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SPACING AND DATE OF SEEDING EXPERIMENTS WITH GRAIN SORGHUMS

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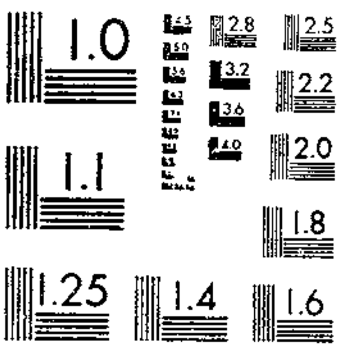

MICROCOPY RESOLUTION TEST CHART
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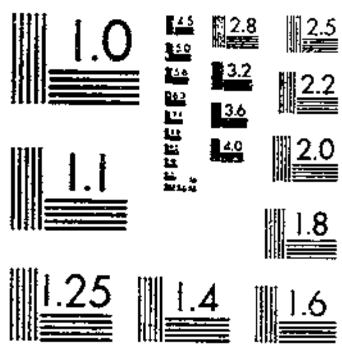

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

TECHNICAL BULLETIN No. 131 — NOVEMBER, 1929

UNITED STATES DEPARTMENT OF AGRICULTURE
WASHINGTON, D. C.

SPACING AND DATE-OF-SEEDING EXPERIMENTS WITH GRAIN SORGHUMS[1]

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In Cooperation with the Kansas Agricultural Experiment Station

CONTENTS

INTRODUCTION

The experiments here reported were conducted in cooperation with the Kansas Agricultural Experiment Station at Hays, Kans.; in cooperation with the Office of Dry-Land Agriculture, Bureau of Plant Industry, at Garden City, Kans., Woodward and Lawton, Okla., Dalhart and Big Spring, Tex., and Tucumcari, N. Mex.; and in cooperation with the Amarillo Chamber of Commerce at Amarillo, Tex. The results at Chillicothe, Tex., and some of the results at Hays and Amarillo were compiled from the results of experiments conducted by the Office of Forage Crops and Diseases and reported in United States Department of Agriculture Bulletin No. 1260 (*14*).[2]

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[1] The following men conducted the experiments here summarized, at the stations indicated: Hays, Kans., F. A. Kiene, 1912–1918; A. F. Swanson, 1919–1926; and R. E. Getty, 1914–1920. Garden City, Kans., E. H. Coles. Woodward, Okla., J. B. Sieglinger. Lawton, Okla., W. M. Osborn. Dalhart, Tex., H. J. Clemmer. Amarillo, Tex., B. E. Rothgeb. Big Spring, Tex., J. E. Mundell, 1918–1921; F. E. Keating, 1922–1926. Chillicothe, Tex., R. W. Edwards, 1913–1917; A. B. Cron, 1918–1921. Tucumcari, N. Mex., H. G. Smith, 1917; H. J. Clemmer, 1918–1921; D. R. Burnham, 1922–1926. Acknowledgments are made to B. E. Rothgeb and E. F. Chilcott for assistance in outlining and supervising these experiments.

[2] Reference is made by italic numbers in parentheses to "Literature cited," p. 46.

Profitable yields of grain sorghum depend to a large extent upon good cultural methods. Two of the most important cultural practices are the optimum spacing of the plants and the seeding at proper dates. The best cultural methods are difficult to determine locally because of the extreme irregularity of temperature and moisture conditions in the southern section of the Great Plains area, where most of the grain sorghums are grown. The varieties of grain sorghum differ in time of maturity and in tillering ability. Insects cause greater damage to some seedings than to others. In the northern portion of the grain-sorghum area seeding at a relatively early date may be necessary, in order that the crop may have time to mature. Farther south there is a considerable period during which grain sorghums may be sown without danger of killing frosts before the crop is mature.

Cultural experiments with grain sorghums in the southern Great Plains were begun in 1904 at Channing, Tex. Definitely planned and coordinated experiments were started at several field stations a few

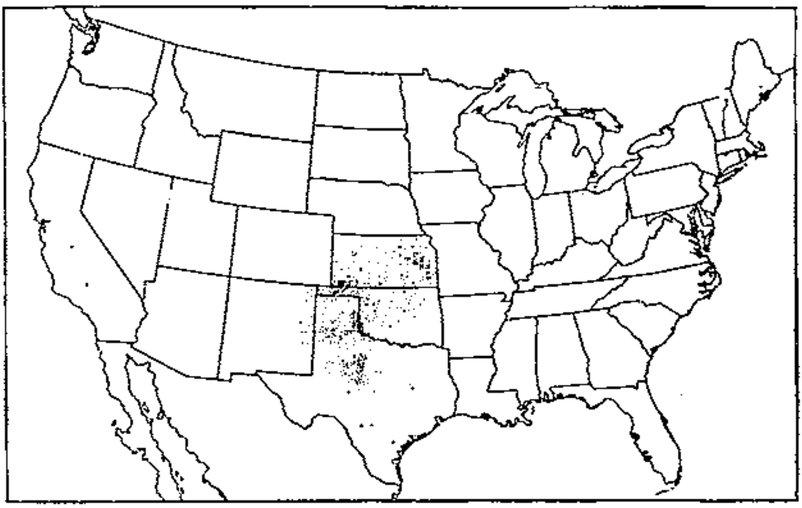

FIGURE 1.—Outline map of the United States, showing the distribution of the grain-sorghum acreage in 1921

years later. A considerable portion of the results of these experiments has been published in bulletins presenting results from individual stations, and most of the results obtained before 1922 were published previously in Department Bulletin 1260 (*14*). In the present publication the data obtained previous to and during 1926 are summarized, and the factors affecting dates of seeding and distance of spacing grain-sorghum varieties are discussed.

LOCATION, SOIL AND CLIMATIC DATA, ETC.

The experiments reported here were conducted at nine field stations in the southern section of the Great Plains area, in the western parts of Kansas, Oklahoma, and Texas, and in northeastern New Mexico. These stations are located in the midst of the important grain-sorghum producing region indicated in Figure 1. The average precipitation, altitude, and frost-free period in the region are shown in Figure 2.

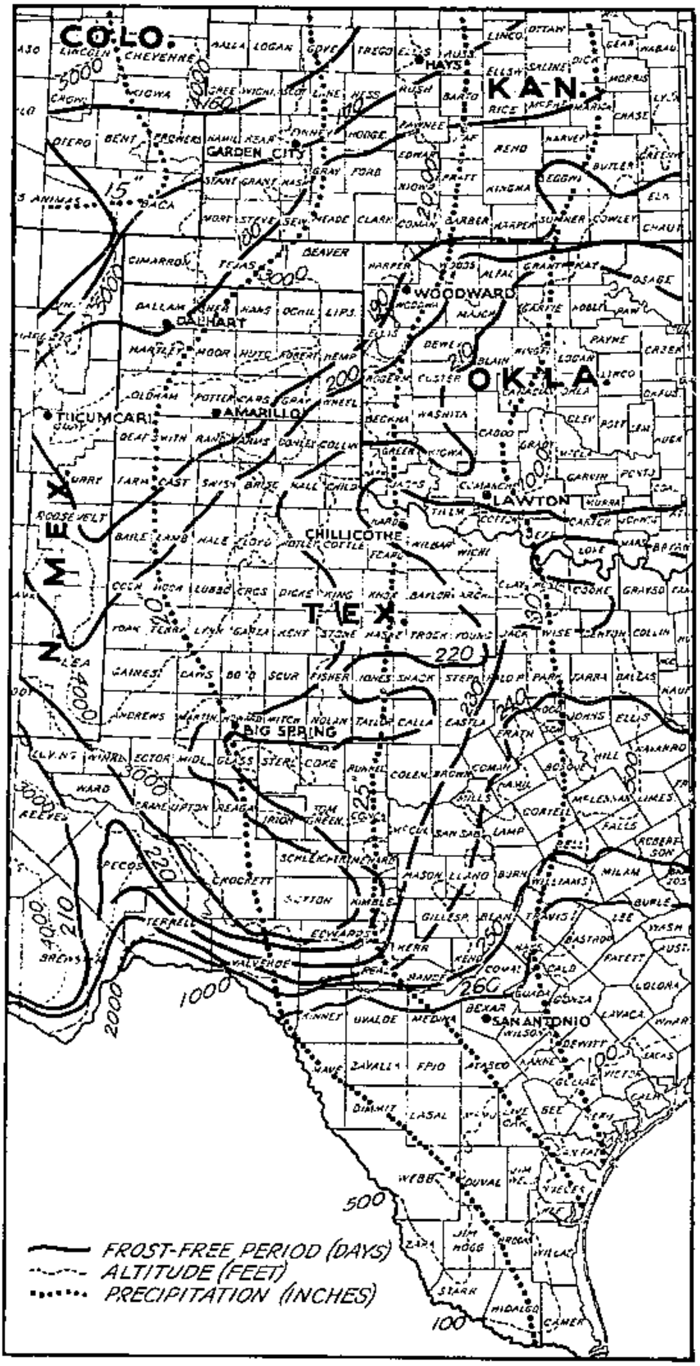

FIGURE 2.—Map of the southern Great Plains, showing the average annual precipitation, the number of days in the frost-free period, and the altitude

The soil type, altitude, latitude, longitude, "corresponding date," and frost-free season at each of the nine field stations are shown in Table 1. At these stations there is a range in soil type from sandy loams to clay loams, in altitude from 1,111 to 4,158 feet, and an average frost-free period from 161 to 222 days. The "corresponding date" was calculated according to Hopkins's bioclimatic law (7), which states that "other things being equal, the variation between two or more geographical positions bears the same proportion to the distance between them, that four days of time bears to 1 degree of latitude, 400 feet of altitude, or 5 degrees of longitude." Woodward, Okla., was taken as the base in determining the corresponding dates at the other stations. The calculations show, for example, that the same stage of plant development is reached about 15 days earlier at Lawton, Okla., and 22 days later at Dalhart, Tex., than at Woodward. This, however, does not take into consideration differences in soil type or any factors other than the three mentioned in the bioclimatic law.

