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Wheat Production in Texas

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Contents

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WHEAT IS THE THIRD MOST VALUABLE CASH CROP in Texas, exceeded in acreage only by cotton and grain sorghum. The 10-year average seeded acreage, 1959-68, was 4,313,100 acres. The harvested acreage was 3,278,000 acres with production averaging 65,904,300 bushels or 20.1 bushels per acre. Annual and average production data as reported by the USDA Crop Reporting Service (17) are given in Table 1. The largest acreage ever grown in Texas was in 1947 when 7,310,000 acres produced 124,270,000 bushels of wheat. The smallest harvested acreage since 1925 was in 1955, when severe drouth reduced the harvested crop to 1,508,000 acres and production to only 14,326,000 bushels.

Wheat was first grown commercially in Texas near Sherman about 1833. The acreage expanded greatly in North Central Texas after 1850 because of rapid settlement of the State and introduction of the well-adapted Mediterranean strain of wheat. A major family-flour industry developed in the Fort Worth-Dallas-Sherman and nearby areas between 1875 and 1900. The distribution of wheat in Texas in 1899 is shown in Figure 1. After 1900, there was rapid development of dry land farming in the Rolling and High Plains of Texas, and by 1919 there were three major wheat producing areas — North Central, the northern Rolling Plains and the High Plains, Figure 2. More than half of the state acreage is now grown on the High Plains, and approximately half of this now is irrigated. Because of the recent development of improved varieties and use of the crop for winter pasture, there has been some expansion of acreage in South Texas during the past 10 years. The distribution of the seeded acreage of wheat in Texas in 1968 is shown in Figure 3 (17).

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TABLE 1. ANNUAL SEEDED AND HARVESTED WINTER WHEAT ACREAGE AND PRODUCTION IN TEXAS, 1959-68.

Year	Acreage: Seeded	Acreage: Harvested	Production, bushels	Yield per acre
1959	4,029,000	3,228,000	54,876,000	17.0
1960	4,150,000	3,583,000	78,826,000	22.0
1961	4,067,000	3,690,000	84,870,000	23.0
1962	3,498,000	2,731,000	43,696,000	16.0
1963	4,023,000	2,458,000	45,473,000	18.5
1964	4,184,000	3,245,000	64,900,000	20.0
1965	4,435,000	3,472,000	76,384,000	22.0
1966	4,258,000	3,229,000	72,652,000	22.5
1967	5,578,000	3,326,000	53,216,000	16.0
1968	4,909,000	3,825,000	84,150,000	22.0
Average	4,313,100	3,278,700	65,904,300	20.1

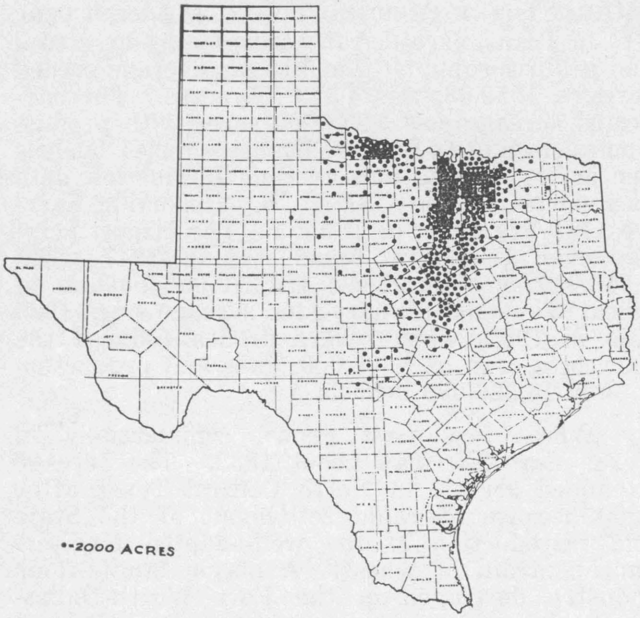

Figure 1. Wheat production in Texas, 1899.

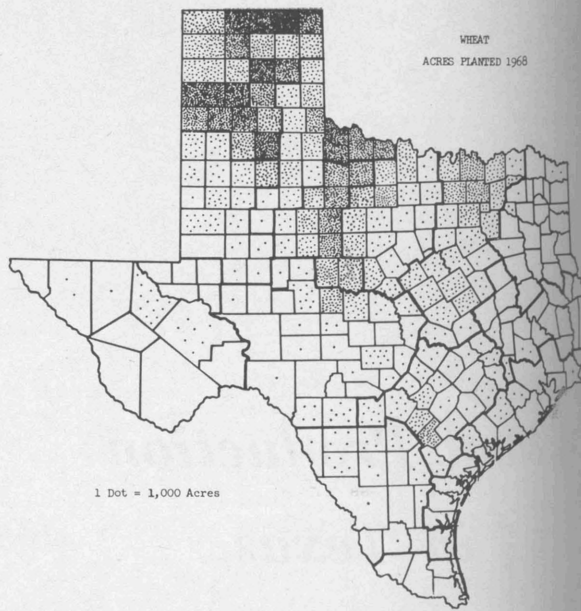

Figure 3. Distribution of wheat in Texas, 1968.

AREAS OF ADAPTATION

Wheat is grown over a wide range of climatic conditions and on many soil types in Texas. It does better on well-drained fertile soils than on sandy-type soils. Typically, the wheat acreage of the Rolling and High Plains and of Central Texas is found on the "tighter" soils. Sandy-type soils are used to grow peanuts, grain sorghum, cotton and feed crops.

Climatic conditions, such as winter temperatures, rainfall and humidity are important in establishing the limitations of varieties and market types grown in Texas. For easy reference in making recommendations and describing conditions, the State is divided into five research or growing areas, Figure 4. Each research area includes one or more districts of the Texas A&M Agricultural Extension Service. Land-use areas, in general, also coincide with the lines but are only approximate. Table 2 gives the seeded and harvested acreages and production by extension district and research area. The locations of field units of the Texas Agricultural Experiment Station and cooperating "off-station" trial locations

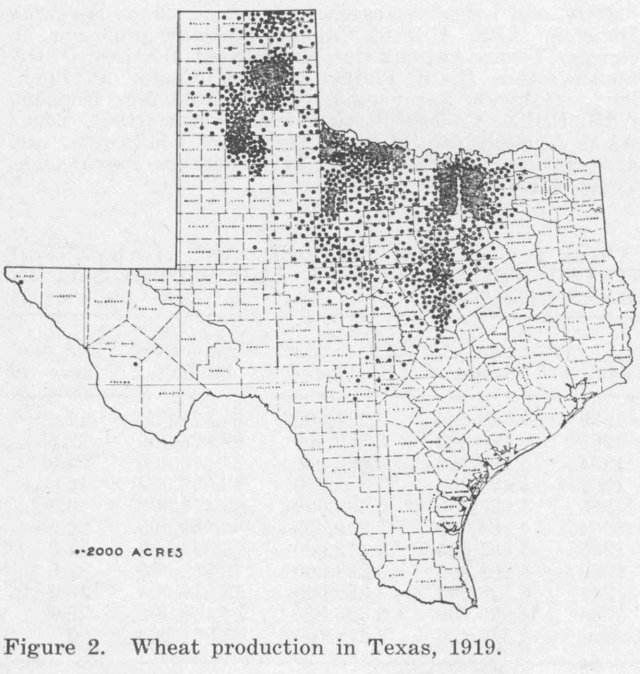

Figure 2. Wheat production in Texas, 1919.

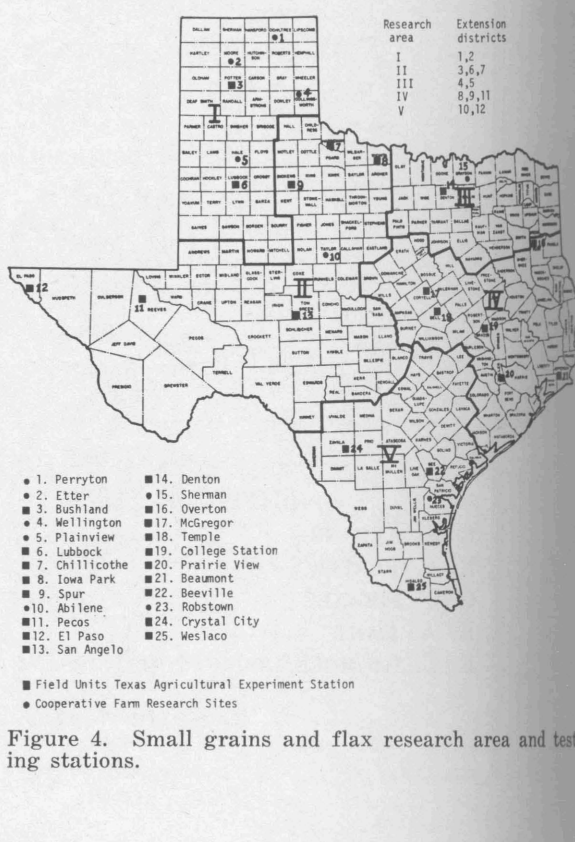

Figure 4. Small grains and flax research area and testing stations.

TABLE 2. ACREAGES AND PRODUCTION OF WHEAT BY EXTENSION DISTRICTS AND RESEARCH TESTING AREAS, 1968[1]

Extension district	Research testing area	Land use area	Average seeded	Average harvested	Percent of each district of state: Seeded	Percent of each district of state: Harvested	Production, bushels	Percent of seeded acreage harvested for grain
1	I	Northern High Plains	2,139,650	1,660,690	43.6	43.3	38,997,395	77.8
2	I	Southern High Plains	520,950	368,000	10.6	9.6	9,052,500	70.6
3	II	Northern Low Rolling Plains	1,101,300	956,230	22.4	25.0	20,882,300	86.8
6	II	Trans-Pecos	33,550	24,340	0.7	0.6	863,900	72.5
7	II	Southern Low Rolling Plains and upper Edwards Plateau	319,350	261,200	6.5	6.8	4,259,600	81.7
4	III	North Central Blacklands, Prairies and Cross Timbers	401,200	328,100	8.2	8.6	6,080,000	81.8
5	III	Northeast Timberlands	16,000	7,850	0.3	0.2	11,675	49.1
8	IV	Central Blacklands, Prairies and Cross Timbers	192,800	126,900	3.9	3.3	2,127,000	65.8
9	IV	Central East Timberlands	1,800	0				0
11	IV	Southeast Texas and upper coast	21,270	2,290	0.4	0.1	37,500	10.8
10	V	South Central Blacklands, Prairies and Coastal Bend	124,640	69,500	2.5	1.8	1,216,100	55.8
12	V	Rio Grande Plain, South Texas	36,490	19,900	0.7	0.5	487,800	54.5

[1]Literature reference, Palmer (17).

are also shown on this map. Table 3 gives some meteorological and other information for each of these locations.

Several market classes or types of wheat are grown in Texas. More than 90 percent of the acreage is seeded with hard red winter wheat varieties. Approximately 6 percent of the acreage is seeded with soft red winter wheat varieties. Most of this acreage is in the Fort Worth-Dallas-Sherman area. A small amount of hard red spring and durum wheat is grown some seasons.

Among the hard red winter varieties, there is a wide range of growth habit types ranging from prostrate-growing, highly cold tolerant and obligate winter types, through intermediate, more erect-growing types, to near-spring type varieties with low cold tolerance.

TABLE 3. ELEVATION AND SELECTED CLIMATOLOGICAL DATA FOR RESEARCH STATIONS IN TEXAS

Location	Elevation	Number years record	Precipitation Long-time mean: Annual	Precipitation Long-time mean: Growing season[1]	Mean temperatures: Maximum	Mean temperatures: Minimum	Mean temperatures: Mean	Length of growing season	Average date of: First fall frost	Average date of: Last spring frost
Area I:										
Perryton	2930		20.4	12.0	70.7	42.1	57.0	185	Oct. 22	Apr. 20
Bushland	3825	26	18.3	11.0	72.0	42.0	57.0	192	Oct. 28	Apr. 18
Plainview	3370	36	19.0	11.9	73.7	45.7	59.7	206	Nov. 2	Apr. 10
Wellington	2320		23.1	15.7	74.0					
Area II:										
Iowa Park	978	43	29.2	21.4	78.0	51.7	64.5	211	Nov. 29	Mar. 30
Chillicothe	1406	63	24.4	17.0	76.6	50.2	63.4	217	Nov. 6	Apr. 3
Abilene	1750	83	24.3	13.6	76.0	53.0	64.5	229	Nov. 13	Mar. 23
El Paso	3641	19	6.9	3.7	79.0	44.8	61.9	238	Oct. 31	Apr. 3
Area III:										
Denton	621	44	32.3	24.9	77.5	52.6	64.2	237	Nov. 15	Mar. 24
Stephenville	1466	27	26.9	23.8	77.1	53.3	65.2	239	Nov. 13	Mar. 21
Overton	520	63	43.9	28.7	76.3	55.3	65.8	249	Nov. 17	Mar. 12
Area IV:										
McGregor	713	34	31.6	27.6						
Temple	740	56	34.0	27.3	78.9	55.6	67.3	252	Nov. 22	Mar. 15
Area V:										
College Station	308	78	39.8	30.1	79.1	57.1	68.2	263	Nov. 27	Mar. 8
Prairie View	250	18	39.3	30.6	76.0	57.0	67.0	263	Nov. 30	Mar. 5
Beaumont	26	55	54.1	39.5	78.3	58.5	68.5	276	Nov. 28	Feb. 26
Beeville	240	78	29.8	22.2	82.1	60.0	70.9	291	Dec. 6	Feb. 20
Weslaco	100	25	27.3	19.9				311	Dec. 23	Feb. 15

[1]September through May.

TABLE 4. ANALYSIS OF SOME TEXAS-GROWN GRAINS[1]

Crop	Protein	Crude fibre	Nitrogen free extract	Water	Ash	Digestible nutrients	Productive energy for 100 pounds
Oats	11.4	12.8	58.6	8.6	3.7	8.9	70.5
Barley	12.0	6.3	67.5	9.3	2.8	9.6	74.4
Corn	10.4	4.4	72.5	9.1	1.3	6.4	84.8
Grain sorghum	11.1	2.9	70.9	10.7	1.9	8.1	84.8
Wheat	14.0	1.7	69.4	10.0	1.9	11.3	78.8

[1]Taken from Texas Agr. Expt. Sta. Bul. 461, "The Composition and Utilization of Texas Feeding Stuffs."

USES

Practically all wheat grown for grain is used in some phase of the milling industry. The best grades of high quality varieties are used to produce commercial bakery flour. Lower grades and less desirable varieties are used in family flours. Byproducts of both types are used in the feed industry. Large quantities of both wheat and flour are exported from the state.

Feed

Normally the best grades of wheat are too valuable for use as livestock feed, so wheat does not compete with feed grains, except when the price of wheat is low. Wheat contains more digestible and total protein and less crude fiber than most feed grains; so the rations must be adjusted accordingly. The recently developed livestock feeding industry of Northwest Texas may find it economical to use wheat, especially low grades, for feed or for supplement to grains of lower protein. The analysis of some Texas feed grains is given in Table 4. Recent research to compare wheat with milo for fattening cattle is given in Oklahoma Agricultural Experiment Station Miscellaneous Publication 80 (28).

