworms, white grubs and grasshoppers.

Good sources of information include "Wheat Insects," Circular 514, Agricultural Extension Service, Oklahoma A. & M. College; "Grasshopper Control," Progress Report 1235, "False Wireworm Control," Progress Report 1245, and "Greenbug Control," Progress Reports 1234 and 1438, Texas Agricultural Experiment Station; and "Preventing Greenbug Attacks," USDA Leaflet 309.

Greenbugs

Greenbugs and several other species of aphids attack wheat. The greenbug is best known to the Panhandle farmer because of the serious losses it caused in 1950 and 1951. Aphids are insects which damage the plant by sucking the juices and destroying the tissue within the leaves. Outbreaks of the greenbug are more severe in years having wet, cool summers followed by dry, mild winters.

Greenbugs are controlled most years by parasites and predators, such as a tiny black wasp and the ladybeetle, and by weather conditions unfavorable for the development of the aphid. The greenbug can reproduce at temperatures as low as 40 degrees, whereas temperatures lower than 65 degrees are not favorable for reproduction of its biological enemies.

Parathion, benzene hexachloride (BHC) and tetraethyl pyrophosphate (TEPP), under favorable conditions, have given good control. Parathion spray applied at the rate of .25 to .50 pound of active material (one to two pints of 25 percent parathion) in at least two gallons of water per acre is the most effective chemical control. It should be applied when temperatures are above 50 degrees. For best results, the temperature should be above 60 degrees. Tests conducted to date show that the control of aphids with parathion and other chemicals may be erratic and that their use may not be an economical practice.

Parathion is highly poisonous to both man and animals. It should be applied by commercial airplane sprayers or power equipment. Application of the spray with hand equipment is dangerous. Directions for applying parathion should be followed closely. Wheat treated with parathion should not be grazed for at least 3 weeks.

Spider Mites

Several species of spider mites are known to cause damage to wheat during extended dry weather. Wheat infested with mites has a withered appearance, and the damage usually occurs in irregular spots in the field. The leaves of infested plants have a spotted, grayish cast. The mites are very small and may not be noticed since they drop from the plants when disturbed. Crop rotation may offer some control and sulfur of phosphorus compounds, such as parathion, may be

Figure 8. This field was suffering from drouth and damage from spider mite attack. Damage from greenbugs in a view such as this would have a similar appearance.

effective under favorable conditions. Since a new population of mites may hatch from eggs in about 4 days, it is likely that two applications of the chemical may be necessary to obtain control. In many instances, because of erratic results and the cost of the treatment, chemical control of spider mites may not be economical.

A period of wet weather often will eliminate populations of spider mites.

Armyworms and Cutworms

There are a number of species of armyworms and cutworms and accurate species identifications often is difficult. Several species of such worms caused serious damage to wheat in the Panhandle during 1951 and in other years. Armyworms may attack wheat at heading time and completely defoliate the plant.

Toxaphene, or a mixture of toxaphene and DDT (in a ratio of 1 to 2), applied as a spray emulsion at from two to three pounds of the active material per acre, or DDT at from one to two pounds in a least two gallons of water per acre, should give good control.

Poison bait at times gives better control than sprays, especially in protecting margins of fields and small localized areas. A poison bran bait formula and its use are given in USDA Farmers' Bulletin No. 1990.

Pale Western Cutworms

Pale western cutworms are grayish to white and have no distinctive markings. They damage the wheat plants by feeding just below the surface. In many instances, so many roots may be cut just below the crown that the plant is killed or produces little grain.

Chemical control is not effective for this sub-surface feeder. Crop rotation offers the most practical control.

White Grubs

White grubs may attack the roots of the wheat plant during both the fall and spring. Damage from white grubs is likely to become greater from year to year as infested fields are continuously farmed to wheat.

Crop rotation is the only practical control measure.

Wireworms

Wireworms often destroy seed and damage stands in fields "dusted in" or seeded under adverse moisture condi-

Figure 9. This field had a good stand of wheat which was almost destroyed by the pale western cutworm.

tions. Lindane, a purified form of the gamma isomer of benzene hexachloride, gave good control as a seed treatment in tests conducted by the Texas Station. At the rate of 2 ounces per 100 pounds of seed (8 ounces of a 25 percent Lindane wettable concentrate), Lindane gave good control of the false wireworm.

Additional tests are being conducted with other insecticides as seed treatments for the control of wireworms.