TABLE 1.—*Soil type, altitude, location, "corresponding date," and frost-free period at nine experiment stations in the southern Great Plains where the experiments with grain sorghums were conducted*

Station	Soil type	Altitude	Latitude (north)		Longitude (west)		Corresponding date [1]	Average date of last frost in spring [2]	Average date of first frost in fall [2]	Average frost-free period [2]
		Feet	°	′	°	′				*Days*
Hays, Kans.	Silt loam	2,000	38	52	99	19	June 12	Apr. 30	Oct. 8	161
Garden City, Kans.	Sandy loam	2,836	37	58	100	54	June 18	May 1	Oct. 11	163
Woodward, Okla.	do	2,002	36	26	99	23	June 1	Apr. 8	Oct. 25	200
Lawton, Okla.	Heavy clay; fine sandy loam.	1,111	34	32	98	24	May 17	Apr. 3	Oct. 31	211
Dalhart, Tex.	Sandy loam	3,978	36	4	102	31	June 23	Apr. 23	Oct. 17	177
Amarillo, Tex.	Clay loam	3,676	35	13	101	49	June 16	Apr. 14	Oct. 25	194
Big Spring, Tex.	Fine sandy loam	2,400	32	9	101	23	May 22	Mar. 31	Nov. 1	215
Chillicothe, Tex.	Clay loam	1,406	34	15	99	23	May 18	Mar. 28	Nov. 5	222
Tucumcari, N. Mex.	Sandy loam	4,158	35	11	103	44	June 20	Apr. 21	Oct. 24	186

[1] Date corresponding to June 1 at Woodward, Okla., according to Hopkins's bioclimatic law (7).
[2] Average for 13 years, 1914 to 1926, inclusive. Data from Office of Biophysical Investigations where available; remainder from Weather Bureau records. Data for Chillicothe, Tex., taken from Weather Bureau records at Quanah, Tex. Frost dates shown are for days on which the minimum temperatures recorded were 32° F. or less, regardless of whether vegetation was killed or not.

The monthly, annual, and seasonal records of precipitation at the nine field stations during the approximate period of the grain-sorghum experiments are shown in Table 2. Averages for longer periods at these stations also are shown. The average precipitation ranged from less than 18 inches at Tucumcari, N. Mex., to more than 30 inches at Lawton, Okla. The rainfall shows a gradual decrease from east to west. The average precipitation during the period of the grain-sorghum experiments is not markedly greater or less than the long-time average at any station. The results obtained, therefore, should apply to average conditions at these stations. Results of many of the individual seasonal conditions at these stations and their effects on the grain-sorghum crops produced have been shown previously by others (*2, 3, 4, 9, 10, 11, 13, 14*).

The wide variation in the monthly precipitation at each of the stations has resulted in a similar fluctuation in yields. Late frosts in the spring sometimes injured early-sown grain sorghums, and frequently the late seedings were killed by frost before the crop was mature.

In addition to the results from stations listed in Tables 1 and 2, results from other stations are referred to occasionally in the discussion of the various experiments.

TABLE 2.—*Monthly, annual, and seasonal precipitation, in inches, at the nine field stations in the southern Great Plains where sorghum experiments were conducted for the years during which these experiments were in progress, with averages for this period and for the whole period covered by the climatic data*

[T.=trace]

Station and year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual	Seasonal[1]
Hays, Kans.:														
1912	0.02	1.98	1.60	1.66	2.70	4.32	0.88	3.52	1.85	0.51	1.13	0.03	20.20	14.03
1913	.36	.08	.41	2.78	5.72	3.53	.63	.11	4.80	.25	.72	3.11	23.10	17.57
1914	.04	.42	.15	2.31	2.36	3.39	2.77	2.03	.60	1.33	T.	.63	16.63	14.06
1915	.08	1.80	1.74	3.13	6.82	3.97	8.18	4.11	2.44	.93	.30	.04	34.14	28.65
1916	.53	.15	.31	2.21	1.03	5.88	.30	1.97	1.26	1.14	.02	.61	16.01	13.25
1917	.11	T.	.07	1.96	1.72	2.15	1.46	5.73	1.84	.09	1.64	.15	16.92	14.86
1918	.80	1.15	1.71	2.40	4.79	.53	3.04	1.76	1.42	2.41	1.10	2.38	23.58	14.03
1919	T.	2.18	.33	4.51	6.85	3.51	1.16	.77	3.32	1.61	1.54	.15	26.13	20.12
1920	.05	.37	.30	2.04	3.32	1.87	1.89	5.11	1.56	3.53	.73	.46	21.28	15.79
1921	.40	.10	.49	3.58	2.59	3.67	3.36	3.04	.08	.05	0	.50	18.40	16.92
1922	T.	.93	1.71	4.51	2.61	2.18	4.20	.81	.43	.32	1.28	T.	18.98	14.74
1923	T.	.10	1.04	1.03	3.97	5.06	.70	4.15	4.52	4.37	.29	.37	27.10	20.93
1924	.31	.26	1.81	1.05	3.19	.77	2.32	1.95	1.03	.46	.25	1.11	14.51	10.31
1925	.05	.24	.38	4.27	1.01	4.13	6.73	3.33	.99	.75	1.12	.02	23.02	20.46
1926	.36	1.13	1.75	.81	2.16	2.55	1.94	.83	2.83	.60	1.12	.37	16.45	11.12
Average:														
1912–1926	.25	.77	.92	2.60	3.43	3.23	2.64	2.65	1.97	1.24	.75	.66	21.10	16.52
1868–1926	.51	.83	.99	2.32	3.30	3.19	3.25	2.95	2.27	1.44	.77	.79	22.62	17.28
Garden City, Kans.:														
1921	1.02	.32	T.	2.63	.96	5.81	2.21	2.25	2.46	.20	0	.65	18.51	16.32
1922	.24	.10	1.35	3.55	3.31	.64	2.05	2.49	.07	0	.49	T.	14.38	12.11
1923	T.	T.	.41	3.02	6.60	6.88	4.52	3.86	6.19	3.10	.33	.29	36.19	32.06
1924	T.	.76	1.73	2.08	1.06	1.39	1.09	1.74	1.73	.59	T.	.55	12.72	9.09
1925	T.	.46	.80	2.54	2.06	1.16	1.30	1.81	2.00	.28	1.01	T.	13.42	10.67
1926	.33	.38	1.09	.91	2.35	2.98	2.05	2.56	1.15	0	.73	.32	14.85	12.00
Average:														
1921–1926	.26	.35	.90	2.00	2.74	3.14	2.20	2.45	2.27	.69	.43	.30	18.33	15.40
1908–1926	.30	.85	.85	1.87	2.30	2.75	2.41	2.41	1.86	1.05	.72	.61	18.04	13.66
Woodward, Okla.:														
1914	.18	.51	.34	1.69	3.16	.61	1.88	2.64	.58	1.96	.06	.77	14.36	10.54
1915	1.17	3.44	1.45	6.53	5.29	2.43	3.14	3.62	5.74	2.36	.55	.06	35.78	26.75
1916	1.50	.03	.82	1.78	1.70	10.26	0	1.02	2.34	1.71	.75	.60	22.51	17.10
1917	.20	.20	.10	1.58	1.03	1.37	1.13	6.05	2.72	.05	.67	.01	15.71	14.48
1918	1.60	.29	2.09	2.22	4.00	1.91	.73	1.35	1.24	3.35	1.53	2.92	23.23	11.45
1919	.06	1.53	1.94	4.10	4.29	2.22	1.35	1.87	.63	1.85	2.37	T.	22.21	14.46
1920	1.03	.07	.61	1.06	3.40	1.29	4.60	3.00	5.01	2.55	1.32	1.53	25.56	18.45
1921	2.22	.61	1.33	1.80	1.01	5.75	2.50	5.11	2.94	.01	0	.11	24.32	20.04
1922	1.02	.96	5.08	2.07	3.69	.18	1.07	2.31	2.83	.74	1.15	0	22.00	13.05
1923	T.	.06	1.86	2.32	8.11	4.20	.69	.39	9.33	11.99	.89	.84	40.68	25.04
1924	.03	.81	2.96	3.14	.78	1.46	3.07	3.40	3.22	2.29	1.90	1.48	24.54	15.07
1925	.14	.12	.40	3.18	1.34	2.00	2.34	.79	2.44	.70	2.04	.40	16.01	12.15
1926	.54	.11	1.59	1.70	2.23	3.51	5.18	1.79	3.37	6.00	1.09	1.34	28.84	17.78
Average:														
1914–1926	.75	.67	1.61	2.62	3.15	2.87	2.14	2.61	3.26	2.74	1.10	.78	24.29	16.64
1805–1926	.68	1.03	1.14	2.30	3.15	3.00	2.70	2.79	2.72	2.08	1.22	.80	23.68	16.00
Lawton, Okla.:														
1917	.30	.57	1.74	1.28	4.50	1.01	3.02	2.84	.72	.19	1.08	.03	17.28	13.37
1918	.20	.25	2.16	2.36	1.20	3.08	2.57	1.48	4.18	8.68	1.20	3.50	30.95	14.96
1919	.54	1.41	2.99	4.60	5.44	4.36	3.71	1.98	1.67	13.78	2.25	.92	43.65	21.76
1920	1.04	.61	1.84	3.14	7.53	.69	1.88	4.18	2.05	8.78	2.29	.86	34.89	19.47
1921	1.15	1.47	2.05	2.14	1.30	5.93	2.95	.83	2.13	.03	T.	.53	20.51	15.28
1922	.59	.46	.97	6.85	6.63	1.01	4.40	.04	1.61	2.46	1.04	.21	26.17	20.14
1923	4.37	.70	1.30	3.48	5.56	2.68	1.25	1.70	4.99	9.04	3.51	1.76	40.43	19.75
1924	.20	.11	2.47	3.88	3.05	3.36	1.30	4.15	.61	.78	.50	.99	21.49	16.44
1925	.05	.82	T.	5.78	2.00	.65	2.01	3.52	7.73	3.58	1.53	.11	28.08	21.69
1926	1.33	0	1.67	2.22	3.79	1.20	2.10	7.48	4.67	3.78	.22	4.50	32.96	21.46
Average:														
1917–1926	1.10	.64	1.72	3.57	4.11	2.40	2.43	2.89	3.04	5.11	1.30	1.34	29.74	18.44
1870–1926[2]	1.13	1.12	1.59	3.12	4.92	3.48	2.95	2.94	3.22	2.99	1.71	1.63	30.80	20.63

[1] April to September, inclusive. [2] Not including 1909–1912, inclusive.