Winter Pasture

Wheat has been used for livestock pasture since the State was settled because it is one of the few forage crops which can be grown during the winter months. The relatively mild winters in Texas permit wheat to grow and produce a highly palatable, succulent feed of 20 to 30 percent protein. A high proportion of the seeded acreage is grazed to some extent, Figure 5. Under irrigation and in high rainfall areas the value of the crop for winter pasture may equal or exceed the value of the grain crop. On most of the acreage the livestock are removed in the spring, and the crop is permitted to produce a grain crop. When moisture for maturing the grain crop is limited or the value of the forage exceeds that for grain, wheat may be pastured until it matures.

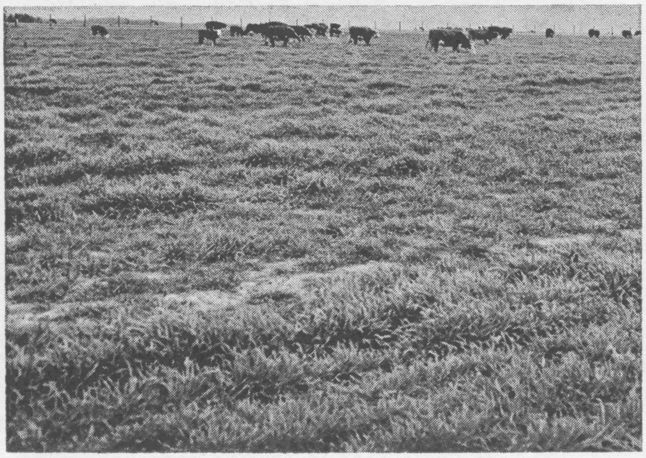

Figure 5. Livestock on small grain pasture during the winter months, Prairie View, 1962.

Wheat, sown for winter pasture or for pasture and grain, should grow 4 to 6 weeks before livestock are permitted to graze the crop. Close grazing, early grazing, severe tramping when the ground is soft or grazing in the spring after the spike has started to develop may result in reduced grain yields. Early maturing varieties are more frequently injured by this practice than late maturing varieties.

Varieties differ in the amount and time at which they produce the maximum amount of forage. Results of grazing management studies have been published by Holt (12, 13), Atkins (5), Cook (8), McLean and Norris (14) and the reader is referred to these for greater details on grazing management.

CULTURE

Cultural operations for wheat are similar to those for other small grains. They vary so greatly over the State that only limited suggestions can be made here. Dryland wheat culture on the High and Rolling Plains traditionally has been one of continuous cropping because there were few other crops with which it could be rotated in a practical manner. Alternate wheat and summer fallow increases the chances for stable yields but may not always be profitable. Wheat-sorghum-fallow, a three-season rotation, may be more practical. Large-scale operations with one-way plows or sweep-type cultivators permit rapid preparation of land after wheat harvest. Early land preparation improves conditions for penetration of summer rains and destroys weed growth that may have started. Leaving the stubble as a mulch aids in preventing wind erosion, Figure 6. Another system is that of delayed fallow in which the land is not cultivated until the following spring.

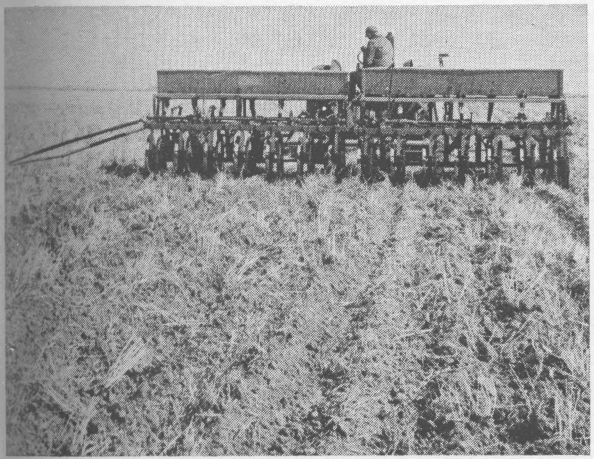

Figure 6. Drilling wheat in a trashy seedbed prepared with a sweep-type plow.

Irrigation has become an important factor in wheat production in Texas. Most of the irrigated acreage is on the High Plains, Research Area I. From an estimated 66,046 acres of irrigated wheat in 1939, the practice expanded to 268,600 in 1948, to 686,280 in 1959 to 1,052,424 acres in 1968[1]. Cultural practices for irrigated wheat are somewhat different from those for dryland wheat. Because the other major crops of the area, grain sorghum and cotton, occupy the land until late in the fall, it is difficult to rotate with these crops. If land retired from production (diverted acres) can be used, then these crops and the retired acreage can be worked into a rotation with wheat. Where wheat follows wheat or other small grain crop, the stubble should be plowed and the straw worked into the soil so it will decay as rapidly as possible. Weeds and volunteer grain should be controlled during the summer months. The final land preparation is usually made with sweeps or listers to prepare contour ridges for later irrigation, Figure 7.

[1]High Plains Irrigation Survey. 1968. Texas Extension Service — Mimeographed. Compiled by Leon New, area irrigation specialist.

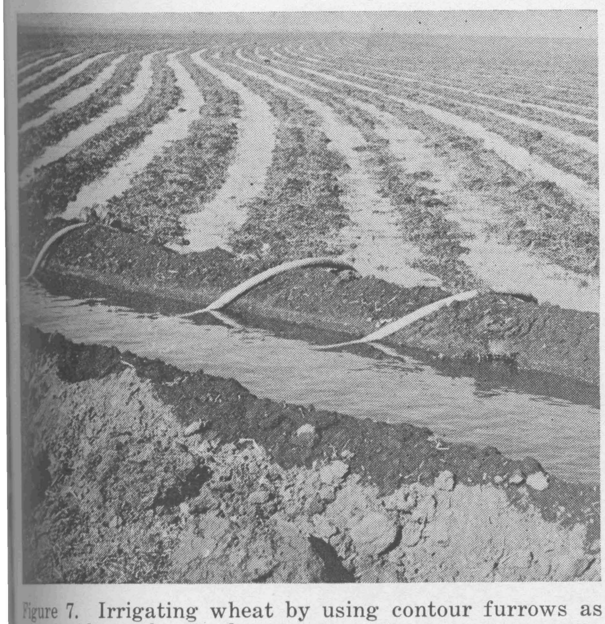

Figure 7. Irrigating wheat by using contour furrows as water guides and spreaders.

Continuous wheat production under irrigation soon depletes the soil nutrients so that the addition of commercial fertilizer is essential for economical wheat production. Also, animal manure from feedlots nearby may be available at certain locations. The proper balance of water and plant nutrients is not only essential for economical and efficient use of fertilizer but for the production of adequate grain protein levels. High yields, without adequate soil nitrogen, may cause the production of low quantity of protein in the grain.

Extensive studies of the effects of fertilizer on irrigated wheat were carried out by Pope (20), Table 5. He reported that the amount and time of application of fertilizer depend upon previous cropping history of the field. Generally, the application of nitrogen and phosphorus, in combinations of 40 to 80 pounds of each, were the most profitable for grain production and produced satisfactory protein content of grain. Response from phosphorous was less than from nitrogen. Also, these applications gave the greater increases in production. Much heavier applications are frequently made on wheat used principally for grazing. In most instances, the source of nitrogen was not a critical factor. One exception was that anhydrous ammonia produced grain with the highest protein.

Although wheat uses relatively small amounts of moisture during the fall and winter, under High Plains conditions it requires good moisture from a preplant irrigation or from rainfall to establish a good root system. This is highly desirable in order for the plants to withstand low temperatures and to prevent damage from livestock grazing. During the boot and heading

TABLE 5. THE INFLUENCE OF NITROGEN RATES ON GRAIN YIELDS, PROTEIN CONTENT AND FORAGE YIELDS ON THE HIGH PLAINS OF TEXAS, 1957-61(20)

	Clay-loam soils		Sandy-clay soils		
Pounds fertilizer per acre N-P	5-year grain yields, bushels per acre	Protein content, percent	4-year grain yields, bushels per acre	Protein content, percent	Pounds air-dry forage per acre
0	34.3	10.1	34.9	11.9	634
40-0	42.3	11.0	47.6	13.1	
60-0					1885
80-0	46.5	12.3	51.2	14.8	
120-0			51.4		2701
160-0	46.0	13.4			2707
40-40			57.7	11.7	
40-80			60.3	11.3	
80-40			59.4	13.8	
80-80			64.4	13.0	

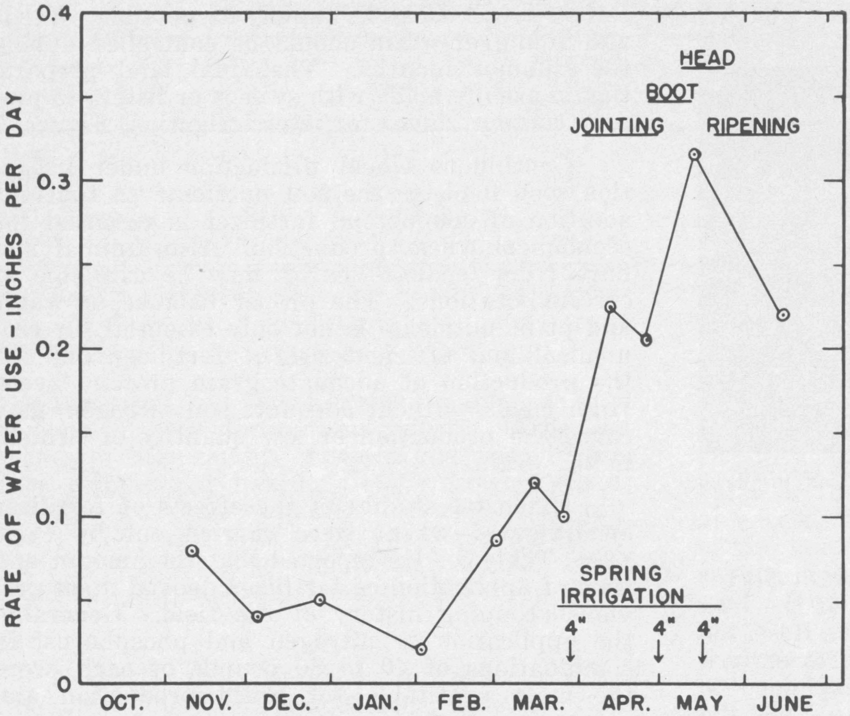

Figure 8. Rate of water use by winter wheat under optimum irrigation conditions with times and amounts of spring irrigation shown, USDA Southwestern Great Plains Research Center at Bushland.

stages, wheat may use up to 0.3 inch of water per day, Figure 8. A crop yielding 45 to 50 bushels per acre will require 27 to 30 inches of water during the growing season. For best growth, this should be distributed during the season to coincide with the rate of water use by the crop.

Lodging is an important problem when tall varieties are heavily irrigated or fertilized, Figure 9. Varieties of short stature and good straw strength should be selected under these conditions. New semidwarf varieties, Sturdy and Caprock, as well as the variety Tascosa, are well suited to growing under these conditions. Furthermore, they are strong gluten wheats which will produce grain of satisfactory milling and baking characteristics.

Wheat often is grown continuously on the same land in the Rolling Plains, Area II. Average rainfall in this area ranges from 20 to 30

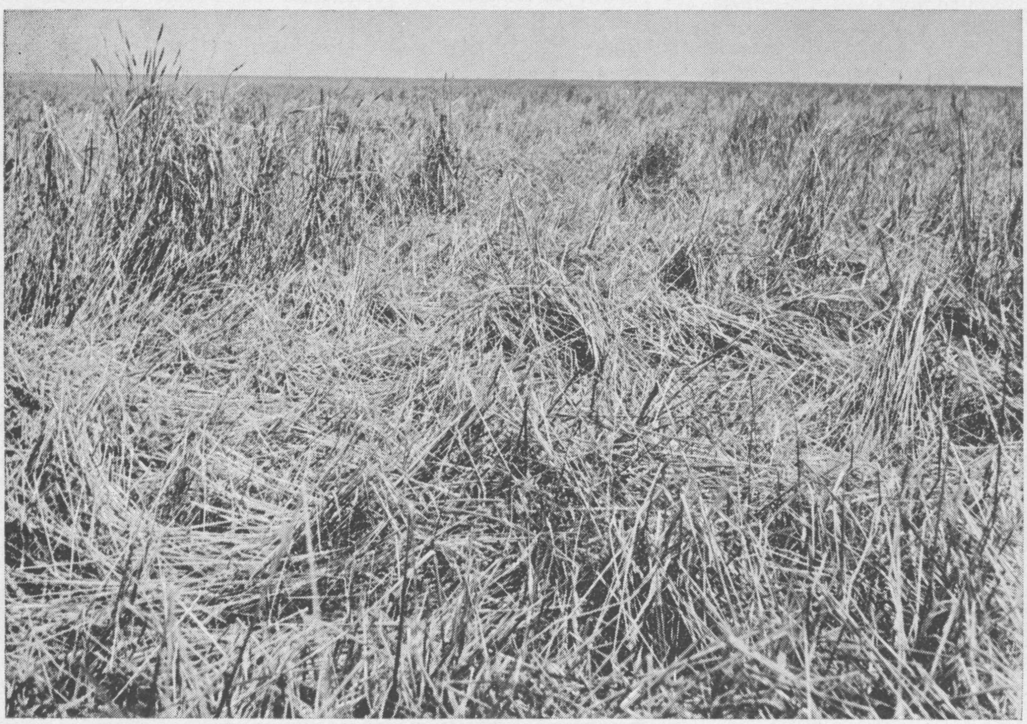

Figure 9. Severe lodging of winter wheat grown with irrigation, Hereford, 1961.

inches, and only small areas have water available for irrigation. Because of the poor distribution of rainfall and of soil types which do not store moisture effectively, summer fallowing one season to insure production the second year is not a good risk in this area. Summer fallow is not practiced extensively, except as it is utilized on diverted acres.

Under continuous wheat production, conservation of moisture from summer rains is practiced by immediately plowing the stubble after harvest and keeping the land free of volunteer wheat and weeds until fall planting time. One-way plows or sweeps are used almost universally for this purpose, and fields are frequently plowed within hours after harvest. Rotation of wheat with legumes or nongrass crops is desirable for control of weeds, some insects and some diseases. However, this may not be practical because of the few crops adapted to this area. Recently, guar acreage has expanded in this area and serves as a desirable crop to rotate with wheat and as a source of income.

Wheat production in the more humid Areas, III, IV and V is handled on a much smaller scale than in the two areas previously described. Usually wheat is grown in rotation with corn, grain sorghum, cotton, grass or legume feed crops. Grain sorghum, ahead of wheat in the rotation, may depress fall growth of wheat because of lack of available nitrogen in the surface soil. Early destruction of grain sorghum stubble and the addition of nitrogen to the soil will speed up the decay of roots and stubble and provide better conditions for wheat. Application of fertilizer to wheat, after a soil test to determine local needs and consultation with the local county agent, usually pays dividends in increased grain and forage yields throughout these higher rainfall areas.

Lodging is a problem in these areas, and this must be considered in selecting varieties and in applying fertilizers. Rich (24) showed in studies at Denton that the new semidwarf variety Sturdy not only stands without lodging, but also uses fertilizer more efficiently in grain production as compared to tall varieties, Figure 10. Additional data on the response to fertilizers of small grain in grain and forage production are given by Spence and Dudley (26), Cook (8) and McLean and Norris (14).

Figure 10. Semidwarf Sturdy vs. Kaw, tall variety, in wheat fertilizer test, Denton, 1967.