As a precautionary measure, seed treated with Lindane or other benzene hexachloride products, should not be planted on land that later may be used for the production of root crops such as potatoes. Residual amounts of the material might be retained in the soil and cause an off-flavor in root crops.

Grasshoppers

Grasshopper damage to wheat is common in the fall. In many years, margins of fields several drills wide may be killed by grasshoppers. Grasshoppers also may damage wheat at heading time by clipping the stalk just below the head.

Tests conducted by the Texas Station showed that .50 to 1.25 pounds of active toxaphene or chlordane per acre as an emulsion spray, or 1 to 1.5 pounds per acre as a dust, will control young grasshoppers, but 2 or 3 pounds are necessary to protect crops from migrating adults.

Poison bait is sometimes more desirable than a spray in protecting margins of a field and localized areas from grasshoppers. The poison bait formula for grasshopper control is given in PA-149, "Grasshopper Control with Aldrin, Chlordane and Toxaphene," Bureau of Entomology and Plant Quarantine, U. S. Department of Agriculture.

Flea Beetles

Flea Beetles usually are not considered an important insect on wheat, although some damage was caused by this insect in the Panhandle in the fall of 1951. These insects are active, tiny, black metallic-colored, flea-like beetles. They damage wheat by eating the surface of the leaves, leaving irregular grayish white blotches.

Few tests have been conducted to determine the best control of this insect in wheat. Toxaphene at the rate of two pounds of active ingredient per acre was used with some success in 1951.

Cold weather will retard their activity.

CARE OF STORED WHEAT ON THE FARM

USDA Farmers' Bulletin No. 2009, "Storage of Small Grains and Shelled Corn on the Farm," is a good source of information on the care of stored wheat on the farm. The brief discussion and recommended practices following are based on information given in that publication.

Loss and lower market value of wheat stored on the farm can be avoided if proper facilities and care of the wheat are provided during the storage period. Weather-tight bins should be provided for storage. Wooden bins should be thoroughly cleaned and walls and floors treated with a residual spray. Steel bins should be cleaned and joints and the door frame, where insects may be concealed, should be sprayed. Sprays that have been satisfactory for treating bins consist of 2.5 percent by weight of DDT, TDE, methoxychlor or chlordane as emulsions or water suspensions, and an emulsion containing 1 percent by weight of piperonyl butoxide and 0.1 percent pyrethins. The sprays should be applied at the rate of 2 gallons per 1,000 square feet of surface area, using an ordinary garden sprayer.

Wheat should be stored as dry as possible. Wheat stored on farms in the Panhandle should contain not more than 12 percent moisture.

Farm-stored wheat in the Panhandle should be fumigated within 6 weeks after it is placed in the bin. One fumigation probably will be sufficient to control insect infestations. In steel bins, use 3 gallons of carbon tetrachloride, or the 3-to-1 mixture of ethylene dichloride and carbon tetrachloride per 1,000 bushel, or 3 gallons of the 4-to-1 mixture of carbon tetrachloride and carbon disulfide. In wooden bins, this dosage should be doubled. The fumigant should be sprayed on the surface of the grain from outside of the bin with an inexpensive bucket pump.

Fumigants similar to those mentioned are sold under various trade names.

It is unwise to attempt to apply the fumigant with a sprinkling can. Vapors have an anesthetic action when breathed in concentrated form and fumigators exposed to the vapors for an appreciable time are likely to become seriously ill. A gas mask provided with a full face piece and black canister, approved by the U. S. Bureau of Mines for protection against the gases, should always be worn by anyone who is exposed to the concentrated vapors for more than a brief per-

iod. The canister should be replaced with a new one after 30 minutes of continuous or intermittent exposure to grain fumigants. The operator should avoid spilling the fumigant on the skin, clothing or shoes. Wearing apparel wet with the fumigant should be removed at once and the skin washed with soap and water.

All stored wheat should be inspected periodically for insects and other damaging conditions.

THE COVER PICTURE

The important varieties and the most promising experimental strains of wheat are tested each year in field plots on the Amarillo Conservation Experiment Station. Entries include the most promising wheat strains from other states as well as those originating in Texas. Several hundred experimental wheat varieties and selections are tested in smaller nursery plots each season.

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C. E. Van Doren, soil conservationist, and Wendell C. Johnson, soil scientist, Amarillo Conservation Experiment Station, made available results of the cultural studies conducted on the Amarillo station.