TABLE 2.—*Monthly, annual, and seasonal precipitation, in inches, at the nine field stations in the southern Great Plains where sorghum experiments were conducted for the years during which these experiments were in progress, with averages for this period and for the whole period covered by the climatic data*—Continued

Station and year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual	Seasonal
Dalhart, Tex.:														
1916	0.44	0	0.12	1.40	0.09	4.11	2.55	3.45	0.72	0.22	0.03	0.37	14.19	13.01
1917	.14	.09	.03	.37	2.70	.03	1.64	2.28	1.28	.31	1.02	0	10.79	9.20
1918	.27	.05	2.85	.80	4.87	1.23	1.49	1.67	1.49	1.87	.25	1.74	18.67	11.64
1919	.09	.06	3.18	3.48	2.75	1.88	2.41	3.45	5.12	2.50	1.14	T.	26.96	19.09
1920	.36	.43	.05	.32	3.25	6.81	2.56	1.33	.81	4.49	.34	.08	20.83	15.08
1921	1.80	.08	.15	.76	3.70	5.82	5.12	.69	.04	.54	0	.26	18.96	16.13
1922	.37	.07	.73	5.20	5.06	3.40	1.57	1.88	.52	.15	.36	.02	19.03	17.63
1923	0	1.03	1.72	4.09	1.78	6.05	.87	6.92	2.10	6.29	1.23	1.32	33.40	21.81
1924	.05	.09	1.61	1.16	2.44	.69	1.32	5.00	1.72	1.01	.24	.03	15.36	12.33
1925	.07	.34	.54	1.12	3.36	1.93	4.09	3.00	4.56	1.16	.35	.14	20.66	18.06
1926	.19	.01	1.00	2.84	3.70	4.00	.68	1.32	2.05	.33	.10	.81	17.03	14.59
Average:														
1916–1926	.34	.34	1.00	1.97	3.12	3.35	2.21	2.62	1.86	1.72	.46	.43	19.71	15.33
1908–1926	.23	.40	.76	2.05	3.03	3.13	2.35	2.40	1.50	1.55	.50	.53	18.43	14.46
Amarillo, Tex.:														
1913	.11	.55	.50	1.76	1.41	2.32	1.80	.61	4.19	.81	1.98	2.84	18.97	12.09
1914	.06	.10	.15	.95	4.43	.84	3.07	2.97	1.07	4.46	T.	1.17	19.27	13.33
1915	.72	1.00	1.00	5.05	1.70	1.04	4.14	5.85	4.69	1.55	.18	.13	27.05	22.47
1916	.36	.02	.57	1.71	.89	2.16	.94	3.82	1.76	2.90	.40	.88	16.43	11.30
1917	.69	.22	.25	.71	2.49	.83	2.08	6.17	2.05	.34	.59	.04	17.06	14.93
1918	1.01	.26	1.00	.48	2.23	1.43	2.23	2.36	.64	2.47	1.16	2.78	18.11	9.37
1919	T.	.73	1.73	2.56	2.08	2.94	1.75	3.21	4.58	.67	1.26	.50	22.01	17.12
Average:														
1913–1919	.42	.50	.76	1.89	2.18	1.65	2.37	3.57	2.71	1.89	.80	1.19	19.90	14.37
1892–1921	.55	.82	.59	1.67	2.97	2.61	2.99	3.21	2.23	1.48	1.00	.87	20.99	15.68
Big Spring, Tex.:														
1915	.45	.15	.83	5.75	.44	1.58	3.43	3.26	2.95	1.33	0	.67	20.84	17.41
1916	.13	0	1.74	2.12	.14	1.59	2.48	4.31	.87	1.30	1.01	.10	15.79	11.51
1917	.28	0	.03	.97	.61	.98	.73	.17	.79	0	.12	0	4.68	4.25
1918	.60	.73	.00	.10	1.10	3.53	.16	.24	1.66	1.99	.74	1.32	12.35	6.88
1919	.57	.06	3.06	1.45	1.43	8.28	.95	3.60	7.43	6.31	.78	.09	34.01	23.14
1920	1.97	.20	.12	.08	5.32	1.33	.91	6.30	.69	1.95	2.22	.20	21.29	14.63
1921	.25	.90	1.15	.11	3.69	2.77	.45	.85	.71	.23	T.	T.	11.11	8.58
1922	.38	.08	1.73	12.77	2.36	2.89	.38	.22	0	1.15	1.35	0	23.31	18.62
1923	.20	3.01	2.16	4.58	1.24	2.01	1.68	.98	1.53	5.31	1.18	1.69	26.26	12.62
1924	.03	.50	.62	.91	3.62	.05	.96	2.03	.68	1.42	.05	.13	11.00	8.25
1925	.15	0	0	4.43	2.09	1.00	1.22	2.96	3.06	3.11	.14	0	18.16	14.76
1926	.98	.06	2.18	2.24	1.96	4.38	2.27	1.62	3.56	3.49	.32	2.19	25.25	16.03
Average:														
1915–1926	.61	.47	1.14	2.90	2.01	2.58	1.30	2.21	1.99	2.30	.66	.53	18.67	13.04
1900–1926	.41	.62	.87	2.28	2.44	2.26	1.98	1.89	2.05	2.20	1.08	.65	18.73	12.90
Chillicothe, Tex.:[1]														
1913	.35	1.90	1.32	1.77	1.01	2.33	.29	.05	4.21	4.71	2.79	5.51	26.24	9.66
1914	T.	.30	1.68	2.40	6.16	1.07	1.76	8.47	1.04	1.44	.41	1.28	26.61	21.50
1915	.34	1.88	1.22	5.13	2.15	6.71	4.07	3.73	3.83	5.07	.15	.53	34.81	25.62
1916	1.00	T.	1.48	3.02	1.62	1.17	.48	1.19	1.77	3.06	1.53	.02	16.34	9.25
1917	.20	.30	.30	.73	2.33	.34	4.05	1.11	2.06	.35	.82	T.	12.59	10.62
1918	.10	.42	1.56	1.15	.95	4.49	.76	.26	3.35	6.35	2.82	3.44	25.65	10.96
1919	.26	.76	2.28	5.27	8.79	2.88	1.22	1.41	2.04	13.23	2.24	.29	41.27	22.21
1920	1.92	.63	1.49	2.41	9.66	1.45	1.39	8.37	3.61	5.42	2.83	.52	39.70	26.89
1921	.31	1.02	1.20	.69	.67	9.60	.06	2.73	1.52	.03	T.	.13	17.06	15.27
Average:														
1913–1921	.50	.80	1.39	2.57	3.64	3.40	1.56	3.04	2.67	1.41	1.51	1.30	20.80	16.89
1907–1921	.43	.90	1.50	2.27	3.49	3.76	1.86	2.54	2.36	3.65	1.59	1.32	25.67	16.28
Tucumcari, N. Mex.:														
1914	.30	.40	.50	2.52	5.24	2.81	3.90	1.06	.72	3.48	T.	1.31	22.24	16.25
1915	.66	.08	.90	4.00	1.59	.71	3.13	2.28	2.94	.67	T.	.27	18.13	14.65
1916	.70	0	.09	1.55	.50	.63	.98	4.43	.50	.78	.29	.32	10.89	8.71
1917	.31	.11	.12	.32	1.82	.90	.74	6.11	2.74	.16	.62	.04	13.99	12.63
1918	.10	.13	.21	1.14	.21	.80	2.54	1.62	2.85	2.00	.51	2.00	14.11	8.56
1919	.04	.32	3.69	3.61	5.84	6.39	3.16	2.53	4.16	2.31	.51	.93	33.40	25.09
1920	.76	.15	.34	.20	2.55	3.91	1.52	1.46	1.44	3.08	.40	0	16.52	11.10
1921	1.56	.32	.83	T.	8.72	5.58	3.65	1.86	.75	.21	0	0	23.76	20.86
1922	.13	.13	1.37	2.64	2.04	1.24	1.65	.67	1.20	.37	.93	0	12.37	9.44
1923	0	.06	1.04	3.35	1.92	3.55	.63	5.64	1.78	7.51	1.69	1.64	20.71	16.57
1924	T.	.19	.00	.63	1.67	2.07	1.93	3.79	1.31	1.09	.04	.47	13.79	11.40
1925	.30	.05	T.	.38	1.85	1.33	3.60	3.36	2.32	1.26	.24	.25	14.43	12.33
1926	.14	.10	2.04	3.13	5.25	1.87	2.24	1.59	1.57	.58	.02	1.23	19.76	15.65
Average:														
1914–1926	.38	.30	.90	1.81	3.02	2.47	2.24	2.70	1.67	1.90	.41	.55	18.71	14.10
1905–1926	.32	.51	.77	1.76	2.26	2.13	2.44	2.86	1.57	1.48	.74	.71	17.55	13.02

[1] Data for Chillicothe taken from Quanah, Tex.

Partial or complete crop failures occurred during the period of the experiments at several stations. Most of the failures at Lawton, Okla., were due to chinch bugs. Dwarf milo was completely destroyed by chinch bugs at Lawton in 1921 and 1922, and practically all grain sorghums were destroyed by the chinch bugs in 1918 and 1925. The failures at Garden City, Kans., in 1925, Big Spring, Tex., in 1924, and Chillicothe, Tex., in 1909, 1910, 1911, 1913, and 1916 were due to drought. The failures at Hays, Kans., in 1916, 1917, and 1918 were caused by drought, the failure in 1913 by both drought and chinch bugs, and that in 1926 by drought and bird damage. The crop of 1918 at Tucumcari, N. Mex., was destroyed by drought. Soil blowing at Tucumcari destroyed some of the earlier sown plots in 1917, 1919, and 1925.

When the plots from all spacings or dates of seeding of any variety failed, the results from the station affected usually were omitted from the tables for that season. When only part of the plots in an experiment failed, however, the yields of the affected plots are given as zero unless the failure was due to soil blowing. The results from plots destroyed by soil blowing were omitted from the tables because soil-blowing injury usually is not a direct result of any particular spacing or date of seeding, although it has occurred at Tucumcari, N. Mex., when the seeding was done too early.

EXPERIMENTAL METHODS

The cultural experiments with grain sorghums were conducted in field plots varying in size from about one-fiftieth to one-tenth of an acre. Most of the plots were 132 feet long and consisted of 2 to 10 rows spaced 40, 42, or 44 inches apart. In some of the spacing experiments the rows were double the above distances apart. The usual plot consisted of 10 rows with the two border rows removed before harvest and only the eight inside rows harvested for yield.

Nearly all of these experiments, except those at Chillicothe, Tex., were conducted in single plots, but in 1926 and occasionally in other years some of the experiments at the other stations were conducted in duplicate, triplicate, or quadruplicate.

In all of the experiments in recent years and in most of the earlier experiments the plots were seeded thickly, and the plants were thinned later to the desired spacing. This was found to be absolutely necessary in the spacing experiments.

The acre yields of grain are all calculated at 56 pounds to the bushel. Other weights have been used previously, however, in publishing some of the results presented in this bulletin. Yield results from the spacing and date-of-seeding experiments are presented from all stations. Agronomic data other than yield, including the heads per plant, size of head, period of growth, forage yields, weight per bushel, etc., are shown only for the experiments at Woodward, Okla., where the experiments have been more extensive or complete or were continued longer than at the other stations.

SPACING EXPERIMENTS

Experiments with distances of spacing with one or more varieties of grain sorghum have been conducted at nine field stations. Dwarf Yellow milo, Dawn, Sunrise, Reed, Blackhull, Dwarf, and Pink kafirs, Standard feterita, and Freed sorghum have been included in these experiments. Data are shown for plots with the plants spaced at different distances apart in the row and also for plots with the rows at different distances apart. Yield data are presented from all stations, but the other agronomic data are shown only from the experiments at Woodward, Okla.