TABLE 6. SUGGESTED RATES AND DATES OF SEEDING WHEAT IN TEXAS AND DATE FOR REMOVAL OF LIVESTOCK FOR GRAIN CROP PRODUCTION

Areas	Rate of seeding: Irrigated	Rate of seeding: Non irrigated	Date of seeding: For grain and forage uses	Date of seeding: For grain production only	Date of livestock "take-off"[1]
I	60	30	Sept. 1	Sept. 20	Mar. 1
II	60	45	Sept. 15	Oct. 1	Mar. 1
III		60	Sept. 15	Oct. 15	Feb. 15
IV		75	Oct. 1	Nov. 1	Feb. 15
V	75	75	Oct. 1	Nov. 15[2]	Feb. 1

[1]Date livestock should be removed if a grain crop is to be produced.
[2]Daylength neutral Mexican varieties should not be seeded before December 15.

Rates and dates of seeding wheat vary greatly because of the wide range of climatic conditions and uses made of the crop. Nearly all wheat in Texas is fall sown, but in favorable spring seasons small acreages may be spring sown in Northwest Texas. Suggested rates and dates of seeding in the several areas under certain conditions are given in Table 6. Daylength neutral spring-type varieties, especially certain Mexican varieties, should be seeded 15 to 30 days later than other varieties in South Texas. Otherwise, they may head early and may be damaged by late freezes. Suggested "take-off" dates for livestock to permit production of a grain crop are given.

VARIETIES

The first wheat variety grown in Texas, on which records have been found, was the "Little Red May" variety brought by settlers from Missouri into the Dallas area before 1850. About 1870, the Mediterranean type strains were brought in by settlers from the East. These two types made up the majority of the acreage for many years. When the first U.S. Department of Agriculture wheat variety survey was made in 1919, 58 percent of the State acreage was to soft red winter wheat varieties. The acreage of soft winter wheat declined rapidly after 1919, but a substantial acreage (about 6 percent) is still sown to soft wheats in North Central Texas.

The hard red winter, Turkey-type wheats brought to Central Kansas by Russian immigrants about 1873 soon spread into the High Plains of Texas. After 1900, this type rapidly replaced all others, except in North Central Texas. Pure line selections from Turkey (such

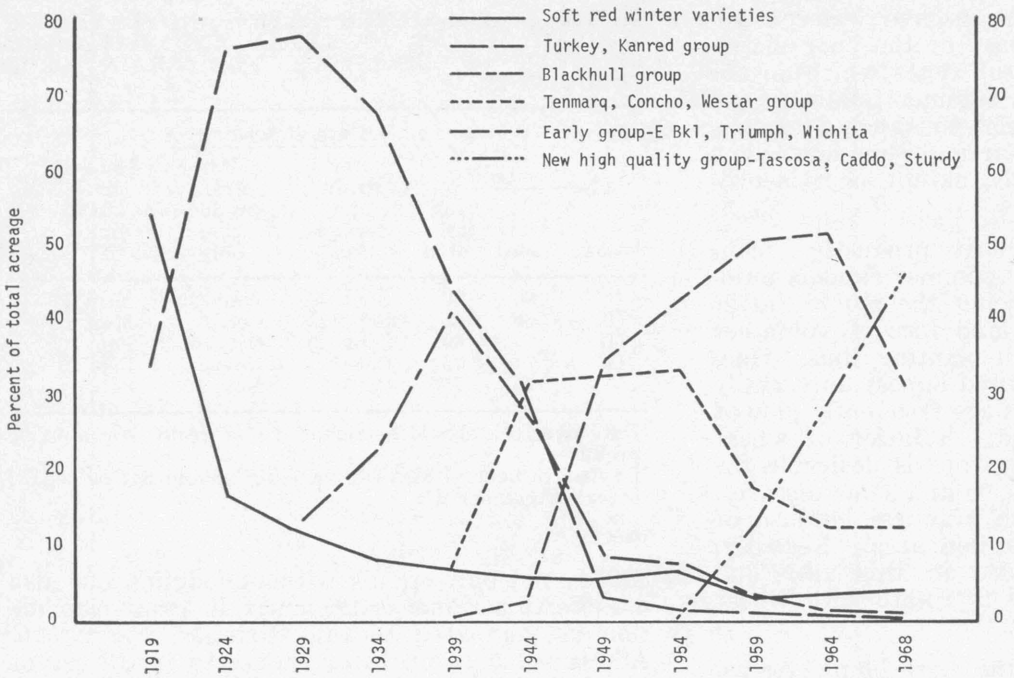

Figure 11. Percentages of state acreage devoted to variety groups in Texas, 1919-1968.

as Kanred, Blackhull, Kharkof) made up nearly 80 percent of the total by 1929 and were grown on large acreages until the late 1940's. The percentages of major variety groups sown in Texas are shown in Figure 11.

Early maturing varieties (Early Blackhull, Wichita and the Triumph strains) increased rapidly after 1944, and by 1964 made up more than half of the Texas crop. Improved varieties (such as Tenmarq, Comanche, Westar, Concho) resulting from plant breeding efforts in Texas and other states occupied large acreages from 1944 to 1959. More recently, varieties of high yield potential, good agronomic characteristics, high test weight and quality (Crockett, Tascosa, Caddo, Milam, Sturdy and Caprock) have spread rapidly and now occupy almost half of the Texas acreage. The acreages of varieties and percentage of the State total, by research testing areas, are given in Table 7. Tascosa now occupies

TABLE 7. ACREAGES AND PERCENT OF TOTAL FOR WHEAT VARIETIES GROWN IN TEXAS IN 1968[1]

Research testing area / Extension district	I / 1, 2	II / 3, 6, 7	III / 4, 5	IV / 8, 9, 11	V / 10, 12	Total	Percent of total
Variety							
Atlas 66	0	0	700	7,937	50	8,687	0.18
Bison	13,620	0	0	0	0	13,620	0.29
Caddo	138,411	152,257	35,184	123,186	1,375	450,413	9.53
Comanche	14,265	15,742	4,729	1,725	0	36,461	0.77
Concho	275,615	21,320	1,702	1,100	0	299,737	6.34
Crockett	36,073	238,170	10,430	10,100	100	294,873	6.24
Kaw	46,761	61,874	5,810	1,070	15	115,530	2.44
Knox and K. 62	0	0	287,628	9,930	0	297,558	6.30
Milam	0	2,250	0	9,549	118,254	130,053	2.75
Penjamo 62	0	0	0	0	17,880	17,880	0.38
Quanah	0	21,592	0	28,340	600	50,532	1.07
Riley and R. 67	0	0	2,717	300	0	3,017	0.06
Scout	227,750	6,325	0	0	0	234,075	4.95
Scout 66	42,260	1,700	0	0	0	43,960	0.93
Sturdy	154,722	28,620	12,985	2,410	2,310	201,047	4.25
Tascosa	832,956	76,213	3,400	1,672	0	914,246	19.34
Triumph	84,252	125,510	1,575	0	0	209,337	4.43
Triumph, Improved	482,520	525,756	32,000	6,854	0	1,047,130	22.15
Triumph, 64	7,880	15,400	270	0	0	23,550	0.50
Triumph, Super	23,140	5,610	270	0	0	29,020	0.61
Turkey	440	50	0	0	0	490	Tr
Warrior	4,502	1,750	0	0	0	6,252	0.13
Westar	8,290	500		1,100	0	9,890	0.21
Wichita	220,131	19,175	0	1,875	0	241,181	5.10
Others	5,583	9,230	18,591	304	4,700	38,408	0.81

[1]Based on private estimates made by county agents.

nearly 1 million, Caddo 450,000, Crockett 295,000 and Milam 130,000 acres.

The pedigrees, dates and states releasing the more important commercial varieties are given in Table 8. Table 9 gives the market classes and some characteristics of the varieties as observed under Texas conditions. A number of varieties developed in adjoining states have been tested and foundation seed released to Texas growers. As only a minor part of the plant breeding work is devoted to soft wheats, Indiana varieties of soft red winter wheat have been used extensively in Texas. Knox was released in 1954, and, later, foundation seed of Knox 62, Riley and Riley 67 were made available to Texas growers.

TABLE 8. VARIETY, PEDIGREE, YEAR AND STATE ORIGINATING COMMERCIAL WHEAT VARIETIES GROWN IN TEXAS

Variety	Developed or released by	Year	Pedigree
Agent	Oklahoma	1967	Triumph x Triticum sp.-Agropyron elongation
Arthur	Indiana	1968	[1]
Atlas 66	North Carolina	1948	Frondoso x (Redhart 3-Noll 28)
Aztec	New Mexico	1958	Red Chief x Cheyenne
Benhur	Indiana	1966	Knox 62^{5} x Trumbull-Hope-Hussar-Fulhio-Purkof x Kenya Farmer
Bison	Kansas	1956	Chiefkan x Oro-Tenmarq
Blueboy	North Carolina	1967	Norin 10-Brevor x Anderson x Coker 55-9
Caddo	Texas	1964	Wichita x Marquillo-Oro
Caprock	Texas	1969	[Sinvalocho-Wichita x Hope-Cheyenne) x Wichita^{2} C.I.12703] x Seu Seun 27
Comanche[2]	Kan-Okla-Texas	1942	Oro x Tenmarq
Concho	Oklahoma	1954	Blackhull x Hard Federation
Crockett	Texas	1956	(Sinvalocho x WichitaF_1) x Hope-Cheyenne) x Wichita
Gage	Nebraska	1963	Ponca x (Mediterranean-Hope) x Pawnee
Gaines	Washington	1961	[Norin 10 x Brevor-14 x (Orfed x Hybrid 50)-3] x Burt
Guide	Nebraska	1967	Cheyenne x (Cheyenne-Kenya-Mentana)
Kaw	Kan-Okla	1960	(Early Blackhull x Tenmarq) x (Oro x Mediterranean-Hope)
Kaw 61	Kansas	1965	Reselections from Kaw
Knox[3]	Indiana-Texas	1953	Trumbull-Fultz Sel x Minhardi-Wabash-Purplestraw-Chinese-Michigan Amber
Knox 62^{5}	Indiana	1962	Knox^{5} x (Purdue 478A7-26-2 x Purdue 4126A9-16-1-1-3) F_1
Lancer	Nebraska	1963	Turkey-Cheyenne x Hope-Cheyenne
Lewis	Missouri	1965	[Kawvale x White Federation-Mo.Early Premium) x Mediterranean-Clarkan]Irradiated
Milam	Texas	1960	Bowie x Lee
Monon	Indiana	1959	Sister strain of Knox (see Knox)
Ottawa	Kansas	1960	Mediterranean-Hope x Pawnee) x (Oro-W38 x Comanche F_1)
Parker	Kansas	1967	Complex cross involving Quivera,Kanred,Hard Fed.,Prelude,Marquillo, Tenmarq
Penjamo 62	Mexico	1962	(Frontana x Kenya 58-Newthatch) x Norin 10-Brevor
Ponca	Kan-Okla	1951	Kawvale-Tenmarq x Kawvale-Marquillo
Quanah	Texas	1951	(Comanche x Honor-Forward) x (Mediterranean-Hope x Comanche)
Riley	Indiana	1965	Knox-(Kawvale-W38-Fultz Sel-Hungar.-Wabash-Fairfield x Trumbull^{3}-Hope-Hussar) x Monon Sib.
Riley 67	Indiana	1967	Riley^{5} x (Knox type^{7} -Transfer x Purdue 501)
Seabreeze	Texas	1945	Mediterranean-Hope x Gasta
Scout	Nebraska	1963	Nebred-Hope-Turkey x Cheyenne-Ponca
Scout 66	Nebraska	1967	Reselection from Scout
Shawnee	Kansas	1967	Reselection from Ottawa
Stadler	Missouri	1965	(Thorne x Clarkan) Irradiated
Sturdy	Texas	1966	[Sinvalocho-Wichita x Hope-Cheyenne x Wichita C.I.12703] x Seu Seun 27
Tascosa	Texas	1959	(Kanred-Hard Federation-Tenmarq x Mediterranean-Hope) x Cimarron
Trapper	Nebraska	1968	Warrior x Selkirk-Cheyenne^{2}
Trader	Nebraska	1968	Sister strain of Trapper
Triumph	Joe Daane	1940	(Blackhull-Kanred) x (Blackhull-Kanred x Florence)
Improved Triumph	Joe Daane	1944	(Daane Beardless x Blackhull) x (Kanred-Blackhull)
Triumph 64	Oklahoma	1969	(Daane Beardless-Blackhull x (Kanred-Blackhull x Florence) x Kanred-Black. x Triumph
Super Triumph	Joe Daane	1957	[Daane Beardless-Blackhull x Kanred-Blackhull x Florence)] x (Kanred-Black. x Triumph
Turkey	Introduced	1873	Introduction from Russia
Warrior	Nebraska	1960	Pawnee x Cheyenne
Westar	Texas	1944	Kanred x Hard Federation Sel.25007) x Tenmarq
Wichita[3]	Kan-Texas	1944	Early Blackhull x Tenmarq
Vermillion	Indiana	1955	Sister strain of Knox
Wakeland	North Carolina		(Frondoso x Redheart 3-Noll 28) x Hardired

Minhardi x Wabash 5x Fultz Sel. x Hungarian 2x W38 3x Wabash 4x Fairfield 6x Redcoat sib. x Wisc. C.I.12633 7x Vigo 4x Trumbull 2x Hope x Hussar 3x Fulhio x Purkof^{3}

Released jointly with Texas Agricultural Experiment Station.

Released jointly with Texas Agricultural Experiment Station.

TABLE 9. SUMMARY OF CHARACTERISTICS OF SOME WHEAT VARIETIES GROWN UNDER TEXAS CONDITIONS

Variety	Market class	Growth habit[1]	Hardiness rating[2]	Maturity[3]	Plant height	Straw strength	Test weight	Awns	Chaff color	Shatter resistance
Agent	HRW	IW	6	MS	tall	good	F[4]	awned	white	good
Arthur	SRW	W	2	E	short	good	VG	awnless	white	fair
Atlas 66	SRW	IW	7	MS	tall	good	G	awnless	white	good
Aztec	HRW	W	2	ML	tall	good	VG	awned	brown	excellent
Benhur	SRW	W	3	E	medium	good	G	awnless	white	fair
Bison	HRW	W	1	MS	tall	fair	VG	awned	white[5]	good
Blueboy	SRW	W	4	ME	short	good	F	awnless	white	fair
Caddo	HRW	W	4	ME	tall	good	E	awned	white	good
Caprock	HRW	W	4	E	short	good	F	awned	white[5]	good
Comanche	HRW	W	3	MS	medium	fair	F	awned	white	good
Concho	HRW	W	3	MS	tall	fair	F	awned	brown	fair
Crockett	HRW	W	3	ME	tall	fair	VG	awned	white[5]	fair
Gage	HRW	W	2	ML	tall	fair	F	awned	white	good
Gaines	SW	W	2	L	short	good	P	awned	white	good
Guide	HRW	W	2	ME	medium	fair	F	awned	white	good
Kaw	HRW	W	3	ME	tall	poor	VG	awned	white	good
Kaw 61	HRW	W	3	ME	tall	poor	VG	awned	white	good
Knox	SRW	W	2	E	medium	fair	G	awnless	white	fair
Knox 62	SRW	W	2	E	medium	fair	G	awnless	white	fair
Lancer	HRW	W	1	MS	medium	fair	F	awned	white	good
Lewis	SRW	W	2	ML	tall	good	F	awnless	white	fair
Milam	HRS	IW	8	MS	medium	good	G	awned	white	good
Monon	SRW	W	3	ME	medium	fair	F	awnless	white	fair
Ottawa	HRW	W	2	L	tall	good	G	awned	brown	good
Parker	HRW	W	2	ME	medium	fair	G	awned	white	good
Penjamo 62	HRS	S	10	MS	short	good	F	awned	white	good
Ponca	HRW	W	4	ML	tall	good	F	awned	white	good
Quanah	HRW	W	6	ML	tall	good	F	awned	white	good
Riley	SRW	W	3	ME	medium	good	G	awnless	white	fair
Riley 67	SRW	W	3	ME	medium	good	G	awnless	white	fair
Seabreeze	HRS	S	10	E	tall	fair	F	awnless	white	fair
Scout	HRW	W	2	MS	medium	fair	F	awned	white	good
Scout 66	HRW	W	2	MS	medium	fair	F	awned	white	good
Shawnee	HRW	W	2	L	tall	good	F	awned	brown	good
Stadler	SRW	W	3	MS	tall	good	G	awnless	white	good
Sturdy	HRW	W	4	E	short	good	F	awned	white[4]	good
Tascosa	HRW	W	4	MS	medium	good	E	awned	brown	excellent
Trader	HRW	W	1	ML	medium	good	F	awned	white	good
Trapper	HRW	W	1	ML	medium	good	F	awned	white	good
Triumph	HRW	W	3	E	medium	fair	G	awned	white	good
Improved Triumph	HRW	W	3	E	medium	fair	G	awned	white	good
Triumph 64	HRW	W	3	E	medium	fair	G	awned	white	good
Super Triumph	HRW	W	3	E	medium	poor	G	awned	white	good
Turkey	HRW	W	1	L	medium	poor	G	awned	white	good
Warrior	HRW	W	1	L	medium	good	F	awned	white	good
Westar	HRW	W	3	ML	tall	fair	G	awned	white	fair
Wichita	HRW	W	3	ME	tall	fair	G	awned	white[4]	good
Vermillion	SRW	W	3	E	medium	fair	G	awnless	white	fair
Wakeland	SRW	W	5	E	tall	fair	G	awnless	white	fair

[1]S = Spring, IW = intermediate winter, W = Winter.
[2]Rated 1 to 10 with 1 most hardy.
[3]E = early, ME = Moderately early, MS = Midseason, ML = Moderately late, L = Late.
[4]F = Fair, G = Good, VG = Very good, E = Excellent, P = Poor.
[5]Chaff is white with black stripes under some conditions.

PERFORMANCE TRIALS

Winter Wheat

Performance trials are conducted with wheat and other small grains on a statewide basis; and detailed data on yield, test weight, reaction to diseases and information on agronomic characteristics are reported annually in mimeographed form (3). These trials are summarized at intervals of 5 to 10 years and published in bulletin form (6). Copies of these are available through the Texas Agricultural Experiment Station and Texas Extension Service.

Most performance trials are conducted in nursery size plots (4 x 12 feet) in randomized block trials of four replications. Since all varieties are not grown in all seasons at all locations, in order to compare varieties directly, comparable average data are computed as suggested by Patterson (19). Comparable average data are based on a set of check varieties grown in all

TABLE 10. COMPARABLE YIELD AND AGRONOMIC DATA OF IRRIGATED WINTER WHEAT VARIETIES GROWN AT BUSHLAND, 1958-68[1]

	Comparable data[2]						
Variety	Number years tested	Grain yield, bushel per acre	Test weight, pounds per bushel	Date first head	Plant height, inches	Leaf rust 1960	Percent survival, 1963
Comanche[3]	8	51.5	58.4	5-11	37.4	40	83
Early Blackhull[3]	8	46.6	59.6	5-3	37.9	40	83
Kharkof[3]	8	43.0	57.2	5-15	38.6	60	83
Average of checks	8	47.1	58.4	5-10	38.0		83
Aztec	4	47.6	60.0	5-14	39.5	50	
Bison	7	53.0	59.2	5-10	38.0	50	87
Caddo	8	54.5	61.0	5-6	36.6		58
Caprock	4	63.3	59.3	5-5	32.8	Tr	
Concho	4	52.5	59.7	5-10	38.3	30	80
Crockett	6	47.5	60.1	5-8	38.0	10	80
Gage	3	46.1	57.8	5-10	35.5	10	82
Gaines	2	47.8	51.8	5-17	29.7		
Guide	4	54.8	59.5	5-8	36.5		
Kaw	5	51.7	61.1	5-6	36.4	2	85
Ottawa	3	48.0	58.9	5-9	37.1	Tr	90
Parker	3	58.1	60.4	5-9	35.7		
Scout	5	58.4	59.9	5-7	37.7		73
Scout 66	3	58.0	60.3	5-7	35.9		
Shawnee	3	63.4	59.4	5-8	36.3		
Sturdy	4	56.1	58.2	5-6	31.7		75
Tascosa	8	59.8	61.5	5-9	36.1	40	67
Triumph	7	50.3	59.9	5-6	37.0	40	82
Triumph, Improved	7	54.3	60.2	5-4	36.1	40	78
Triumph '64	4	49.5	60.3	5-4	36.7		87
Warrior	2	55.2	58.6	5-13	36.9		95
Wichita	6	40.2	59.7	5-5	38.0	40	80

[1]Destroyed by hail in 1961, 1963 and 1965.
[2]Calculated comparable yields based on data for years grown.
[3]Check varieties used to calculate comparable yields.

seasons. From these a correction factor is computed. Varieties grown for less than the full period are then adjusted by means of these correction factors. Comparable yields and agronomic data are given in tables which follow. Varieties grown for only a few years may be evaluated less accurately than those grown for longer periods, and the reader may wish to refer to other publications for actual yields.

RESEARCH AREA I: This area is made up of the High Plains, Extension Districts 1 and 2, and grows more than half the state acreage, Table 2. Approximately half of the acreage is irrigated. Average annual rainfall for this area is about 18 inches, the majority being received during the summer months. Winters are severe, and only winter wheats of moderate to high cold tolerance should be fall sown. In favorable spring seasons, a small acreage of wheat may be spring sown. Figure 12 shows wheat harvest under large scale production in this area.

Comparable grain yields and agronomic data for wheat varieties grown in irrigated trials at the U.S. Southwestern Great Plains Research Center at Bushland and several off-station farm locations are given in Tables 10 and 11, and data from similar dryland tests are given in Table 12. The ranking of varieties varies with location and treatment. Under irrigation Shawnee, Caprock, Tascosa, Parker, Scout, Sturdy, Caddo, Improved Triumph, Guide and Warrior have produced excellent yields. Concho, Kaw, Wichita and Scout are tall varieties which have performed well but may lodge under some conditions. Hail is an important hazard of production in this area, and the variety Tascosa has shown outstanding ability to resist hail, Figure 13. Sturdy and Tascosa in increase fields at Bushland are shown in Figure 14.

Dryland tests at Bushland and Wellington have yielded in the 15 to 25-bushel range, with no great differences in yield for the leading

Figure 12. Combine harvesting new short-statured Sturdy wheat, Bushland, 1968.

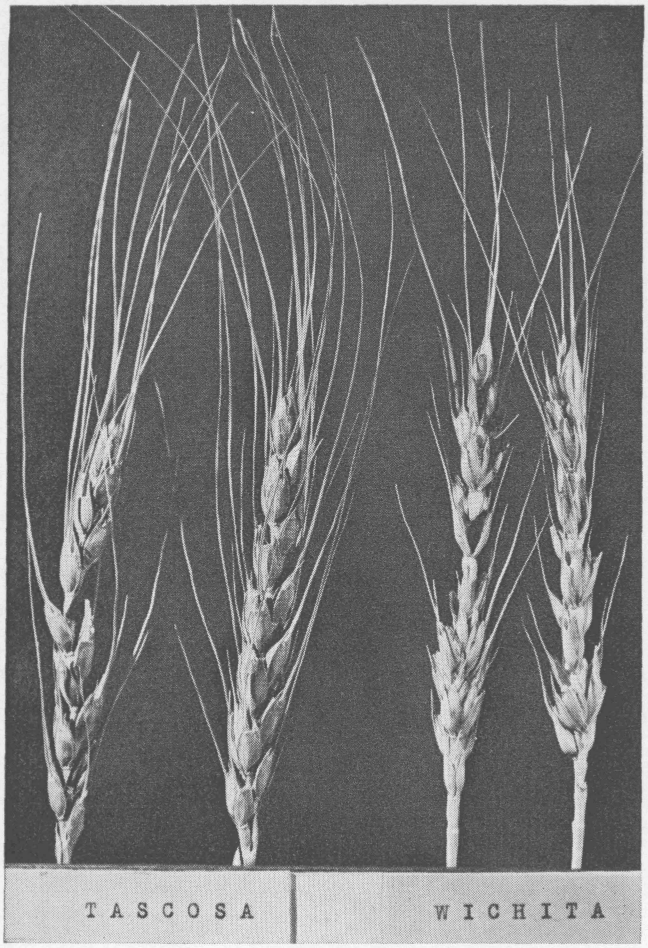

Figure 13. Tascosa wheat (left) was damaged much less in a hail storm than Wichita (right), Bushland, 1965.

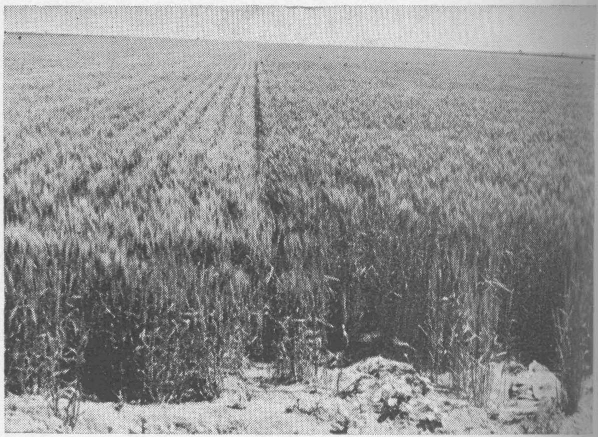

Figure 14. Sturdy (left) and Tascosa (right) winter wheat varieties growing under irrigation, Bushland, 1968.

strains. Tall varieties are satisfactory for dryland production. Guide, Ponca, Scout and Kaw produced the highest yields at Bushland and Lancer and Bison, Concho and Crockett the highest yields at Wellington. Tascosa, Kaw, Caddo, Crockett and Bison have been outstanding in test weight in both dryland and irrigated tests in this area.

Strong gluten wheats of high test weight are needed for growing under irrigation because the protein content may be low if there is not adequate nitrogen. Tascosa, Caprock, Sturdy, Caddo and Warrior are strong gluten wheats suitable for these conditions. Kaw, Bison and Scout are also strong gluten wheats but have weaker straw and may lodge.

TABLE 11. COMPARABLE GRAIN YIELDS AND AGRONOMIC DATA FOR IRRIGATED WINTER WHEAT VARIETIES GROWN AT STRATFORD, ETTER, HARTLEY, PERRYTON AND PLAINVIEW, 1958-68

	Stratford		Etter			Perryton		Plainview		Etter	
Variety	Number years grown	Grain yield, bushels per acre	Number years grown	Grain yield, bushels per acre	Hartley 1 year bushels	Number years grown	Grain yield, bushels per acre	Num- years grown	Grain yield, bushels per acre	Test weight, pounds per bushel	Plant height, inches
Comanche	8	37.4	3	51.8		4	44.8	3	62.1	59.1	38.0
Early Blackhull	8	39.6	3	51.5		4	46.3	2	50.6	60.7	33.0
Kharkof	8	35.9	3	43.5		4	34.4	2	39.3	57.5	38.3
Average	8	37.6	3	48.9						59.1	36.4
Aztec	3	37.2									
Bison	7	41.8	2	55.8		2	42.5		59.5	60.5	34.6
Caddo	7	40.7	3	52.4	33.4	4	47.7	3	53.7	62.0	32.7
Caprock	1	38.3	3	52.0		2	50.4			59.0	27.0
Concho	3	44.5	2	65.1	44.6	1	69.1	1	59.1	57.9	35.7
Crockett	6	36.0									
Gage	3	40.0				1	56.4				
Gaines	2	31.5	1	53.7		1	27.9	1	53.0	53.6	23.4
Kaw	5	40.2				1	57.0				
Ottawa	3	38.8									
Parker					36.1	1	51.7	1	52.3		
Scout	3	49.3	3	60.2	39.4	4	59.8	3	62.5	60.7	36.6
Scout 66											
Sturdy	4	40.7	3	52.9	38.4	4	54.6	3	52.2	59.1	28.3
Tascosa	8	44.7	3	57.1	35.9	4	50.9	3	57.2	63.2	33.3
Triumph	4	41.5									
Triumph, Improved	6	43.8	3	57.2	28.1	4	45.8	3	49.1	60.7	30.3
Triumph '64	1	31.9	2	54.4		2	43.4	2	51.4	61.1	32.1
Warrior	4	45.9	1	56.9		1	28.6			59.1	36.7
Wichita	3	38.1									

TABLE 12. COMPARABLE GRAIN YIELDS AND AGRONOMIC DATA FOR NONIRRIGATED, WINTER WHEAT VARIETIES GROWN AT BUSHLAND AND WELLINGTON, 1959-68

	Grain yield, bushels per acre						
	Bushland		Wellington		Bushland		
Variety	Number years tested	Comparable yield[1]	Number years tested	Comparable yield[1]	Test weight, pounds[1]	Date first head[1]	Plant height, inches[1]
Comanche[2]	7	18.5	9	20.6	58.3	5-11	23.1
Early Blackhull[2]	7	20.0	9	18.1	59.0	5-4	25.1
Kharkof[2]	7	18.5	9	20.0	57.9	5-16	24.0
Average of checks	7	19.0	9	19.6	58.4	5-10	24.1
Agent	1	10.1			54.2	5-2	23.4
Aztec	3	19.0	3	20.6	60.4	5-13	24.8
Bison	6	19.6	8	23.2	58.6	5-10	24.4
Caddo	7	20.5	9	19.7	60.0	5-7	24.6
Caprock	2	19.7	2	17.1	60.3		
Concho	3	20.7	6	22.4	58.2	5-9	23.0
Crockett	6	18.8	6	22.3	58.5	5-8	24.1
Gage	3	19.2	3	20.4	55.9	5-10	24.9
Gaines	2	14.8	2	19.7	57.3	5-15	20.1
Guide	3	22.0			57.0	5-6	23.1
Kaw	4	20.8	7	20.4	60.7	5-7	24.0
Lancer	1	18.9	2	23.4	59.8		21.8
Ottawa	4	19.4	4	21.5	57.2	5-10	23.3
Parker	3	19.9			57.7		22.8
Ponca	3	21.4	1	21.9	56.9	5-11	23.9
Scout	4	21.0	4	20.6	56.8	5-7	24.2
Scout 66	2	20.0			57.7	5-6	24.4
Shawnee	2	18.2			58.0		
Sturdy	3	18.2	5	17.3	55.8	5-6	22.1
Tascosa	7	20.9	9	21.0	59.8	5-8	23.1
Triumph	6	18.5	5	19.9	58.1	5-5	25.0
Triumph, Improved	6	19.2	8	20.5	57.7	5-4	23.7
Triumph 64	3	17.7	2	18.9	57.5	5-3	24.6
Warrior	2	18.1	4	21.1	57.7	5-11	23.1
Wichita	4	19.0	3	18.8	57.8	5-6	24.6

[1]Calculated data based on years grown.
[2]Check varieties used to calculate comparable data.