YIELD RESULTS

DWARF YELLOW MILO

The annual and average yields of Dwarf Yellow milo grown in spacing experiments in ordinary rows 40 to 44 inches apart, at eight experiment stations, are shown in Table 3. The 6-inch spacing produced the highest average yields at Dalhart, Tex.; the 12-inch spacing at Garden City, Kans., Lawton, Okla., and Chillicothe, Tex.; the 18-inch spacing at Amarillo, Tex., and Tucumcari, N. Mex.; the 24-inch spacing at Woodward, Okla., and the 30-inch spacing at Big Spring, Tex. At no station were the average yields of the best spacing more than 4 bushels per acre higher than the yields from the poorest spacing, except at Lawton, Okla., where the 1-year results under poor conditions can not be considered significant. This apparent uniformity in yield shows that milo is very adaptable to different spacings. Dwarf Yellow milo suckers freely when space, moisture, and plant food are abundant, but only slightly when these factors are deficient. Not all stalks produce heads, and the percentage of stalks producing heads is very low in extremely dry seasons (*9, 10*). The heads vary greatly in size, depending upon the environment, and this also tends to balance the plant development.

The average for 43 station years at six stations shows the 18-inch spacing for Dwarf Yellow milo to be most productive. The yields were 23.2, 23.7, 25.2, and 23.5 bushels per acre, respectively, for the 6, 12, 18, and 24 inch spacings. The yield differences are small and probably not very significant within this range of spacing. In this average the results from Lawton and Chillicothe are omitted because the crop at Lawton was affected by chinch bugs and the Chillicothe spacings were not comparable with those at the other stations.

DAWN KAFIR

The yields of Dawn kafir in experiments in varying the spacing between plants in the row, at seven stations, are shown in Table 4. The 6-inch spacing produced the highest yields at five of six stations. At Garden City, Kans., where the thickest spacing used was 9 inches, the yields from this spacing were greater than from the 18-inch spacing. At Amarillo, Tex., where rather nonuniform results were obtained, the 18-inch spacing produced higher average yields than other spacings. In comparing the yields from 6, 12, and 18 inch spacings from all stations where these three spacings were included in any year, the average yields obtained in 41 station years are 24 bushels per acre for the 6-inch spacing, 23.6 bushels for the 12-inch spacing, and 22 bushels for the 18-inch spacing. These yields show that the 6-inch spacing is the most productive, on the average, but that the 12-inch spacing is nearly as productive, and the difference in yield between the 6-inch and 18-inch spacings was only 2.1 bushels per acre.

TABLE 3.—*Annual and average yields of Dwarf Yellow milo grown in spacing experiments in ordinary rows at eight experiment stations in the southern Great Plains in stated years*

Station and distance of spacing in row	Acre yield (bushels) in—													
	1914	1915	1916	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	Average
Garden City, Kans.:														
6 inches	----	----	----	----	----	----	----	32.3	20.4	13.4	30.7	7.8	----	20.9
12 inches	----	----	----	----	----	----	----	28.4	30.1	22.2	42.1	1.7	----	24.9
18 inches	----	----	----	----	----	----	----	28.4	15.8	27.6	42.1	1.7	----	23.1
24 inches	----	----	----	----	----	----	----	32.5	13.8	26.3	34.9	4.8	----	22.5
Woodward, Okla.:														
6 inches	----	----	----	21.6	2.6	28.6	20.1	42.5	7.5	8.8	36.4	21.9	50.5	25.0
12 inches	----	----	----	18.5	2.2	17.5	29.8	53.4	8.8	6.3	35.0	27.9	50.9	25.0
18 inches	----	----	----	26.2	4.7	15.5	36.8	53.2	8.3	6.0	36.6	32.1	52.9	27.3
24 inches	----	----	----	20.9	3.4	31.3	39.0	49.8	13.1	6.9	44.2	20.5	52.2	28.7
30 inches	----	----	----	21.8	1.5	24.0	35.3	45.3	7.6	5.5	39.2	26.5	52.1	25.9
Lawton, Okla.:														
6 inches	----	----	----	6.7	----	----	----	----	----	----	----	----	----	6.7
12 inches	----	----	----	0.8	----	----	----	----	----	----	----	----	----	0.8
18 inches	----	----	----	3.6	----	----	----	----	----	----	----	----	----	3.6
24 inches	----	----	----	2.7	----	----	----	----	----	----	----	----	----	2.7
30 inches	----	----	----	2.2	----	----	----	----	----	----	----	----	----	2.2
Dalhart, Tex.:														
6 inches	----	----	----	----	----	54.5	30.1	38.9	8.5	26.0	33.2	35.9	38.0	33.2
12 inches	----	----	----	----	----	53.6	27.9	38.9	12.5	31.6	31.3	21.8	42.0	32.5
18 inches	----	----	----	----	----	54.3	25.2	34.3	11.8	31.6	30.4	22.0	38.8	31.1
24 inches	----	----	----	----	----	52.9	28.4	31.3	11.2	31.4	23.4	24.8	30.3	30.3
30 inches	----	----	----	----	----	50.5	35.7	----	----	----	----	----	----	----
Amarillo, Tex.:														
6 inches	27.1	60.6	7.7	28.6	1.8	52.3	----	----	----	----	----	----	----	[1] 33.2
9 inches	20.2	70.5	7.9	27.1	4.9	----	----	----	----	----	----	----	----	32.9
12 inches	15.3	75.4	16.1	28.3	3.4	63.0	----	----	----	----	----	----	----	33.8
18 inches	21.2	63.7	19.0	35.7	----	64.5	----	----	----	----	----	----	----	34.9
24 inches	----	72.3	20.0	20.1	----	52.4	----	----	----	----	----	----	----	----
Big Spring, Tex.:														
6 inches	----	----	----	----	0	4.5	4.0	19.0	31.4	41.0	8.6	8.0	1.4	13.3
12 inches	----	----	----	----	0	3.6	4.0	28.5	32.6	34.4	10.7	12.3	3.6	14.4
18 inches	----	----	----	----	0	5.9	3.8	23.6	30.0	34.3	13.3	12.3	4.5	14.2
24 inches	----	----	----	----	0	6.1	2.5	26.7	27.2	32.1	11.7	12.3	6.6	13.9
30 inches	----	----	----	----	7.4	4.7	3.8	34.7	24.1	20.8	9.6	11.2	9.5	15.0
36 inches	----	----	----	----	9.4	----	----	----	----	----	----	----	----	----
Tucumcari, N. Mex.:														
6 inches	----	----	----	20.1	----	----	----	31.3	14.5	7.6	22.0	3.6	26.2	17.9
12 inches	----	----	----	26.8	----	----	----	26.6	10.5	9.1	24.4	8.4	19.3	17.9
18 inches	----	----	----	21.4	----	----	----	22.1	14.7	12.6	24.0	9.1	23.2	18.2
24 inches	----	----	----	8.0	----	----	----	18.8	13.1	12.1	18.4	12.5	20.9	14.5
30 inches	----	----	----	7.1	----	----	----	24.3	11.2	12.9	10.1	12.1	20.7	15.3

Station and distance of spacing in row	Acre yield (bushels) in—										
	1907	1908	1909	1910	1911	1913	1914	1915	1916	1917	Average
Chillicothe, Tex.:											
4 inches	34.5	13.9	10.4	10.7	0	0	23.8	30.0	11.4	6.1	14.1
8 inches	31.8	23.4	10.5	13.2	0	0	19.3	26.4	11.2	5.1	14.1
12 inches	26.1	27.9	10.9	16.1	0	0	21.8	28.6	13.9	2.5	14.8
16 inches	31.1	17.9	7.0	11.4	0	0	21.8	27.1	13.2	6.7	13.6

[1] The years 1918 and 1919 are not included in the averages for Amarillo because comparable data for these two years are not available.

MISCELLANEOUS KAFIRS

The annual and average yields from somewhat limited spacing experiments with Sunrise, Reed, Blackhull, Dwarf, and Pink kafir are presented in Table 5. The Sunrise kafir at both Woodward, Okla., and Tucumcari, N. Mex., produced the highest average yields from the 12-inch spacing. Reed kafir produced the highest average yields from the 6-inch spacing at Woodward and Lawton, Okla., but at Tucumcari, N. Mex., slightly higher yields were obtained from the 12-inch than from the 6-inch spacing. Blackhull kafir (C. I. No. 71), grown in a single year at one station, produced the highest yields from the 6-inch spacing. Another strain of Blackhull kafir grown at Chillicothe, Tex., in an earlier series of years produced the highest yields from the 8-inch spacing. Pink kafir at Hays, Kans., produced the highest yields from the 6-inch spacing. A 4-year comparison of Dwarf kafir in 8-inch and 16-inch spacing at Chillicothe, Tex., shows a slightly higher average yield for the 8-inch spacing.

TABLE 4.—*Annual and average yields of Dawn kafir grown in spacing experiments in ordinary rows at seven experiment stations in the southern Great Plains during three or more years from 1912 to 1926, inclusive*

[The data for 1913 are omitted because of crop failure]

Station and distance of spacing in row	Acre yield (bushels) in—														
	1912	1914	1915	1916	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	Average
Hays, Kans.:															
3 inches	37.1														
6 inches	27.5	34.7					33.6	58.2	45.7	15.4	17.4	20.5	36.7		[1] 32.8
9 inches	17.7	23.9													
12 inches		31.0					35.5	58.0	30.8	19.3	25.9	20.3	37.3		32.3
15 inches	24.3														
18 inches		24.3					28.7	47.1	30.6	15.4	21.7	24.8	32.7		28.2
20 inches	24.8														
24 inches		25.5													
30 inches		15.3													
Garden City, Kans.:															
9 inches		2.4	22.8	4.2	11.0	4.1	23.3	45.0	23.9	43.1	30.9	55.5	40.2	24.3	25.5
18 inches		1.6	33.1	9.4	11.8	7.0	23.0	40.0	17.4	38.0	24.9	40.3	30.8	30.5	24.0
Lawton, Okla.:															
6 inches					25.7		45.4	29.0							33.7
12 inches					17.7		38.0	33.0							29.6
18 inches					16.7		30.5	33.8							30.0
24 inches					17.1		25.2	35.4							25.9
30 inches					13.0		21.4	33.6							22.7
Dalhart, Tex.:															
6 inches							26.5	30.1	33.6	0	23.2	44.3	48.4	30.7	30.7
12 inches							28.0	27.0	30.4	6.7	25.0	38.8	47.7	28.2	29.1
18 inches							32.7	24.3	33.9	8.3	24.3	33.0	42.1	25.4	28.0
24 inches							33.9	21.0	27.1	11.2	27.7	29.6	38.6	26.8	27.0
30 inches							21.7	20.8							
Amarillo, Tex.:															
6 inches		9.3	64.5	1.1	15.0	.8	41.6								[2] 26.4
9 inches		10.8	73.0		13.1	1.9	27.2								27.2
12 inches		20.0	73.2	6.2		.8	34.6								
18 inches		20.4	67.2	4.1	10.1	3.5	35.1								29.1
24 inches			59.5		28.7		31.8								
Big Spring, Tex.:															
6 inches						.9	4.7	4.4	15.0	21.1	23.3	1.6	17.7	28.6	13.1
12 inches						1.3	3.3	2.1	21.6	10.3	20.4	5.6	15.4	28.0	13.0
18 inches						2.7	3.1	3.2	13.9	14.1	18.8	7.2	15.6	24.5	11.5
24 inches						3.8	2.8	2.7	17.9	13.0	16.3	5.8	14.6	21.4	11.0
30 inches						4.9	2.0	3.4	12.6	10.5	15.6	8.3	12.3	19.3	9.9
36 inches						4.4									
Tucumcari, N. Mex.:															
6 inches					30.4			17.5	22.5	4.1	14.3	17.7	9.6	26.0	17.8
12 inches					20.9			12.6	19.6	6.5	17.4	20.1	9.4	21.0	17.1
18 inches					25.3			13.5	13.6	8.9	10.8	14.1	15.0	20.0	16.3
24 inches					11.6			12.0	17.1	9.4	21.6	10.5	14.3	18.5	14.5
30 inches					13.5			8.8	12.5	8.5	10.6	11.3	10.3	22.0	13.3

[1] The year 1912 is not included in the averages for Hays, Kans.
[2] The year 1916 is not included in the averages for Amarillo, Tex.

TABLE 5.—*Annual and average yields of miscellaneous varieties of kafir grown in spacing experiments in ordinary rows at five experiment stations in the southern Great Plains in stated years*

SUNRISE KAFIR

Station and distance of spacing in row	Acre yield (bushels) in—										
	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	Average
Woodward, Okla.:											
6 inches	31.3	8.4	27.9	34.4	40.8	11.1	14.3	35.8	26.5	42.9	27.3
12 inches	30.0	10.4	29.7	36.5	40.2	12.9	13.6	33.8	26.7	30.8	27.5
18 inches	32.1	9.1	26.5	36.3	39.4	13.3	15.4	32.8	26.9	32.7	26.5
24 inches	30.2	11.5	28.1	38.0	33.6	13.1	15.8	29.4	24.7	20.7	25.4
30 inches	28.9	11.3	35.1	36.2	30.2	16.2	19.8	29.4	27.6	28.3	26.2
Tucumcari, N. Mex.:											
6 inches								19.5	7.5	25.7	17.6
12 inches								23.0	12.5	25.4	20.3
18 inches								16.9	12.6	21.2	16.9
24 inches								15.0	16.8	17.7	16.5
30 inches								15.5	9.9	19.8	15.1

REED KAFIR

Station and distance of spacing in row	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	Average
Woodward, Okla.:											
6 inches						20.7	24.8	55.4	41.4	47.7	38.0
12 inches						22.3	24.8	41.1	30.7	39.8	31.7
18 inches						20.2	20.0	31.9	28.5	35.6	27.2
24 inches						19.5	17.7	27.8	25.5	30.7	24.2
30 inches						16.8	14.9	16.4	22.3	27.1	19.9
Lawton, Okla.:											
6 inches						1.8	13.2	34.3		30.3	19.9
12 inches						3.5	9.4	31.8		20.8	18.6
18 inches						4.0	9.9	31.3		24.4	17.4
24 inches						4.1	8.9	30.1		21.8	16.2
30 inches						4.1	8.4	25.2		17.9	13.9
Tucumcari, N. Mex.:											
6 inches								28.4	13.8	26.8	23.0
12 inches								32.5	13.4	25.9	23.9
18 inches								23.7	16.1	25.0	21.6
24 inches								18.1	20.6	22.0	20.2
30 inches								16.9	13.0	23.4	17.8

BLACKHULL KAFIR (C. I. No. 71)

Station and distance of spacing in row	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	Average
Lawton, Okla.:											
6 inches					29.8						29.8
12 inches					26.5						26.5
18 inches					20.9						20.9
24 inches					19.1						19.1
30 inches					15.4						15.4

PINK KAFIR

Station and distance of spacing in row	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	Average
Hays, Kans.:[1]											
6 inches			30.3	40.6	58.1	34.8	27.7	30.3	33.6		30.1
12 inches			45.7	32.9	52.0	20.9	29.8	33.9	35.9		37.2
18 inches			35.7	31.8	41.9	21.2	28.1	29.6	47.5		33.7
24 inches			20.1	33.2	43.5	26.0	26.3	30.5	30.4		32.1

DWARF KAFIR

Station and distance of spacing in row	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	Average
Chillicothe, Tex.:											
8 inches			25.6	20.5	22.8	7.7					21.4
16 inches			24.8	30.1	16.3	13.4					21.2

[1] These experiments were conducted by the Office of Forage Crops and Diseases, and the results from 1919 to 1922, inclusive, were reported in Department Bulletin No. 1260 (*14*). The results from 1923 to 1925, inclusive, were supplied by courtesy of the Office of Forage Crops and Diseases.

TABLE 5.—*Annual and average yields of miscellaneous varieties of kafir grown in spacing experiments in ordinary rows at five experiment stations in the southern Great Plains in stated years*—Continued

BLACKHULL KAFIR

Station and distance of spacing in rows	Acre yield (bushels) in—									
	1907	1908	1909	1910	1911	1913	1914	1915	1916	1917	Average
Chillicothe, Tex.:											
4 inches	----	27.1	0	0	0	0	6.8	26.4	0	11.2	7.9
8 inches	31.3	31.3	0	0	0	0	10.4	28.6	0	16.8	11.8
12 inches	29.8	27.7	0	0	0	0	10.7	27.9	0	9.8	10.8
16 inches	30.0	29.6	0	0	0	0	12.1	21.4	0	7.0	10.0

FETERITA

The yields of the ordinary Standard feterita in plant-spacing experiments are found in Table 6. In one 2-year experiment at Hays, Kans., the 9-inch spacing outyielded the 15-inch spacing. In another 5-year experiment the 8-inch spacing outyielded all others. At Chillicothe, Tex., a 10-year comparison of 8-inch and 16-inch spacing shows that the 8-inch spacing was the more productive, but in three years at Woodward, Okla., of the 6, 12, and 18 inch spacing the 18-inch spacing was most productive. In general it appears that feterita will produce the highest yields from spacings of about 8 or 9 inches.

TABLE 6.—*Annual and average yields of feterita grown in spacing experiments in ordinary rows at three experiment stations in the southern Great Plains during stated years*

[The data for 1923 are omitted because of crop failure]

Station and distance of spacing in row	Acre yield (bushels) in—													
	1912	1913	1914	1915	1916	1917	1918	1919	1920	1921	1922	1924	1925	1926	Average
Hays, Kans.:															
3 inches	28.0	----	----	----	----	----	----	----	----	----	----	----	----	----	----
4 inches	----	----	----	35.4	----	----	----	----	----	----	----	----	----	----	----
6 inches	32.1	----	----	----	----	----	----	----	----	----	----	----	----	----	----
9 inches	23.0	----	----	48.6	----	----	----	----	----	----	----	----	----	----	35.8
15 inches	17.7	----	----	22.6	----	----	----	----	----	----	----	----	----	----	20.1
20 inches	13.4	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Hays, Kans.:[1]															
4 inches	----	----	24.6	34.9	5.0	17.5	12.1	----	----	----	----	----	----	----	18.8
8 inches	----	----	28.9	33.0	10.5	13.2	19.2	----	----	----	----	----	----	----	21.1
12 inches	----	----	20.6	26.0	6.4	15.0	18.8	----	----	----	----	----	----	----	18.9
16 inches	----	----	28.3	22.1	5.4	15.0	18.2	----	----	----	----	----	----	----	17.8
24 inches	----	----	21.5	18.4	6.1	10.4	13.9	----	----	----	----	----	----	----	14.1
Woodward, Okla.:															
6 inches	----	----	----	----	----	----	----	----	----	----	----	23.1	20.4	30.3	24.6
12 inches	----	----	----	----	----	----	----	----	----	----	----	27.9	18.4	30.3	25.5
18 inches	----	----	----	----	----	----	----	----	----	----	----	30.5	18.9	33.8	27.8
24 inches	----	----	----	----	----	----	----	----	----	----	----	----	10.2	33.2	----
30 inches	----	----	----	----	----	----	----	----	----	----	----	----	19.7	34.8	----
Chillicothe, Tex.:															
4 inches	----	1.9	----	27.1	21.4	10.5	----	----	----	----	----	----	----	----	----
8 inches	----	2.8	----	28.2	10.5	8.1	1.5	39.0	37.0	30.7	28.8	----	----	----	[2] 27.3
12 inches	----	3.8	----	26.4	10.3	10.0	----	----	----	----	----	----	----	----	----
16 inches	----	3.1	----	23.6	17.2	10.6	1.8	37.2	34.7	29.1	26.4	----	----	----	[2] 25.5

[1] These yields were obtained in experiments conducted by the Office of Forage Crops and Diseases and reported in Department Bulletin No. 1280 (*14*).
[2] Seven year averages, 1915–1917, and 1919–1922.

FREED SORGHUM

The annual and average yields of Freed sorghum grown in a plant-spacing experiment at Chillicothe, Tex., are shown in Table 7. The yield from the 12-inch spacing was the highest.

TABLE 7.—*Annual and average yields of Freed sorghum grown in spacing experiments at Chillicothe, Tex., 1913 to 1917, inclusive*

Spacing	Acre yield (bushels) in—					
	1913	1914	1915	1916	1917	Average
4 inches	0	11.4	23.4	19.9	14.4	13.8
8 inches	0	14.3	22.1	19.0	7.1	12.5
12 inches	0	16.4	20.1	18.0	10.0	14.3

AGRONOMIC DATA

DWARF YELLOW MILO

The more important agronomic data obtained in the experiments on spacing Dwarf Yellow milo plants within the row at Woodward, Okla., are shown in Table 8.