RESEARCH AREA II: The Rolling Plains, the Edwards Plateau and the Trans-Pecos land-use areas are included in this research area, Extension Districts 3, 6, 7. This area grows about 33 percent of the state wheat acreage. In general, conditions in this area are similar, although there is a wide range of soils, elevation, rainfall and temperatures. In the Trans-Pecos, only small areas are seeded for winter pasture or for pasture and grain production under irrigation. The Rolling Plains has very limited facilities for irrigating wheat. Average rainfall ranges from 20 to 30 inches, with the majority coming in the spring months and a second lesser peak in September and October. Winter temperatures are fairly severe, but wheat usually remains well hardened and winterkilling seldom occurs. Late spring freezes, after elongation of the spike has started, are common and an important hazard of production.

Performance trials were conducted at Iowa Park with limited irrigation until 1965, Table 13. Tests at Chillicothe, Table 14, were the only ones conducted throughout the period. The leading varieties in comparable yield at Iowa Park were Gage, Kaw, Concho, Ottawa, Improved Triumph, Crockett and Tascosa. At Chillicothe, the leading varieties were Scout 66, Scout, Caprock, Parker and Improved Triumph. Differences among these varieties are probably not significant; some were tested for only short periods. Kaw, Tascosa, Early Blackhull, Caddo and Crockett had the highest average test weight.

Growers in this area have several good varieties available and may select one to fit their needs and conditions. For growing under irrigation, on subirrigated land, bottom land or in other conditions where lodging or accumulation of straw is a problem, Sturdy and Caprock are well adapted. If soils are low in water-holding capacity or inherent fertility or if the production level is low for other reasons, taller varieties such as Scout, Caddo, Crockett, Kaw or Improved Triumph probably should be chosen. Under some conditions, the very short varieties may not be sufficiently tall to combine satisfactorily. Leaf rust is an important hazard in this area. At present the best resistance is found in Agent, Sturdy, Caprock and Caddo. All other varieties are highly susceptible.

RESEARCH AREA III: The Blackland Prairie, Grand Prairie, East and West Cross Timbers and Northeast Texas Timberlands are all included in this reasearch area, Extension Districts 4 and 5, where about 8 percent of the state wheat acreage is grown. The elevation is 600 to 900 feet. The annual rainfall ranges from 30 to 40 inches.

Distribution of rainfall is poor, but the peak months are April, May and October. Winter temperatures are less severe than in Areas I and II but are subject to greater fluctuations, which can be very damaging to small grain crops. Rapid growth is initiated during periods of warm

TABLE 13. COMPARABLE GRAIN YIELDS AND AGRONOMIC DATA FOR WINTER WHEAT GROWN AT IOWA PARK, 1956-65[1]

Variety	Number years grown	Grain yield, bushels per acre	Test weight, pounds	Date first head	Plant height, 1960	Leaf rust, percent
Comanche[2]	7	39.5	60.4	4-24	44	20
Crockett[2]	7	44.5	62.6	4-22	44	16
Early Blackhull[2]	7	41.9	62.6	4-16	42	31
Kharkof[2]	7	35.3	59.4	4-27	45	25
Tascosa[2]	7	44.0	62.4	4-22	39	21
Average	7	41.0	61.5			
Aztec	3	39.3	60.9	4-24	46	27
Bison	6	43.1	61.4	4-23	42	34
Caddo	5	41.9	62.4	4-17	41	5
Concho	5	45.4	61.6	4-23	42	25
Gage	3	45.6	61.4	4-24		Tr
Kaw	5	45.5	63.2	4-19	42	6
Ottawa	2	45.3	61.7	4-21	38	Tr
Ponca	5	40.5	60.6	4-24	42	31
Red Chief	5	36.2	61.9	4-25	45	31
Rodco	3	39.6	60.1	4-23		26
Sturdy	1	40.7	62.1	4-18		Tr
Tenmarq	3	39.0	60.1	4-26		33
Triumph	6	40.8	61.2	4-17	39	33
Triumph, Improved	5	44.9	60.8	4-15	40	23
Triumph, Super	2	43.4	59.5	4-16		33
Warrior	2	38.7	59.1	4-27		30
Westar	3	39.6	61.1	4-25		46
Wichita	4	41.5	61.5	4-19	43	31

[1]Comparable data calculated on basis of years grown.
[2]Check varieties used to calculate comparable data.

TABLE 14. COMPARABLE GRAIN YIELDS AND AGRONOMIC DATA FOR WINTER WHEAT VARIETIES GROWN AT CHILLICOTHE, 1959-68[1]

Variety	Number years grown	Grain yield, bushels per acre	Test weight, pounds per bushel	Date first head	Plant height, inches	Shatter rating,[2] 1959
Comanche[3]	10	20.9	57.9	5-2	27.4	3
Early Blackhull[3]	10	21.0	59.7	4-26	30.2	1
Kharkof[3]	10	18.6	58.3	5-8	28.4	2
Average		20.6	58.6			
Agent	3	23.2	56.0	5-3	30.0	
Aztec	5	20.5	60.1	5-6	28.4	2
Bison	9	21.4	58.4	5-2	27.1	3
Caddo	10	22.3	59.5	4-29	28.1	1
Caprock	3	25.5	57.7	4-23	21.9	
Concho	5	20.9	58.4	5-2	26.8	4
Crockett	10	20.9	59.1	4-30	28.3	3
Gage	5	20.6	57.6	5-3	25.2	
Gaines	4	18.7	55.9	5-13	21.8	
Guide	5	22.7	58.1	4-24	23.3	
Kaw	7	23.3	60.7	4-28	28.3	1
Kaw 61	4	22.0	60.4	4-29	28.1	
Ottawa	4	19.0	57.8	5-3	27.4	
Parker	2	24.3	58.9	4-27	23.5	
Scout	8	25.6	57.7	4-29	26.6	
Scout 66	4	26.9	58.2	4-28	27.2	
Shawnee	3	21.3	59.2	5-2	26.0	
Sturdy	6	24.6	57.8	4-23	20.9	
Tascosa	10	22.5	59.8	5-1	25.3	1
Triumph	10	23.4	59.2	4-24	27.5	1
Triumph, Improved	10	24.0	59.0	4-23	26.4	1
Triumph '64	6	24.3	59.5	4-23	25.8	
Warrior	6	20.3	57.8	5-5	24.1	
Wichita	4	19.5	58.9	4-27	28.4	5

[1]Calculated data based on years grown.
[2]Rated 1 to 5 with 1 lowest shattering.
[3]Check varieties used to calculate comparable data.

TABLE 15. COMPARABLE GRAIN YIELDS AND AGRONOMIC DATA FOR WINTER WHEAT VARIETIES GROWN AT DENTON, 1959-68[1]

Variety	Number years grown	Yield of grain, bushels per acre	Test weight, pounds	Date first head	Leaf rust, percent	Plant height, inches
Comanche[2]	10	29.4	58.6	4-26	32	38.2
Early Blackhull[2]	10	31.5	61.4	4-17	40	38.4
Kharkof[2]	10	23.8	57.8	4-29	55	38.4
Average		28.3				38.4
Agent	2	35.2	58.4	4-24	Tr	39.3
Arthur[3]	1	37.7	61.3	4-13	Tr	35.0
Benhur[3]	3	38.9	59.5	4-14	23	36.3
Blueboy[3]	2	28.3	52.9	4-16	70	36.4
Caddo	10	36.1	62.0	4-20	9	37.4
Caprock	3	33.5	59.8	4-14	14	31.9
Crockett	7	33.0	60.9	4-23	22	36.5
Denton[3]	10	25.4	57.7	4-29	19	42.0
Gaines[4]	1	29.0	54.6	5-1	49	30.0
Gage	8	34.8	59.2	4-24	6	35.3
Guide	4	31.7	58.8	4-15	50	34.0
Knox[3]	7	30.2	59.5	4-16	19	37.9
Knox 62[3]	7	32.8	59.4	4-16	21	37.9
Kaw	7	33.8	62.1	4-20	16	37.4
Lewis[3]	2	24.9	54.4	4-18	50	36.4
Monon[3]	4	28.2	58.5	4-16	17	35.3
Ottawa	6	29.3	59.1	4-25	24	36.8
Parker	2	36.9	61.8	4-19	12	35.2
Ponca	3	31.5	59.1	4-25	7	36.4
Quanah	8	30.9	59.7	4-23	7	38.2
Riley[2]	3	35.1	58.9	4-13	25	38.2
Riley 67[3]	2	39.9	59.4	4-15	Tr	37.8
Scout	8	32.2	59.1	4-24	39	37.4
Scout 66	4	32.6	58.8	4-22	44	38.7
Shawnee	3	23.6	59.3	4-26	48	38.0
Stadler[3]	2	37.4	59.4	4-17	15	39.4
Sturdy	6	34.9	59.9	4-15	1	29.4
Tascosa	10	30.8	60.7	4-25	33	35.1
Triumph	10	30.0	60.8	4-18	51	35.2
Triumph, Improved	10	33.1	60.0	4-17	49	35.1
Triumph 64	5	34.8	61.6	4-16	36	34.8
Vermillion[3]	3	26.0	59.3	4-18	4	40.3

[1]Comparable data calculated from data on years grown.
[2]Check varieties used to calculate comparable data.
[3]Soft red winter wheat varieties, all others hard red winter.
[4]Soft white winter wheat.

weather which may be followed by temperature drops to near zero. However, wheat is damaged only occasionally.

Performance trials were conducted at Denton. Data for both soft and hard red winter wheat varieties are given in Table 15. The majority of this acreage was seeded to soft red winter varieties, largely Knox and Knox 62, Table 7. The best soft wheat yields have been produced by Arthur, Riley 67, Riley, Knox 62 and Knox. Knox 62 and Riley 67 are new strains with greater disease resistance which should replace Knox and Riley.

Among the hard wheat varieties, the highest comparable yields have been produced by Caddo, Sturdy, Caprock, Gage and Kaw. Parker and Agent have yielded well but have been tested only a short time. Sturdy and Caprock are less likely to lodge, an important factor in production in this area. Kaw, Caddo, Parker, Crockett and Tascosa have produced the best test weight. Of the hard wheats, Sturdy and Caprock mature earliest and have about the same maturity as Knox 62 and Riley 67. Leaf rust is important in this area. Agent and Riley 67 were practically free of leaf rust and Caddo, Sturdy, Caprock, Gage and Quanah had low infection readings. Limited yield trials, as part of forage testing, were conducted at Mt. Pleasant and Overton in East Texas. Data are given in Table 16.

RESEARCH AREA IV: The Central Blacklands, Prairies and Central East Texas Timberland land-use areas are included in this area, Extension Districts 8, 9 and 11. The soils and weather conditions of this area are similar to

TABLE 16. YIELDS OF WHEAT TESTED AS PART OF FORAGE TRIALS AT MT. PLEASANT AND OVERTON, 1955-68

Variety	1955	1956	1957	1963	1964	1968
Frisco	8.1					
Knox	7.7					
Atlas 66	9.7	31.2	16.5			
Quanah	2.8			16.3	34.7	17.1
Caddo				17.1		
Milam					8.9	28.1
Sturdy						26.5

those of Area III. However, winter temperatures are less severe, especially in East Texas, so varieties of less cold tolerance can be used for fall seeding. Only 4 percent of the state wheat acreage is sown here, and most in Districts 9 and 11 is grazed to maturity.

Performance trials are grown at Temple and McGregor, Tables 17 and 18. Some data are available from Overton on the border of Areas III and IV. The tests have included soft and hard red winter wheats, plus a few durums and spring-type varieties. For many years, a small acreage of durum wheat has been grown for feed purposes in the "Hill Country" of the lower Edwards Plateau.

At both stations, the soft red winter wheat varieties have produced the best yields. However, there is no local market for soft wheats. Riley and Knox strains, as well as Benhur, have produced good yields. The largest commercial acreages in this area are seeded to Caddo, Quanah and Crockett. Among hard wheat varieties in the tests, the best comparable yields at McGregor have been produced by Gage, Caddo, Sturdy, Kaw and Milam. Milam is less cold tolerant than the winter wheats but is a good variety for winter pasture. At Temple, the best yields among hard wheats were produced by Sturdy, Caprock, Caddo and Gage. Durum wheats have produced yields equal to the best hard and soft winter varieties at these locations.

RESEARCH AREA V: The Rio Grande Plain and southern portions of the Central Blacklands, Prairies and Coastal Bend land-use areas make up this research area, Extension Districts 10 and 12. Less than 3 percent of the wheat acreage is sown here, and more than half of that is grazed to maturity. The area is of low elevation, has high humidity, and rainfall ranges from high along the coast to low in the interior. Also, it is poorly distributed. Small areas along the Rio Grande and other rivers are irrigated.

Performance trials of both winter and spring-type wheat varieties were conducted at College Station and Beeville, Tables 19 and 20. Leaf diseases are very important in this area and frequently prevent grain production. Milam is the principal commercial variety although in recent years, some Mexican varieties have been introduced.

Among varieties grown for long periods, Milam has produced the best yields and is adapted to winter grazing. True winter varieties from the main wheat growing areas are not well adapted here. The Mexican varieties Nadadores, Penjamo 62 and Lerma Rojo produced good yields during the short time they were tested. Durum varieties also have produced good yields. Most spring-type varieties are poor winter forage producers because they tiller sparsely and do not recover well after grazing by livestock.

TABLE 17. COMPARABLE GRAIN YIELDS AND AGRONOMIC DATA FOR WHEAT VARIETIES GROWN AT McGREGOR, 1959-68[1]

Variety	Market class	Number years grown	Grain yield, bushel per acre	Test weight, pounds	Date of first head	Plant height, inches	Estimate of forage value	Percent leaf rust
Denton[2]	SRW	8	25.3	58.3	4-25	37.4	81	15
Early Blackhull[2]	HRW	8	26.5	60.5	4-17	35.6	80	39
Quanah[2]	HRW	8	27.8	59.2	4-21	35.5	94	11
Average		8	26.6	59.3	4-21	36.2		
Agent	HRW	1	29.4	58.0				Tr
Atlas 66	SRW	2	25.8	58.9	4-15	35.9	97	25
Austin	SRW	6	32.3	57.6	4-19	36.7	100[3]	11
Benhur	SRW	1	22.9	60.0	4-11	29.8		21
Blueboy	SRW	1	28.8	59.0	4-10	30.8		49
Caddo	HRW	8	32.6	61.9	4-19	35.1	81	11
Caprock	HRW	2	27.8	60.3				
Comanche	HRW	4	26.7	57.6	4-21	36.1	83	20
Crockett	HRW	8	28.4	60.9	4-21	35.2	79	23
Gage	HRW	3	34.4	60.3	4-20	35.3	85	31
Kaw	HRW	4	30.9	61.8	4-19	34.4	80	18
Knox	SRW	5	33.9	59.8	4-11	37.4	96	19
Knox '62	SRW	4	31.8	60.7	4-11	36.6	99	22
Lakota	Durum	5	30.8	57.1	4-13	37.9	102	8
Langdon	Durum	3	29.9	59.4	4-14	40.2	98	7
Milam	HRS	8	30.9	59.8	4-11	35.4	104	17
Monon	SRW	2	31.0	58.0	4-11	35.3	93	25
Ottawa	HRW	2	30.0	59.2	4-22	34.5	79	30
Riley	SRW	1	22.2	61.7	4-9			19
Riley 67	SRW	1	21.2	61.0	4-8			Tr
Stewart	Durum	6	29.1	61.4	4-17	40.3	93	2
Sturdy	HRW	4	31.2	60.1	4-13	30.8	88	21
Tascosa	HRW	1	15.4	62.1	4-20	34.4	78	52
Wells	Durum	3	33.2	59.1	4-17	36.6	103	3

[1]Comparable data based on years grown.
[2]Check varieties used to calculate comparable data.
[3]Forage standard.

TABLE 18. COMPARABLE GRAIN YIELDS AND AGRONOMIC DATA FOR WINTER WHEAT VARIETIES GROWN AT TEMPLE, 1959-68

Variety	Number years grown	Grain yield, bushels per acre	Test weight, pounds	Date of first head	Plant height, inches	Visual forage estimate, percent
Denton[2]	10	23.2	56.4	4-24	40.0	92
Early Blackhull[2]	10	25.0	61.8	4-16	36.2	85
Quanah[2]	10	24.3	58.6	4-20	36.6	101
Average			58.9	4-20	37.6	
Arthur[3]	1	44.2				
Atlas 66[3]	3	27.3	56.9	4-12	33.9	107
Austin[2]	7	24.6	56.5	4-19	36.4	100[4]
Benhur[3]	2	31.0	60.1	4-7	30.4	
Blueboy[3]	2	22.2	54.6	4-10	31.9	101
Caddo	10	27.3	60.7	4-17	34.8	90
Caprock	3	27.5	58.4	4-10	26.8	
Comanche	5	21.3	55.6	4-22	34.8	85
Crockett	7	24.8	60.4	4-18	36.6	90
Gage	4	25.1	58.9	4-15	33.3	
Kaw	4	24.1	61.4	4-19	33.5	88
Knox[3]	5	25.8	59.9	4-12	37.5	95
Knox 62[3]	5	28.8	61.1	4-10	35.8	96
Milam	10	24.9	59.7	4-12	34.2	109
Monon[3]	2	21.1	60.1	4-13	34.9	93
Ottawa	3	19.7	58.8	4-22	32.8	88
Riley[3]	1	23.5	58.6	4-8	30.9	
Riley 67[3]	2	33.7	57.6	4-8	34.9	93
Sturdy	6	29.2	59.0	4-10	26.5	87

[1]Calculated comparable data based on years grown.
[2]Check varieties used to calculate comparable data.
[3]Soft red winter wheat varieties; all others are hard red winter class.
[4]Forage standard for comparison.

Spring Wheat

True spring wheat varieties are grown to a limited extent in two areas: (1) in Northwest Texas, when spring weather conditions are favorable or some hazard reduces the value and prospect for the fall-sown crop; and (2) in extreme South Texas, where winters are sufficiently mild that spring types can be fall sown without great danger of winter killing.

Spring seeding of wheat has been tested intermittently over a period of 40 years at Denton, Chillicothe and Bushland. Results have never

TABLE 19. COMPARABLE AGRONOMIC AND YIELD DATA FOR WHEAT VARIETIES GROWN AT COLLEGE STATION, 1958-68[1]

Variety	Market class	Number years grown	Grain yield, bushels per acre	Test weight, pounds per bushel	Date of first head	Plant height, inches	Leaf rust, percent
Milam[2]	HRS	10	27.7	61.6	4-1	35.7	20
Seabreeze[2]	HRS	10	18.5	59.9	3-15	37.2	40
Average		10	23.1	60.8		36.5	30
Agent	HRW	1	27.3	60.8	3-29	36.2	Tr
Atlas 66	SRW	5	23.9	58.9	4-1	39.2	10
Austin	SRW	7	24.5	57.4	4-6	39.9	25
Blueboy	SRW	1	17.9		4-3		74
Bowie	HRS	5	23.8	60.2	4-3	35.9	15
Caddo	HRW	3	22.6	60.3	4-15	40.0	5
Chris	HRS	3	9.1	58.6	3-5	33.5	Tr
Comanche	HRW	2	16.8	41.8	4-18		30
Crim	HRS	3	13.5	58.3	3-13	41.5	35
Early Blackhull	HRW	2	17.4	58.8	4-13		53
Justin	HRS	2	20.1	56.7	3-30	38.0	34
Lakota	Durum	3	29.1	57.4	4-1	40.5	Tr
Langdon	Durum	1	28.4	59.8	4-2	43.5	Tr
Lee	HRS	5	23.5	60.4	4-1	38.4	20
Nadadores	HRS	2	26.7	58.2	4-2	31.7	Tr
Quanah	HRW	10	22.7	59.8	4-9	39.1	15
Sturdy	HRW	1	19.7	54.8	4-8		Tr
Supremo	SRW	3	20.0	59.6	3-28	44.0	20
Wells	Durum	3	33.2	59.4	4-1	40.0	9

[1]Calculated comparable average based on years grown.
[2]Check varieties used to compute comparable data.

TABLE 20. COMPARABLE GRAIN YIELDS AND AGRONOMIC DATA FOR WHEAT VARIETIES GROWN AT BEEVILLE, 1959-68[1]

Variety	Market class	Number years grown	Grain yield, bushel per acre	Test weight, pounds per bushel	Plant height, inches	Leaf rust, percent	Date first head
Milam[2]	HRS	10	14.3	56.2	33.9	12	3-31
Seabreeze[2]	HRS	10	13.1	56.0	32.2	27	3-17
Average		10	13.7	56.1			
Atlas 66	SRW	5	15.4	54.5	34.1	17	4-4
Austin	SRW	7	12.7	52.8	33.9	26	4-4
Blueboy	SRW	1	6.5		26.6	50	4-3
Bowie	HRS	4	13.5	55.9	34.4	8	3-30
Caddo	HRW	1	13.3	58.1	28.1	13	
Chris	HRS	2	16.3	59.9	30.6	5	3-20
Comanche	HRW	1	9.6				
Crim	HRS	3	9.7	57.9	33.6	47	3-30
Justin	HRS	1	7.3	52.0	39.6	20	4-3
Lakota	Durum	3	12.8	52.4	36.7	22	3-28
Lee	HRS	5	14.1	54.2	33.5	35	3-28
Lerma Rojo	HRS	1	24.5				
Nadadores	HRS	3	20.7	57.1	31.9	10	4-2
Penjamo 62	HRS	1	28.5				
Polk	HRS	1	10.0				
Quanah	HRW	10	12.1	56.4	34.4	16	4-7
Red River 68	HRS	1	10.2				
Rio Bravo	HRS	1	33.8				
Sturdy	HRW	1	8.6	53.1		Tr	
Supremo	HRW	2	16.6	55.9	39.9	19	3-24
Wells	Durum	2	13.6	53.9	36.7	18	3-27

[1]Calculated data based on years grown.
[2]Check varieties used to calculate comparable data.

been sufficiently favorable to establish the crop. Normally, the rainfall at seeding time is low and poorly distributed (January 0.44, February 0.48 and March 0.55 at Bushland). The crop can be better managed under irrigation, but yields have not been equal to that of fall-sown wheat. Detailed data for spring seeded wheat at three locations are given in Progress Report 2545 (4). A brief summary of results is given in Table 20. Only in very favorable spring seasons have yields of spring wheat varieties approached those of fall sown wheat, and they do not provide winter pasture for livestock.

Spring-type varieties have been tested from fall seeding in South Texas as early as 1919 at the former U.S. San Antonio Field Station. Wheat production in this area has been limited because of damage by the cereal rusts. Data on the spring varieties Seabreeze, Lee and durum varieties are given in Table 20 for Beeville. Lee averaged 14.1 bushels for a 5-year period compared to 14.3 for Milam for a 10-year period.

Performance data for fall-sown spring wheats at three locations in South Texas are given in Progress Report 2581 (11), and quality data on these wheats are given in Progress Report 2582 (25). A brief summary of these results is given in Tables 21 and 22. In 1968, several Mexican varieties seemed promising in tests, but they require additional testing before

TABLE 21. DATA ON AVERAGE YIELDS OF SPRING-SOWN WHEAT VARIETIES GROWN AT THREE TEXAS LOCATIONS AND YIELDS OF WINTER WHEAT IN THE SAME SEASONS

	Bushland					Chillicothe	Denton		
	Dryland			Irrigated		5 years			
Variety	4 years 1939-42	1960	1968	3 years 1940-46	1968		4 years 1937-40	5 years 1940-45	3 years 1956-58
Spring-type									
Thatcher	8.7	13.6		24.3		2.3	19.4	16.6	5.0
Marquis	4.9			18.9			9.8	8.5	
Mindum-durum	11.2						27.8	26.1	
Chris			17.7		37.7				
Ciano			20.0		39.0				
Red River 68			19.6		48.1				
Winter-type									
Comanche	16.5	17.6	22.4	36.5	60.6		32.9	20.7	14.5
Tenmarq	14.0	21.1		36.9			27.7	17.4	20.8
Blackhull	15.2	18.4		35.4		21.9	23.9		
Tascosa			21.7		65.9				

firm recommendations can be made. Spring wheat varieties from the Northern United States have not performed as well as the Mexican varieties or even as well as Milam.

The spring-type varieties may be separated into two classes — those that are daylength-neutral and those that require increasing length of day to cause normal heading. The daylength-neutral varieties may head in midwinter if conditions become favorable. If frosts or freezes occur after this, they may be damaged. The day-neutral type should be seeded 15 to 30 days later than the long-day varieties if they are to avoid damage from late freezes. Nearly all Mexican varieties are of the day-neutral type. Some of the U.S. spring varieties are of this type, but Polk, Crim and Justin are long-day varieties, Table 22. Growers should be informed as to the characteristics of each variety and handle their culture on this basis. True-winter type varieties from the north and northwestern part of the state do not perform well in southern Texas and should not be grown.

QUALITY

The quality of a wheat variety, with respect to its performance and usefulness in the manufacture of flour, is important to the grower and the plant breeder as well as to the milling industry. Quality characteristics are the result of the interaction between inherited genetic characters and the environmental conditions under which the crop is grown. Varieties that inherit undesirable characteristics produce poor quality wheat under most conditions. Varieties that inherit desirable quality characteristics will produce good quality wheat under favorable conditions but may not if grown under unfavorable conditions. The environmental conditions that influence quality are not well understood. High temperature during the fruiting period, low amounts of available nitrogen during filling of the grain, available moisture during filling and other factors influence quality in various ways.

TABLE 22. PERFORMANCE OF SPRING-WHEAT VARIETIES IN SOUTH TEXAS IN 1968[1]

	Bushels per acre		
Variety	Beeville	Robstown	Pearsall[3]
Day-neutral spring			
Chris	30.5	17.1	
Lerma Rojo	30.1[2]	7.8	45.1
Penjamo 68	34.1[2]	9.7	51.6
Red River 68	15.8[2]	5.9	
Long-day spring			
Polk	15.6	8.7	
Crim	20.5	13.9	
Justin	16.4	12.1	21.8
Nadadores	27.4	15.1	
Semi-winter			
Milam	19.2	15.0	31.3

[1]Taken from Progress Report 2582.
[2]Damaged by spring freeze.
[3]Irrigated

Under most seasonal conditions, the best quality wheat for commercial bakery flour production is produced in the drier parts of the state. Irrigation tends to produce grain with lower protein and weaker mixing properties. Wheat produced in the more humid, high rainfall areas of North Central and Central Texas tends to have lower protein and weaker gluten. Often it is too low in quality to be used in bakery flour, except when blended with strong gluten wheats. Such grain may be lower in price or in less demand than high quality grain.

The majority of bread is baked in large, mechanized, commercial bakeries, and, because mechanical devices are involved in the process, nonuniformity of the flour or other ingredients may cause serious economic loss to the baker. To insure uniformity, the miller selects wheat with various quality characteristics and blends them together to meet the baker's flour specifications. To meet these requirements, large quantities of strong-gluten, high-quality varieties are required by the miller. The milling trade, terminal elevators and others who buy wheat for domestic or foreign markets are well informed on the varieties and quality of wheat grown in each area. To obtain the high quality wheat desired, they will buy from an area which grows good varieties and buy from other areas only for blending purposes. Areas growing good quality varieties attract and develop a market for good quality wheat. Unfortunately, there is usually no way for an individual grower to profit directly from growing good quality varieties because it is impossible to separate wheat in local markets.

The choice of a variety to grow should be based on performance and quality. Fortunately, growers in Texas have available high yielding, high test weight, well-adapted varieties with excellent quality. As part of the wheat improvement program of the Texas Agricultural Experiment Station, all new varieties considered for release are tested thoroughly for quality in the Cereal Quality Laboratory at College Station. More advanced strains, entered in Regional trials, are tested at the U.S. Department of Agriculture Regional Quality Laboratory at Manhattan, Kansas. Later, when larger quantities are available, 25-bushel seed lots are tested by the Hard Winter Wheat Quality Council in cooperation with commercial laboratories. Figure 15 shows bread and farinograph curves of a strong gluten and a weak gluten wheat variety.

Although varieties differ greatly from season to season and are influenced by the environmental conditions under which they are grown, their relative quality usually is much the same. A general classification based on many quality tests follows:

Group 1: High quality hard red winter wheat varieties suitable for production of bakery flour under most conditions: Tascosa, Sturdy, Caprock, Caddo, Quanah, Bison, Kaw, Warrior, Comanche, Turkey, Shawnee, Guide.

Group 2: Good quality varieties suitable for bakery flour if grown on dryland under favorable conditions but

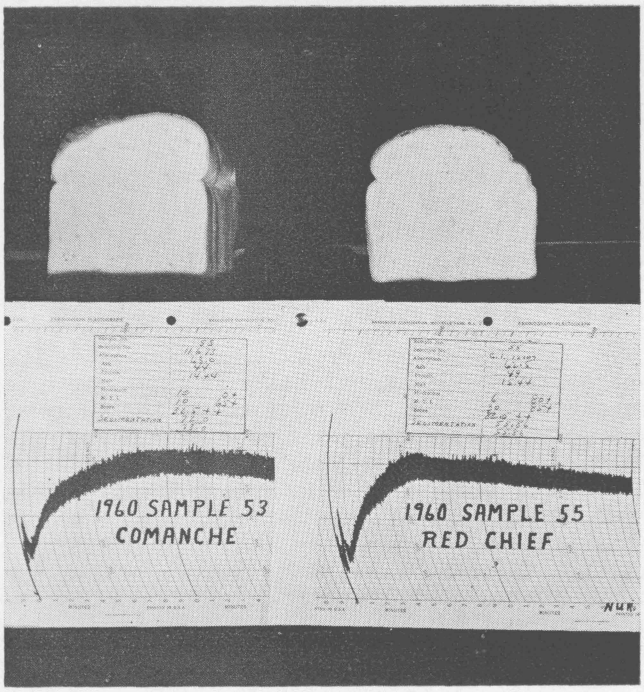

Figure 15. Bread and farinograph curve showing gluten strength of Comanche, a high quality variety, and of Red Chief, a weak gluten wheat.

producing blending flours if grown under unfavorable conditions. Not equal in quality to Group 1: Crockett, Concho, Westar, Ponca, Ottawa, Gage, Lancer, Parker.

Group 3: Mellow gluten wheats suitable for blending or for family flour production or for bakery flour production at high protein levels: Triumph, Improved Triumph, Triumph 64, Wichita, Ottawa, Gage, Agent, Milam.

Group 4: Soft red winter wheats suitable for family flour production under Texas conditions: Knox, Knox 62, Riley, Riley 67, Monon, Arthur, Vermillion, Atlas 66, Mediterranean.