TABLE 8.—*Annual and average agronomic data obtained in a spacing experiment with Dwarf Yellow milo grown in 44-inch rows at Woodward, Okla., from 1917 to 1926, inclusive*

ACTUAL SPACING (INCHES)

Spacing in row	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	Average
6 inches	9.90	8.04	5.93	6.12	6.00	6.26	6.51	6.19	6.61	6.52	6.81
12 inches	14.40	13.77	12.06	12.30	12.03	12.15	12.50	12.27	11.94	12.09	12.55
18 inches	19.88	22.30	18.08	18.36	18.00	17.40	18.20	18.12	17.42	18.72	18.64
24 inches	25.05	24.82	23.92	24.18	23.97	23.56	24.95	24.36	23.87	24.88	24.30
30 inches	28.28	30.64	28.96	29.61	30.23	29.55	29.82	30.23	29.38	29.53	29.62

HEADS PER PLANT

Spacing in row	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	Average
6 inches	1.30	0.57	1.02	1.06	1.21	0.38	0.50	1.00	1.17	1.32	0.98
12 inches	1.77	.70	1.28	2.07	2.20	.66	.73	1.21	2.04	2.07	1.49
18 inches	2.47	2.17	1.62	3.17	2.87	.84	1.09	1.72	3.16	2.67	2.17
24 inches	2.77	1.75	2.46	3.52	3.12	1.56	1.79	2.56	3.56	2.81	2.50
30 inches	2.95	1.36	2.71	3.18	3.03	1.30	2.01	2.68	3.52	2.74	2.55

GRAIN PER HEAD (POUND)

Spacing in row	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	Average
6 inches	0.061	0.014	0.065	0.066	0.083	0.023	0.021	0.088	0.050	0.098	0.057
12 inches	.059	.015	.065	.070	.110	.045	.020	.130	.064	.117	.070
18 inches	.083	.019	.068	.083	.131	.057	.030	.151	.070	.151	.084
24 inches	.074	.019	.110	.105	.150	.077	.041	.165	.070	.182	.100
30 inches	.082	.013	.101	.129	.177	.079	.049	.174	.087	.221	.111

GRAIN PER PLANT (POUND)

Spacing in row	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	Average
6 inches	0.085	0.008	0.066	0.070	0.099	0.009	0.011	0.088	0.057	0.129	0.062
12 inches	.104	.012	.083	.145	.252	.030	.015	.168	.131	.242	.118
18 inches	.205	.041	.110	.263	.376	.049	.033	.260	.221	.388	.195
24 inches	.205	.033	.203	.370	.468	.120	.073	.422	.249	.511	.274
30 inches	.242	.018	.274	.410	.536	.103	.098	.466	.308	.606	.306

TABLE 8.—*Annual and average agronomic data obtained in a spacing experiment with Dwarf Yellow milo grown in 44-inch rows at Woodward, Okla., from 1917 to 1926, inclusive*—Continued

Spacing in row	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	Average
HEADS PER ACRE											
6 inches	20,016	10,107	24,621	24,892	28,750	8,054	10,950	23,031	25,233	28,862	20,482
12 inches	17,523	8,179	15,131	23,901	27,137	7,744	8,326	14,059	24,358	24,409	17,086
18 inches	17,712	13,873	12,774	24,004	22,730	6,882	8,538	13,533	25,861	19,571	16,617
24 inches	15,783	10,052	14,662	20,754	18,555	9,440	10,228	14,981	21,260	16,101	15,182
30 inches	14,871	6,328	13,341	15,312	14,289	6,271	9,610	12,639	17,079	13,229	12,297
DAYS FROM PLANTING TO MATURITY											
6 inches	130	96	114	104	106	117	138	117	106	102	114
12 inches	130	96	115	108	109	117	138	118	106	106	115
18 inches	139	96	117	111	109	117	138	120	106	106	116
24 inches	139	96	125	111	109	117	138	122	106	106	117
30 inches	139	96	125	111	109	117	138	122	106	106	117
HEIGHT OF PLANTS (FEET)											
6 inches	3.3	2.8	4.0	3.9	4.8	2.4	2.2	4.3	3.8	5.1	3.7
12 inches	3.0	3.0	3.5	3.7	5.0	2.6	2.0	3.7	3.7	5.2	3.5
18 inches	4.0	3.0	3.3	3.8	5.0	2.5	2.0	3.6	3.8	5.0	3.6
24 inches	3.5	3.0	3.3	4.0	4.5	2.3	2.2	3.7	3.9	4.8	3.5
30 inches	3.0	2.8	3.3	3.6	4.3	2.3	2.3	3.6	3.9	4.6	3.4
ERECT HEADS (PER CENT)											
6 inches	49	100	100	100	96	100	93	93	100	79	91
12 inches	52	100	100	100	70	99	86	89	100	61	86
18 inches	51	100	97	99	58	99	85	71	100	48	81
24 inches	53	100	94	95	51	97	92	55	100	38	78
30 inches	46	100	96	96	44	94	91	47	99	39	75
ACRE YIELDS OF GRAIN (BUSHELS)											
6 inches	21.6	2.6	28.6	29.1	42.5	7.5	8.8	36.4	21.9	50.5	25.0
12 inches	18.5	2.2	17.5	20.8	53.4	8.8	6.3	35.0	27.9	50.9	25.0
18 inches	26.2	4.7	15.5	36.8	53.2	8.3	6.6	36.6	32.1	52.9	27.3
24 inches	20.0	3.4	31.3	30.0	49.8	13.1	6.9	44.2	26.5	52.2	28.7
30 inches	21.8	1.5	24.0	35.3	45.3	7.6	5.5	39.2	26.5	52.1	25.0
ACRE YIELDS OF FORAGE (TONS)											
6 inches	2.25	1.07	2.84	3.49	3.65				2.69	3.77	2.82
12 inches	2.30	.73	2.13	3.41	3.92				3.20	3.68	2.77
18 inches	2.70	1.20	1.75	4.56	3.66				3.31	3.77	2.90
24 inches	2.28	1.03	2.03	3.99	3.11				2.84	3.65	2.79
30 inches	2.05	.73	2.23	3.69	2.83				2.67	3.65	2.55
WEIGHT PER BUSHEL (POUNDS)											
6 inches			60	55	59	57.5	52	58.5	57	58.3	57.2
12 inches		55.5	60	55	59	57.0	53	59.5	57	58.5	57.2
18 inches			58	56	59	57.5	53	59.5	57	57.5	57.2
24 inches			59	56	60	57.5	53	59.0	58	57.8	57.5
30 inches			59	57	59	57.5	53	58.5	58	57.7	57.5

The actual spacings obtained were close to the intended spacings except in 1917 and 1918, when the thicker spacings were too thin. The average number of heads per plant increased with spacing up to 24 inches. The increase in the number of heads was not in proportion to the wider spacing, however, so the number of heads per acre decreased with the increased spacing. The greatest average number of heads per plant in any experiment was 3.56.

The weight of grain per head increased with the spacing but not in proportion to it. The average weight of grain per 100 heads of Dwarf Yellow milo from the plots in the spacing experiments varied from 1.3 pounds to 22.1 pounds. The weight of grain per plant increased about in proportion to the spacing up to a spacing of 24 inches. The smaller increase in the yield per plant of plants spaced 30 inches over the yields from plants spaced 24 inches apart resulted in a decreased yield per acre. Under the conditions of these experiments the maximum yield of Dwarf Yellow milo can not be obtained when plants are spaced more than 24 inches apart in 44-inch rows, or, in other words, with fewer than about 6,000 plants per acre.

The crop from the 24-inch and 30-inch spacings matured, on an average, three days later than that from the 6-inch spacing. The plants from the 6-inch spacing were the tallest, owing to the crowding.

The percentage of erect heads decreased with the spacing and was highest in dry seasons when the heads were small. In plots having all heads erect the average head contained 0.07 pound or less of grain. In all cases but one in which all of the heads were erect the yields were less than 30 bushels per acre. Erect heads resulting from close spacing are obtained at a sacrifice both in yield per acre and in the size of heads. The crop from a smaller number of large, partly recurved heads probably can be harvested more easily than the numerous small erect heads on thickly spaced plants, so there appears to be no advantage in thick spacing for milo.

The total or forage yield of milo at Woodward was greatest from the 18-inch spacing.

There was only 0.3 pound difference in the average weight per bushel of milo from the different spacings, which shows that the spacing of the plants has only a slight effect on the plumpness or weight of kernels.

SUNRISE KAFIR

The agronomic data for Sunrise kafir in the experiments on spacing in the row at Woodward are shown in Table 9. The effects of spacing on the development of the plants are very similar to those shown for milo.

The average and the maximum numbers of heads per plant of Sunrise kafir were greater than for Dwarf Yellow milo, and the size of heads was about the same in the same spacings. The number of heads per plant and the weight of grain per head and per plant increased with the spacing, but not in proportion to the spacing.

The fact that there was only one day's difference in time of maturity between the thickest and thinnest spaced crops shows that the increased suckering in this variety did not delay maturity appreciably. The plants in the thinner spacings were slightly taller than those in the thick spacings.

The forage yields show a gradual decrease with increased spacing.

The plumpness or weight of grains from the 30-inch spacing was slightly greater than from the 6-inch spacing, the increase amounting to 0.5 pound per bushel.

TABLE 9.—*Annual and average agronomic data obtained in a spacing experiment with Sunrise kafir grown in 44-inch rows at Woodward, Okla., from 1917 to 1925, inclusive*

Spacing in row	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	Average
ACTUAL SPACING (INCHES)											
6 inches	7.21	8.90	6.05	5.94	6.10	0.49	6.29	0.07	6.79	0.40	6.62
12 inches	13.09	12.48	11.76	12.03	12.00	12.77	12.38	11.97	12.61	12.09	12.32
18 inches	18.40	17.80	15.96	17.02	18.00	18.22	18.26	18.08	18.10	18.97	17.97
24 inches	24.52	23.56	23.50	23.29	24.52	23.74	23.74	24.53	24.29	20.07	24.18
30 inches	28.80	29.34	29.88	20.12	30.00	29.33	28.38	30.05	29.83	28.77	29.35
HEADS PER PLANT											
6 inches	1.64	0.80	1.07	1.23	1.12	0.89	0.87	1.23	1.06	1.21	1.11
12 inches	2.81	1.08	1.45	2.37	1.81	1.31	1.31	2.00	1.49	1.68	1.73
18 inches	3.51	1.49	1.63	3.28	2.46	1.83	1.71	2.60	1.09	1.98	2.25
24 inches	4.02	2.31	2.67	3.00	2.25	2.19	1.90	2.91	2.20	1.87	2.59
30 inches	4.16	2.27	3.18	3.92	2.27	2.71	2.50	3.00	2.00	1.89	2.86
GRAIN PER HEAD (POUND)											
6 inches	0.054	0.036	0.062	0.066	0.087	0.032	0.041	0.069	0.067	0.089	0.060
12 inches	.057	.047	.094	.073	.105	.049	.051	.079	.089	.112	.076
18 inches	.066	.043	.102	.078	.113	.052	.064	.090	.096	.123	.083
24 inches	.072	.046	.097	.097	.144	.056	.078	.097	.107	.103	.096
30 inches	.079	.057	.130	.106	.157	.064	.088	.116	.125	.109	.109
GRAIN PER PLANT (POUND)											
6 inches	0.080	0.029	0.066	0.081	0.097	0.028	0.036	0.055	0.071	0.108	0.069
12 inches	.160	.051	.136	.173	.190	.054	.067	.158	.133	.188	.132
18 inches	.232	.064	.166	.256	.278	.095	.109	.234	.191	.244	.187
24 inches	.289	.106	.250	.349	.324	.123	.148	.282	.235	.305	.242
30 inches	.329	.129	.413	.416	.356	.173	.220	.348	.325	.319	.303
HEADS PER ACRE											
6 inches	32,428	12,814	25,213	20,250	26,174	10,550	19,719	28,888	22,256	26,953	24,325
12 inches	30,004	12,337	17,577	28,085	21,503	14,625	15,085	23,820	16,844	19,811	20,029
18 inches	27,195	11,933	14,550	28,092	19,483	14,318	13,350	20,501	15,673	14,880	17,798
24 inches	23,372	13,966	16,196	22,036	13,082	13,151	11,410	16,913	12,912	10,225	15,326
30 inches	20,592	11,030	16,172	19,192	10,787	13,173	12,558	14,232	12,425	9,365	13,853
DAYS FROM PLANTING TO MATURITY											
6 inches	143	109	107	106	109	132	132	111	113	110	117
12 inches	143	109	107	108	111	132	132	111	113	112	118
18 inches	143	109	110	108	113	132	132	111	113	112	118
24 inches	143	109	110	108	113	132	132	111	113	112	116
30 inches	143	109	110	108	113	132	130	111	113	112	118
HEIGHT OF PLANTS (FEET)											
6 inches	6.3	4.5	5.5	5.8	6.6	4.2	4.3	5.1	5.3	6.7	5.4
12 inches	6.0	4.3	5.5	5.5	6.8	4.3	4.3	5.2	5.1	6.6	5.4
18 inches	6.3	4.3	5.0	5.7	6.5	4.5	4.3	5.6	5.4	6.7	5.4
24 inches	6.0	4.3	5.3	5.7	6.3	4.7	4.5	5.7	5.7	6.7	5.5
30 inches	6.0	4.5	5.5	5.9	6.2	4.9	4.7	5.7	5.3	6.8	5.6
ACRE YIELDS OF GRAIN (BUSHELS)											
6 inches	31.3	8.4	27.9	34.4	40.8	11.1	14.3	35.8	26.5	42.9	27.3
12 inches	30.9	10.4	29.7	36.5	40.2	12.9	13.8	33.8	26.7	30.8	27.5
18 inches	32.1	9.1	26.5	30.3	39.4	13.3	15.4	32.8	26.9	32.7	26.5
24 inches	30.2	11.5	28.1	38.0	33.6	13.1	15.8	29.4	24.7	29.7	25.4
30 inches	28.9	11.3	35.1	36.3	30.2	15.2	19.8	29.4	27.6	28.3	26.2