DISEASES

Diseases are important hazards to wheat production in Texas. The mild, humid winter weather conditions of the eastern half of the state provide favorable conditions for establishment and increase of pathogens causing foliage diseases, especially the rusts, septoria leaf blotch and mildew. The early-spring establishment of local or area-wide epidemics may provide airborne spores which can be carried to all parts of the state. When such conditions develop over a large area, the diseases may become major factors in wheat production. Major epidemics of rusts and septoria occurred in 1935, 1949, 1957 and 1958. The 1949 epidemic, for example, caused an estimated loss of 24 million bushels. Losses to the crop include not only grain but also grain quality and increased cost of harvesting the crop. Diseases of wheat are described in greater detail in Texas Agricultural Experiment Station Bulletin 921 (1). The principal leaf diseases of wheat are shown in Figure 16.

Leaf Rust

Leaf rust of wheat, caused by the fungus *Puccinia recondita* Rob. ex Desm. F. sp. *tritici* Eriks., is probably the most damaging of wheat diseases in Texas. Although usually not spectacular, as is stem rust, it is present almost every year and throughout the winter in a considerable portion of the state. Commonly called "red rust" by growers and often not considered important, it reduces the functional leaf area, damages forage both in the fall and spring and later reduces the number and size of seed.

Leaf rust occurs on either side of the leaves and on the leaf sheathes of the plant as small, reddish-orange pustules, Figure 16E. A given

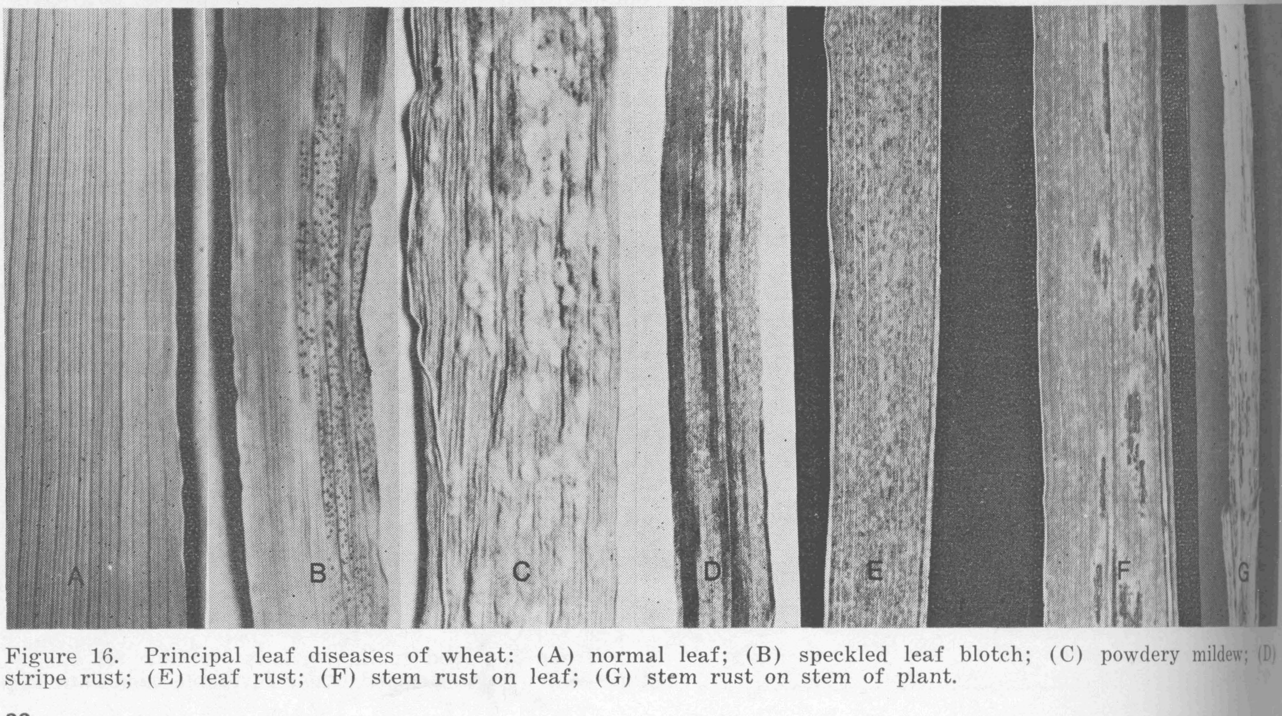

Figure 16. Principal leaf diseases of wheat: (A) normal leaf; (B) speckled leaf blotch; (C) powdery mildew; (D) stripe rust; (E) leaf rust; (F) stem rust on leaf; (G) stem rust on stem of plant.

pustule usually does not penetrate and appear on both sides of the leaf in contrast to the larger, elongated pustules of stem rust which penetrate entirely through the leaf. Leaf rust infects plants and may spread at temperatures below 70° F., thereby permitting it to reproduce throughout much of the winter season in Texas. Unless leaves are killed by low temperatures, the fungus usually is not killed during the winter.

Growing resistant varieties is the only practical means of controlling or avoiding damage by leaf rust. Spray materials which will control or protect the plants from infection for short periods are available. However, in Texas the disease may infect plants from the seedling stage to near maturity so it is not yet practical to control the disease with sprays. Fungicides which are absorbed by the plant and provide protection for several months have been developed but have not yet been cleared by the Pure Food and Drug Administration for use on food or feed products.

At present, the highest degree of resistance to leaf rust is found in the varieties Agent and Riley 67, both having genes for resistance obtained from related species. Arthur, Sturdy, Caprock, Quanah, Gage, Caddo and Ponca have resistance to many races but are susceptible to others. The older varieties Kaw, Crockett, Concho, Westar and others were resistant when released, but races are now present which can attack these varieties.

The fungi which cause the cereal rusts are made up of many physiologic races and biotypes. These may be likened to varieties of wheat. These races vary in prevalence and ability to attack varieties. Therefore, a variety of wheat may be resistant one year, but in another season or different environment, it may be susceptible to the races present. When a variety is resistant to many races but susceptible to some, the growing of that variety over a large area may reduce competition of races and permit the new races to increase rapidly. New races originate by mutation, by fusion of hyphae or during sexual reproduction on the alternate host of the organism. The rusts are very specific in their host range. Leaf rust of wheat does not attack oats or barley but may be found on a number of wheat-related grasses.

Stem Rust

Stem rust of wheat, caused by the fungus *Puccinia graminis*, Pers. f. sp. *tritici* Eriks and E. Henn., is one of the most dreaded diseases because it can cause severe injury to yields and grain quality. If an epidemic starts before or near heading time, it can destroy a field of wheat in a few weeks, making it completely worthless, Figure 16, F and G. As with leaf rust, the disease is caused by a parasitic fungus whose germinating spore enters the plant tissue usually through stomata. Once inside the tissue, the organism grows rapidly, utilizing the moisture and plant nutrients of the host plant and erupting in 6 to 10 days as an elongated, brick-red pustule on the surface of the leaf, stem, leaf sheath, peduncle or even parts of the spike. The pustules contain thousands of microscopic spores which may be carried by wind currents to nearby plants or distant fields. The spores germinate in rain or dew and cause new infection. The host plant is weakened, may lodge, and the grain shrivels. Time of infection, weather conditions and races of rust present determine how much damage will occur. The disease is a constant hazard in Areas III, IV and V, and it occasionally causes important losses even in the lower rainfall areas of the state. A field of wheat at College Station was completely destroyed by stem rust in 1954, Figure 17.

No variety now available is resistant to all races of stem rust which occur in Texas and the Midwest. Austin was released in 1943 and Quanah in 1951 as stem-rust resistant varieties, but the epidemics of 15B in 1954 and 1955, together with changes in leaf rust races, made these varieties no longer highly resistant. Kaw 61, Scout, Gage, Tascosa and Crockett have some resistance to some races but are susceptible to others. Milam has resistance to a broad group of races of both rusts and has made growing wheat in South Texas possible in recent years. However, it now is susceptible to some races of both leaf and stem rust.

Stripe Rust

Stripe rust, caused by *Puccinia striiformis* West., is typically a cool temperature rust which occurred only in traces in Texas prior to 1957. The very cool springs and abundant rainfall of 1957 and 1958 permitted this disease to spread throughout Texas and cause extensive damage (10). Stripe rust resembles leaf rust except that the pustules develop along the leaf veins as long streaks, Figure 16D, and the spores and pustules are bright yellow in color. A considerable number of hard wheat varieties are resistant to stripe rust — Kharkof, Red Chief and Ponca. Wichita, Concho, Crockett and Westar were highly susceptible in 1957. Stripe rust is not a common problem in Texas.

Septoria

Two species of *Septoria* attack wheat. The speckled leaf blotch, caused by *Septoria tritici* Rob. in Desm., occurs over a wide area each year but usually is relatively inconspicuous, and the damage is overlooked. Glume blotch, caused by *Leptosphaeria nodorum* E. Müller (conidial stage, *Septoria nodorum*, Berke is less common than the speckled leaf blotch. Serious epidemics occurred in the cool, wet spring seasons of 1935, 1941 and 1957.

Lesions of the leaf blotch appear first as pale green to yellow spots on the leaf. These lesions enlarge as the fungus invades the adjoining tissue. As the tissue is killed, it turns brown and, later, grey to black fruiting bodies called

Figure 17. Complete destruction of field of wheat by stem rust at College Station, 1954.

pycnidia are formed, Figure 16B. When conditions are favorable for the disease, large areas of leaf tissue may be killed thereby reducing the effective leaf area of the plant and reducing yields. Varieties show different degrees of susceptibility, but none of the adapted varieties are highly resistant.

Glume blotch occurs on the culms, nodes and spikes causing blackened areas, or the entire culm and spike may be darkened. The stems are weakened and may bend or break just above the nodes. The crop lodges and is difficult to harvest, Figure 18. The seed may be shriveled, reducing yields and quality of grain. Relatively

Figure 18. A field of wheat near Chillicothe was seriously damaged by Septoria diseases in 1941. Note breaking or bending of stems at the nodes.

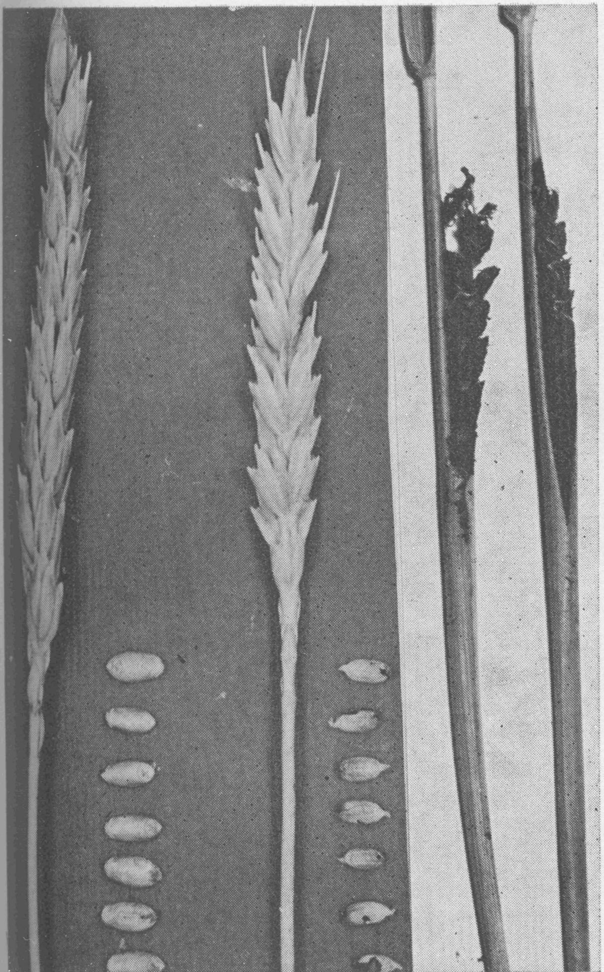

Figure 19. Normal head of wheat (left) contrasted with one head infected with bunt and two destroyed by loose smut.

little is known about varietal resistance. Seed treatment with fungicides, crop rotation and plowing under of crop residues to prevent infection from old straw and from volunteer plants will aid in control of the disease.

Powdery Mildew

Powdery mildew, caused by *Erysiphe graminis* (DC) Mérat. f. sp. *tritici* is important only in the humid parts of the eastern half of the state. Cloudy, cool weather and unpastured, rank forage growth provides a favorable environment for this disease. Mildew appears on the leaf surface as a mass of white mycelium, Figure 16C. Only the epidermal cells of the leaf tissues are invaded, but plant nutrients and water are taken from the host plant. Forage production and grain yields may be reduced if the disease attacks the plants for a long period of time. Usually, as warmer, dry weather of spring occurs, the disease is reduced by the lower humidity and higher temperatures. A number of varieties are resistant to some races of the organism. Sturdy and Quanah, grown in the eastern part of the state, are highly susceptible and may be damaged in some years.

Smuts

Two smut organisms attack wheat in Texas. Loose smut, caused by *Ustilago tritici* (Pers.) Rostr., destroys the grain and all glume structures of the spike leaving only the central stem (rachis), Figure 19. Spores produced by this fungus are spread by wind currents to healthy plants at flowering time. The spores germinate and penetrate the young wheat ovary where they remain dormant until the seed germinates. As the infected seed starts germinating, the fungus also starts developing within the plant tissue, invading the stem and finally replacing the spike with a mass of smut spores.

Varieties differ greatly in their field reaction to this disease and to races of the causal fungus. Crockett, Ponca, Gage, Austin and the original Triumph strain are resistant. Some varieties are susceptible but do not develop much field infection. Other varieties become heavily infected under field conditions. Quanah, Concho, Bison, Scout and others are highly susceptible.

Surface treatment with organic mercury or other fungicides is not effective in controlling loose smut because the fungus hypha is within the kernel. Formerly, it was necessary to use either a hot water treatment or an anaerobic soak treatment to control this disease. Recently, a systemic fungicide, Vitavax[2], which will control loose smut by surface treatment, has been developed. The fungicide may be used only on planting seed for seed increase and may not be used on seed planted for forage or grain production.

Stinking smut or bunt, caused by the fungus *Tilletia foetida* (Wallr.) Liro., differs from loose smut in that the glumes and other floral parts, including the outer wall of the kernel, remain intact and only the internal part of the kernel is replaced by smut spores, Figure 19 (center). Because these smut balls resemble seed, the spike looks normal, except when observed closely. At threshing time, the smut balls are broken, and the spores become attached or lodged in the crease or brushy end of the healthy kernel. After sowing, the spores germinate at the same time as the wheat seed. The fungus hypha penetrates the sprout and grows within the tissues of the plant, finally replacing the kernels with a mass of smut spores.

Varieties differ in reaction to bunt, and breeding efforts to develop resistant varieties were once extensive. Comanche, Concho, Bison, Quanah and others are resistant to many races of bunt. Seed treatment with organic mercury fungicides and others are highly effective against this smut. Recently, seed treatment has become so universal that most bunt resistance breeding efforts have been reduced. Bunt infection is

[2]Mention of a trademark name does not constitute a guarantee or warranty of that product by the U.S. Department of Agriculture or the Texas Agricultural Experiment Station and does not imply its approval to the exclusion of other products that may be suitable.

Figure 20. A field infected with dryland foot rot of wheat, Crowell, 1951. Note thin stands and white, dead spikes.

greatly influenced by the soil temperatures at time of germination. Cool soil temperatures, below 68° F., are favorable for infection. Therefore, the disease is of more importance in Areas I and II than in other parts of the state.

Root Rots

Root rots of wheat cause varying amounts of damage to the establishment of stands of wheat and to later growth of the crop. The degree of damage depends upon both the previous crop and the environmental conditions during a growing season. Organisms causing these diseases are almost universally present in soils and are potentially harmful. Important losses have occurred frequently in the Rolling and High Plains areas where continuous wheat production is practiced and there is only limited opportunity to rotate crops, Figure 20.

The root rots may be caused by one organism or a complex of several organisms. Organisms identified from diseased plants in Texas include *Helminthosporium sorokinianum* Sacci. in Sarok, several species of *Fusarium, Rhizoctonia solani* Kuhn, *Sclerotium rolfsii* Sacc. and others.

The control of root rots is very difficult, especially under conditions of continuous wheat production. Treatment of seed with fungicides aids in control of the seedling blight stage, but this protects the young plant for only a limited period. When infected straw is present, the organisms may attack the plant nearly any time during the growing season. Crop rotation with broad-leaf plants such as guar or other legumes may reduce damage. Varieties differ in reaction to these organisms, but none which has high resistance is known.

Wheat Streak Mosaic

Wheat streak mosaic is a virus disease which causes yellow or greenish, narrow, linear, intermittent stripes or streaks on the leaves. These streaks follow the vascular bundles or ribs of the leaf, Figure 21. Entire leaves may show chlorosis and necrosis. Plants frequently are stunted, and the size of the spike and kernels may be reduced. Damage is related to the stage at which infection takes place and the percent of the plants infected. The virus persists in many native grasses and may be carried from one crop season to the next on these grasses or on volunteer wheat.

The disease is carried and transmitted from plant to plant by a tiny, microscopic mite called the wheat curl mite or Eriphoid mite. The mite, *Aceria tulipae* (Keifer), moves from leaves of one plant to another plant or may be carried some distance by wind currents. The disease occurs most frequently after cool wet summers when there is an abundance of wild grasses and volunteer wheat to serve as host plants for carrying the mites and disease from one crop season to another. Mites will spread from fence rows and volunteer grain to recently planted wheat plants.

INSECTS

A number of insects may cause serious damage to wheat when conditions are favorable for rapid increase of populations. A description of insects attacking small grains, with suggested control measures, is given in Texas Agricultural Extension Service Miscellaneous Publication 339

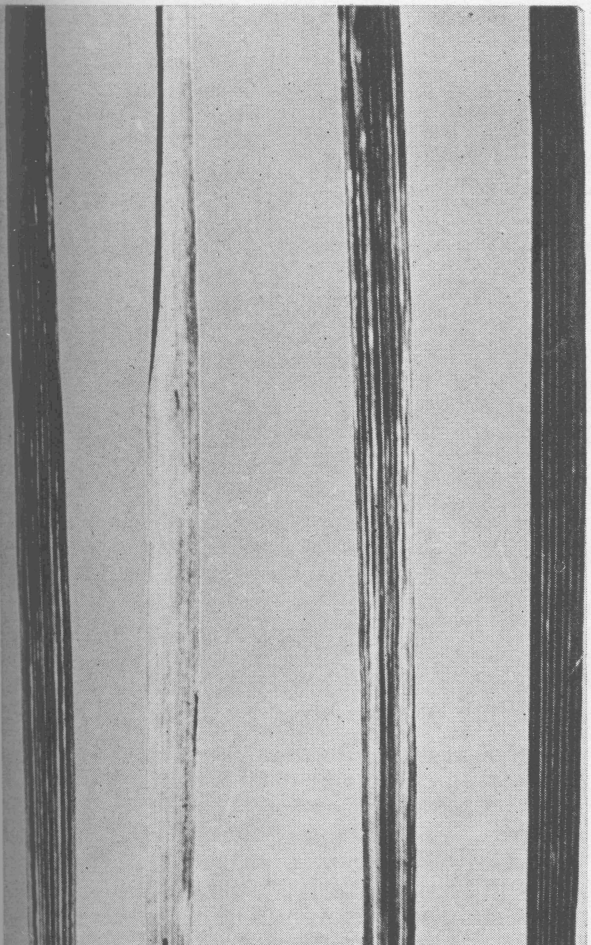

Figure 21. Wheat leaves infected with wheat streak mosaic.

and later publications available through the Extension Service.

Several species of aphids attack wheat, but the most important is the greenbug, *Schizaphis graminum* (Rondani). The greenbug causes a characteristic yellowing or reddening of the leaf tissue where it feeds. Plants are weakened and finally killed by the feeding insects. If the infestation continues and increases, plants in large areas or in the entire field may be killed. Greenbugs and corn leaf aphids are shown in Figure 22. Several other species of aphids may attack wheat, but usually their damage is much less than that of greenbugs. Several species of aphids may transfer the virus causing the Yellow Dwarf disease to wheat and other cereals.

Effective insecticidal sprays for the control of aphids are now available. Recommendations can be obtained from the local county agent. Whether or not the cost of spraying is justified must be determined for each situation.

Another group of pests of wheat is the spider mites. The most important mites attacking wheat are the brown wheat mite, *Petrobie latens* (Müller) and the winter grain mite, *Penthaleus major* (Duges). Spider mites are not classed as insects but are tiny spiders. They damage the crop by cutting the leaf tissues and feeding on the plant juices. The winter grain mite is more frequently found in the humid areas such as Research Areas III and IV where they may greatly reduce the pasture value of the crop. This mite is easily killed by insecticides. The brown wheat mite is more frequently found in the drier sections such as Area I and II. Damage by this mite is difficult to demonstrate because the mite usually is most numerous in dry seasons when the crop is in stress from drouth. Control with insecticides is very difficult and probably under most conditions is not justified.

Armyworms, cutworms and flea beetles may occasionally attack wheat to such an extent that control measures are necessary.

WEEDS

Fall-sown wheat is usually relatively free of weeds if the crop becomes established quickly and develops good strong plants before cool weather. However, if small grains are grown continuously on the same land, several annuals may present problems. Johnson grass, *Sorghum halapense* (L.) Pers., may present a harvesting problem if harvest is delayed beyond the normal time. Numerous sprays are available for this and other grasses and weeds. Suggestions for control of weeds and grasses are published annually, Texas Agricultural Extension Service Bulletin 1029 (18).

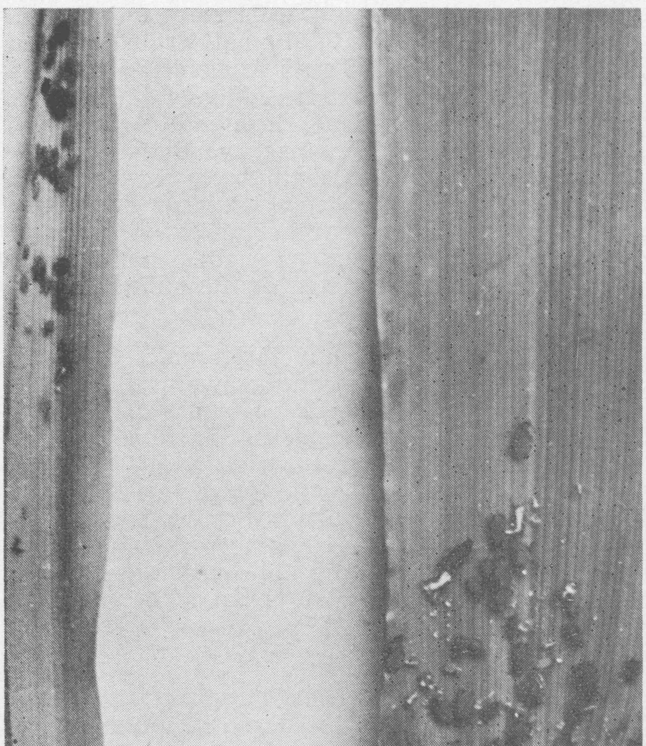

Figure 22. Greenbugs on wheat leaf (left); corn leaf aphids (right).

A number of winter annual grasses may influence yields if allowed to develop high populations. Cheat or chess, *Bromus secalinus* L., little barley, *Hordeum pusillum* Nutt., wild oats, *Avena fatua* L. and goat grass or joint grass, *Aegilops cylindrica* Host., may spread into the field from fencerows and ditches or increase under continuous cropping until they seriously reduce yields. Seed of many of these plants shatter before wheat harvest and the seed also may lie dormant for several years before germinating. Cultural operations before seeding and rotation of crops will usually control these grasses, but it may be necessary under some conditions to use herbicides.

During recent years Tansy mustard, *Descurainia pinnata* (Walt.) Britt., has become an important pest of wheat production on the High Plains. Effective sprays are available for control of this weed, Wiese (30). Perennial weeds, such as field bindweed, *Convolvulus arvensis* L., require more intensive cultural and herbicide controls; the latest recommendations for control should be obtained from the local county agent.

Broadleaf annual weeds may present a harvesting problem in very wet spring seasons. Most of these can be controlled with 2,4-D and related herbicides. However, since wheat can be injured by these sprays during the period between jointing and maturity, caution should be exercised in such operations.

WHEAT IMPROVEMENT

Research work to develop new varieties of wheat especially adapted to Texas needs is carried on as part of the total small grain improvement program of the Texas Agricultural Experiment Station. Extensive breeding to develop new varieties is conducted at Bushland, Denton and College Station, while variety and strain tests are conducted at from eight to twelve locations in the state. Fundamental studies of disease and insect resistance, inheritance of morphological characters, quality, hybrid wheat and other phases are conducted at the main breeding stations.

Varieties with many different characteristics are needed to provide growers with varieties adapted to their needs. Because of the wide range of climatic conditions in Texas, cold hardiness, drouth resistance, reaction to diseases and insects and good agronomic characteristics must be considered in developing varieties. These characteristics must be combined with good yield potential, test weight and approved milling characteristics for all parts of Texas. The extensive wheat breeding program at Denton is shown in Figure 23.

The development of special varietal types for specific needs is illustrated in the present program to develop short statured or semidwarf varieties for irrigation and other high production levels. As approximately half the High

Figure 23. The extensive wheat breeding nurseries at Texas A&M University Agricultural Research Station at Denton.

Plains acreage of wheat is now grown under irrigation, lodging and excessive straw become problems of greater importance. Sturdy and Caprock were released recently to reduce these hazards. This program dates back to 1950 when the original short wheat, Norin 10, was introduced from Japan. Numerous new short strains are being tested in breeding nurseries, Figure 24.

Research to find better varieties was started by the Texas Experiment Station in 1899 and by the U.S. Department of Agriculture at experiment stations at Amarillo and Channing in 1908. Breeding work was started at the Texas A&M Agricultural Research Station at Denton in 1912 and the first variety, Denton, was released in 1926. Since then there has been a continuing series of improved varieties until all the old varieties have been replaced by varieties of better quality, higher yield potential, better disease resistance, lodging resistance or other improved characteristics, Figure 11.

Wheat improvement is a long and tedious process. The wheat plant is self fertile and must be cross-pollinated by hand to produce a hybrid plant from which new types can be selected. The parts of a wheat flower are shown in Figure 25.

In making a cross to combine good characteristics of two varieties, the anthers or male parts of the female parent must first be removed with hand tweezers prior to blooming. Later,

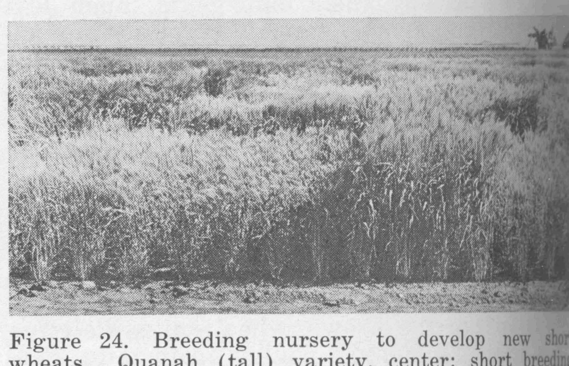

Figure 24. Breeding nursery to develop new short wheats. Quanah (tall) variety, center; short breeding lines on either side.

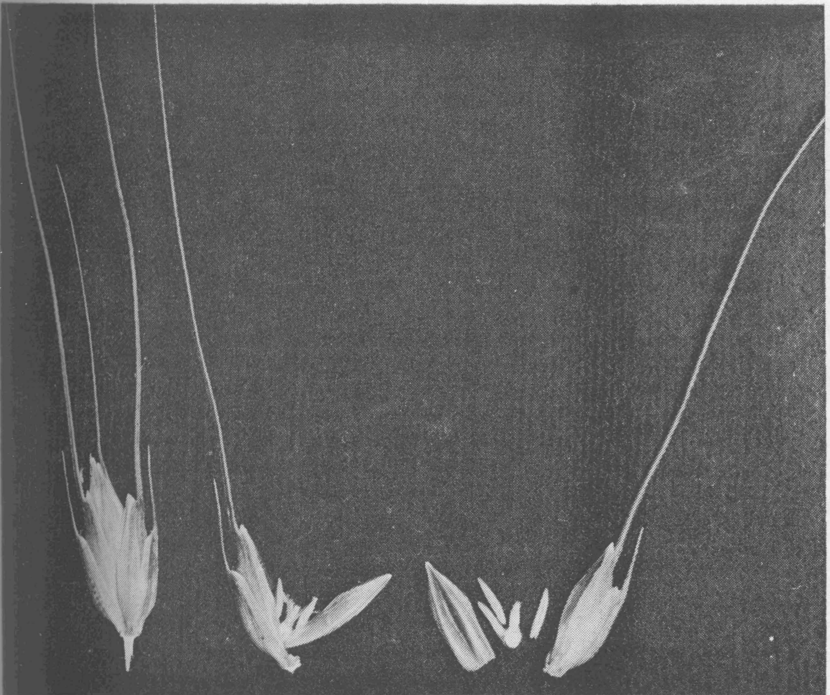

Figure 25. Floral parts of the wheat spikelet.

when the female flower parts are receptive, pollen must be transferred from the male parent. Only a few seeds are necessary for the cross, but progeny from the hybrid must then be grown for from 6 to 8 years before true-breeding selections can be made for testing. Additional years of selection, tests for all characteristics in local, state and regional performance trials, quality tests, increase of seed and distribution takes from 10 to 15 years. However, if a new variety has advantages in yield, quality, lodging resistance or other characteristics, large dividends are returned to the growers of the state. The advantages of newly developed varieties are demonstrated to growers in their own counties by Result Demonstrations, Figure 26.

Hybrid Wheat

Within the past 10 years, major progress has been achieved in the development of hybrid wheat. This development will permit growers to take advantage of hybrid vigor as has been done in corn, sorghum and several other crops. The cytoplasmic male sterility and genetic restorer mechanisms have been found in wheat and made available to state, federal and commercial breeders. Problems and prospects of hybrid wheat were discussed in Texas Agricultural Progress (21), and a report of hybrid wheat work in Texas is given in Texas Agricultural Experiment Station Consolidated Progress Reports (22).

Figure 26. County Result Demonstrations permit the grower to observe new varieties under his own conditions.

The advantages of hybrid wheat include prospects of yield increases comparable to those in corn and sorghum (Briggle 7). Actual release of hybrids to growers has been delayed by incomplete restoration of fertility in the final crosses. A limited amount of hybrid seed was released in 1968 by one seed company to determine grower response, to give growers an opportunity to observe hybrids under their conditions and to provide data on production. It appears probable that additional hybrids will soon be available.

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