TABLE 9.—*Annual and average agronomic data obtained in a spacing experiment with Sunrise kafir grown in 44-inch rows at Woodward, Okla., from 1917 to 1926, inclusive*—Continued

ACRE YIELDS OF FORAGE (TONS)

Spacing in row	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	Average
6 inches	4.07	1.91	2.72	3.15	3.35	1.78	2.25	3.85	2.93	4.10	3.08
12 inches	4.67	2.00	2.53	3.44	3.57	1.86	1.93	3.50	2.78	3.88	3.02
18 inches	4.40	2.18	2.10	3.21	3.18	1.96	1.99	3.38	3.07	3.60	2.91
24 inches	4.18	2.23	2.53	2.09	2.83	1.90	1.93	3.15	2.87	2.70	2.74
30 inches	3.68	2.00	2.73	2.80	2.35	2.03	2.61	2.70	3.01	2.68	2.85

WEIGHT PER BUSHEL (POUNDS)

Spacing in row	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	Average
6 inches			60	59.0	61.5	56.0	57	62.0	60	61	59.6
12 inches		56	61	59.5	61.5	57.0	58	61.5	60	61	59.5
18 inches			61	59.0	61.5	57.0	58	61.5	60	61	59.9
24 inches			61	59.5	61.5	57.0	58	61.0	60	61	59.9
30 inches			61	60.0	61.5	57.5	58	61.0	61	61	60.1

REED KAFIR

The agronomic data for Reed kafir grown in spacing experiments during five years at Woodward, Okla., are shown in Table 10.

TABLE 10.—*Annual and average agronomic data obtained in a spacing experiment with Reed kafir grown in 44-inch rows at Woodward, Okla., from 1922 to 1926, inclusive*

ACTUAL SPACING (INCHES)

Spacing in row	1922	1923	1924	1925	1926	Average
6 inches	5.96	5.98	6.24	8.06	6.59	6.57
12 inches	12.06	12.22	12.52	14.72	12.12	12.73
18 inches	18.32	17.27	18.08	18.72	18.70	18.22
24 inches	23.97	23.20	24.87	24.63	24.05	24.34
30 inches	30.23	28.50	34.21	30.80	29.61	30.69

HEADS PER PLANT

Spacing in row	1922	1923	1924	1925	1926	Average
6 inches	0.85	0.98	1.10	1.05	1.09	1.01
12 inches	.99	1.02	1.15	1.12	1.13	1.08
18 inches	1.05	1.02	1.18	1.12	1.18	1.11
24 inches	1.10	1.08	1.27	1.13	1.13	1.16
30 inches	1.14	1.18	1.26	1.20	1.15	1.19

GRAIN PER HEAD (POUND)

Spacing in row	1922	1923	1924	1925	1926	Average
6 inches	0.057	0.059	0.123	0.125	0.113	0.095
12 inches	.107	.117	.176	.159	.165	.145
18 inches	.138	.133	.192	.187	.221	.174
24 inches	.154	.150	.214	.219	.207	.201
30 inches	.175	.142	.190	.225	.274	.202

GRAIN PER PLANT (POUND)

Spacing in row	1922	1923	1924	1925	1926	Average
6 inches	0.046	0.058	0.135	0.131	0.123	0.099
12 inches	.106	.119	.202	.178	.186	.158
18 inches	.145	.136	.227	.209	.261	.196
24 inches	.183	.162	.273	.247	.302	.233
30 inches	.200	.168	.247	.270	.315	.240

HEADS PER ACRE

Spacing in row	1922	1923	1924	1925	1926	Average
6 inches	20,331	23,362	25,131	18,571	23,580	22,195
12 inches	11,703	11,899	13,095	10,847	13,291	12,167
18 inches	8,171	8,420	9,304	8,529	8,996	8,684
24 inches	7,077	6,611	7,280	6,548	6,457	6,793
30 inches	5,376	5,883	5,250	5,550	5,537	5,519

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TABLE 10.—*Annual and average agronomic data obtained in a spacing experiment with Reed kafir grown in 44-inch rows at Woodward, Okla., from 1922 to 1926, inclusive*—Continued

DAYS FROM PLANTING TO MATURITY

Spacing in row	1922	1923	1924	1925	1926	Average
6 inches	132	108	106	103	108	111
12 inches	132	108	107	103	108	112
18 inches	132	108	108	103	110	112
24 inches	132	105	109	103	115	113
30 inches	132	108	111	103	115	114

HEIGHT OF PLANTS (FEET)

Spacing in row	1922	1923	1924	1925	1926	Average
6 inches	4.2	4.3	5.1	4.3	6.1	4.8
12 inches	4.1	4.2	4.8	4.2	5.6	4.6
18 inches	4.1	4.2	4.8	4.2	5.5	4.6
24 inches	4.1	4.2	4.8	4.3	5.3	4.5
30 inches	4.1	4.2	4.7	4.2	5.3	4.5

ACRE YIELDS OF GRAIN (BUSHELS)

Spacing in row	1922	1923	1924	1925	1926	Average
6 inches	20.7	24.8	55.4	41.4	47.7	38.0
12 inches	22.3	24.6	41.1	30.7	39.8	31.7
18 inches	20.2	20.0	31.0	28.5	35.6	27.2
24 inches	19.5	17.7	27.6	25.5	30.7	24.2
30 inches	16.8	14.0	18.4	22.3	27.1	19.9

ACRE YIELDS OF FORAGE (TONS)

Spacing in row	1922	1923	1924	1925	1926	Average
6 inches	2.07	2.16	4.39	3.32	4.80	3.45
12 inches	2.12	1.66	3.02	2.81	4.21	2.80
13 inches	1.83	1.48	2.31	2.59	3.44	2.33
24 inches	1.67	1.39	1.98	2.11	2.95	2.01
30 inches	1.48	1.13	1.38	1.88	2.69	1.71

WEIGHT PER BUSHEL (POUNDS)

Spacing in row	1922	1923	1924	1925	1926	Average
6 inches	56.0	55.0	61.5	60	60.3	58.6
12 inches	57.5	56.0	61.5	59	60.5	58.9
18 inches	57.5	58.5	61.5	59	60.8	59.5
24 inches	58.5	58.5	62.0	60	61.0	60.0
30 inches	58.0	58.5	62.0	59	61.0	59.7

This variety produced only slightly more than one head per plant with the thinnest spacing, which shows its inability to tiller to any extent. The size of heads increased with the spacing but not in proportion to it. The size of the Reed kafir heads was larger than that of Dwarf Yellow milo or Sunrise kafir.

The weight of grain per plant increased with spacing to a less extent than that necessary to maintain the yields, and, consequently, the yields per acre show a sharp and consistent decrease with the greater spacings.

The crop from the 30-inch spacing matured, on an average, three days later than that from the 6-inch spacing and was 0.3 foot shorter in height.

The forage yields decreased rapidly with the increased spacing.

The weight per bushel of grain from the three thinner spacings was slightly greater than that from the two thicker spacings.

EFFECT OF VARIETY

The results previously shown indicate that there are considerable differences in the optimum spacing of varieties of grain sorghum. Dwarf Yellow milo plants require more space for best development than do those of feterita and the kafirs. The best spacings appear to be about 18 inches for milo, 9 inches for feterita, 12 inches for Sunrise kafir, and 6 inches for other kafirs and Freed sorghum. The spacings required, except for Freed, are in direct proportion to the number of stalks produced per plant. This relationship has been noted previously by Sieglinger (*11*).

Varieties that sucker freely are able to adapt themselves to a considerable variation in spacing without affecting materially the yields of grain. The highest forage yields of all grain sorghums, except sometimes the milos, may be expected from spacings of not to exceed 6 inches between plants.

The increased quantity of seed per acre required to obtain thick stands is so small that it may be neglected in considering the relative values of the yields obtained.

The space required for a given variety is determined by two plant characters, viz, the ability to produce more tillers and the ability to produce larger heads, when the space per plant is increased. These characters are shown for Dwarf Yellow milo, Sunrise kafir, and Reed kafir by data from Woodward, Okla.

By dividing the average number of heads per plant from the 24-inch spacing by the number from the 6-inch spacing, a figure is obtained which may be referred to as the "tillering index." The tillering indexes for Dwarf Yellow milo, Sunrise kafir, and Reed kafir at Woodward are 2.70, 2.33, and 1.15, respectively. Similar calculations for the weight of grain per head show values, or "fruiting indexes," of 1.75, 1.60, and 2.12, respectively, for Dwarf milo, Sunrise kafir, and Reed kafir. The tillering indexes are approximately in the order of the optimum spacing, but the fruiting indexes are not. The products of the two indexes are approximately 4.7, 3.7, and 2.4 for Dwarf milo, Sunrise kafir, and Reed kafir, respectively. These values or "spacing indexes" are in the order of the optimum spacing for the three varieties. The spacing index for a given variety varies with environmental conditions, being higher for dry conditions than those shown and lower for favorable moist conditions, where spacing is a less important factor in determining yield. The spacing indexes appear to maintain about the same rank for varieties, however, regardless of the season.

The optimum spacing for any variety probably can be determined by growing it in 6-inch and 24-inch spacings, in comparison with varieties whose optimum spacing is known, and then determining the spacing index. If the index lies between those of Sunrise and Reed kafir, for example, the optimum spacing for general conditions will lie between 6 and 12 inches. Tillering and variations in fruiting will compensate for minor deviations from the optimum spacing.

EFFECT OF MOISTURE

The low yields of grain from grain-sorghum plants closely spaced in the row in dry seasons [3] have long been observed. Many of the stalks fail to produce heads, and the heads are small when the plants are crowded and moisture is deficient. The results here presented show that the detrimental effect of crowding the milo plants is apparent in favorable seasons also.

The yields of Dwarf Yellow milo under different moisture conditions are shown graphically in Figure 3. It will be seen that the highest, or as high as any, average yields were secured from the 18-inch spacing regardless of whether the season was wet, dry, or of medium moisture. Narrower spacings produced slightly decreased

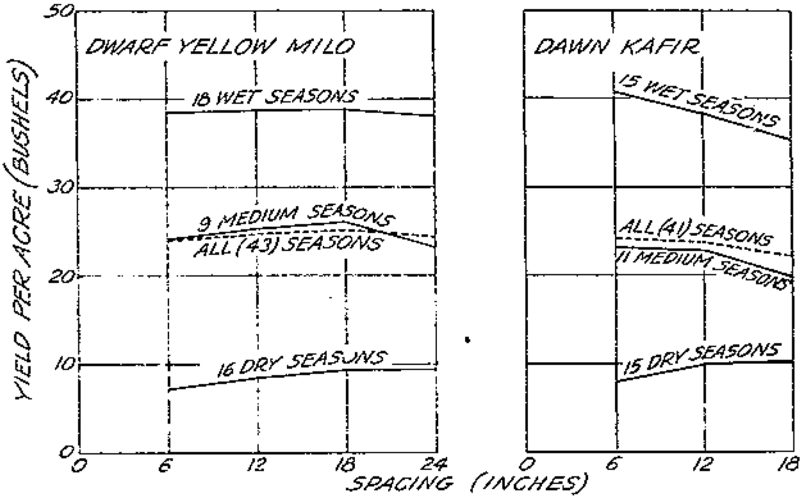


FIGURE 3.—Average yields of Dwarf Yellow milo grown in 6, 12, 18, and 24 inch spacings and Dawn kafir grown in 6, 12, and 18 inch spacings in wet, medium, and dry seasons and also in all seasons

yields regardless of the type of season, and wider spacings than 18 inches also resulted in slightly decreased yields. The yield differences between spacings ranging from 6 to 24 inches are not important in wet, medium, or dry seasons, which shows that considerable latitude in spacing is permissible.

[3] The seasons were classified on the basis of the yields as affected by the moisture supply. Most of the seasons at each station were discussed by Chilcott (1). In general the yields of grain during seasons classified as dry were less than 20 bushels per acre, in seasons of medium moisture 20 to 30 bushels, and in wet seasons over 30 bushels per acre. For Dwarf Yellow milo the dry seasons were as follows: Garden City, Kans., 1925; Woodward, Okla., 1918, 1922, and 1923; Dalhart, Tex., 1922; Amarillo, Tex., 1916; Big Spring, Tex., 1918, 1919, 1920, 1924, 1925, and 1926; and Tucumcari, N. Mex., 1917, 1922, 1923, and 1925. The seasons of medium moisture were the following: Garden City, Kans., 1922 and 1923; Woodward, Okla., 1919; Dalhart, Tex., 1923; Amarillo, Tex., 1917; Big Spring, Tex., 1921; and Tucumcari, N. Mex., 1921, 1924, and 1926. Wet seasons were as follows: Garden City, Kans., 1921 and 1924; Woodward, Okla., 1917, 1920, 1921, 1924, 1925, and 1926; Dalhart, Tex., 1919, 1920, 1921, 1924, 1925, and 1926; Amarillo, Tex., 1915, and 1919; and Big Spring, Tex., 1922 and 1923.

For Dawn kafir the following were the dry seasons: Hays, Kans., 1922; Dalhart, Tex., 1922; Amarillo, Tex., 1914, 1916, and 1918; Big Spring, Tex., 1918, 1919, 1920, 1924, and 1925; and Tucumcari, N. Mex., 1920 and 1922 to 1925, inclusive. The following were midmoisture seasons: Hays, Kans., 1923 and 1924; Lawton, Okla., 1917; Dalhart, Tex., 1923; Big Spring, Tex., 1921, 1922, 1923, and 1926; and Tucumcari, N. Mex., 1917, 1921, and 1926. The wet seasons for Dawn kafir were the following: Hays, Kans., 1914, 1919, 1920, 1921, and 1925; Lawton, Okla., 1919 and 1920; Dalhart, Tex., 1919, 1920, 1921, 1924, 1925, and 1926; Amarillo, Tex., 1915 and 1919.

Similar graphs for Dawn kafir also are shown in Figure 3. The trend in dry seasons is similar to that of milo, but the wet and average seasons favor the thickest spacing of 6 inches. The difference between the 6-inch and the 12-inch spacings in average seasons is hardly significant, however. The 12-inch spacing yielded practically as well as the 18-inch spacing in dry seasons. The most desirable stand where drought is likely to occur probably is one which produces a high yield in average seasons without a risk of failure of grain in dry seasons. This objective will be secured with stands having plants spaced between 6 and 12 inches apart in the row.

EFFECT OF INSECT INJURY

The results just presented apply to the principal grain-sorghum producing sections in the southern Great Plains. In southern Texas and in the other Gulf States the chief factor inhibiting grain-sorghum production probably is the sorghum midge (*Contarinia sorghicola*). In Texas, at the United States San Antonio Field Station, the best yields of milo have been obtained by thick seeding (*6*). This is due to the uniformly early heading of the closely spaced plants. The grain in the later-blooming heads on the sucker stalks usually is destroyed by the midge. The injury caused by this insect prevents the milo from being grown at what would otherwise be the optimum spacing.

DOUBLE SPACING OF ROWS

The growing of grain sorghums in rows spaced double the usual distance apart is a frequent practice in the southern Great Plains. Sometimes the double space (80 to 88 inches) is left only between pairs of normally spaced rows. The chief reason for the widely spaced rows is to allow the plants more space and to permit the crop to produce heads and grain with a limited supply of moisture. Widely spaced rows also may facilitate hand harvesting by producing larger heads. The yields of crops following sorghums in widely spaced rows usually are greater than the yields that follow sorghums in ordinary rows, perhaps partly because more moisture is left in the soil and partly because less of the total soil area contains any of the inhibiting effects of sorghum on other crops.

DWARF YELLOW MILO

The yields obtained from Dwarf Yellow milo in widely spaced rows at three stations are shown in Table 11. The average yields from the same number of plants per acre grown in ordinary rows are shown for comparison. Thus the average yield from the 6-inch spacing in widely spaced rows is compared with the average for the 12-inch spacing in ordinary rows during the same years. All comparisons show lower yields from the widely spaced rows except in the 15-inch plant spacing at Dalhart, Tex., the 6-inch and 9-inch spacings at Amarillo, Tex., and the 6-inch spacing at Woodward, Okla.

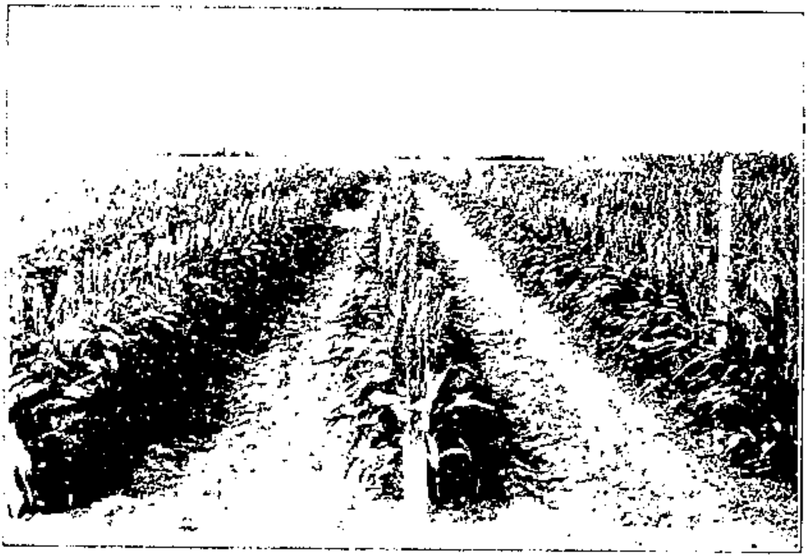
The weighted average yields for all spacings within a row during 12 station years are 32.1 bushels per acre for the wide spacing of rows and 32.7 bushels for the ordinary spacing. This decrease of 0.6 bushel, or nearly 2 per cent, occurred during better-than-average seasons. During extremely dry seasons the yields usually are in favor of the widely spaced rows. If this experiment had been conducted during more dry seasons the average difference might have been less than that shown above. The plants in the widely spaced rows were crowded too closely in the closer spacings.

TABLE 11.—*Annual and average yields of Dwarf Yellow milo grown at different spacings in widely spaced rows (84 to 88 inches apart) at three experiment stations in stated years, compared with the average yields from the same number of plants per acre grown in ordinary rows, 42 to 44 inches apart*

Station and distance of spacing in rows	Acre yield (bushels) in—									
	1914	1915	1916	1917	1918	1919	1920	1921	Average	Ordinary spacing, same years
Dalhart, Tex.:										
3 inches						39.1	31.5		35.3	42.3
6 inches						45.9	31.3		38.6	40.8
9 inches						46.6	25.2		35.9	39.8
12 inches						47.7	28.1		37.9	40.7
15 inches						53.9	34.6		44.3	43.1
Amarillo, Tex.:										
3 inches	33.3	58.4	9.3	28.0	4.1	48.6			[1] 35.6	37.1
4½ inches	28.4	62.0	7.1	33.0	12.5					
6 inches	33.3	62.9	16.1	36.8	4.1	50.6			[1] 39.9	37.6
9 inches	30.8	55.0	28.5	33.8	4.9	47.5			[1] 40.3	38.8
Woodward, Okla.:										
3 inches				14.9	3.3	28.2	30.6	43.6	24.1	24.9
6 inches				14.1	9.3	20.9	35.3	40.6	25.8	24.3
9 inches				18.3	5.4	25.1	37.6	47.0	26.7	27.3
12 inches				15.5	4.7	29.3	39.6	47.4	27.3	28.9
15 inches				16.8	3.7	20.4	37.8	41.3	24.4	25.6
Weighted average									32.1	32.7

[1] 5-year average, 1914–1917 and 1919.

FIGURE 4.—Dawn kafir grown in rows 40 inches apart with plants spaced 6 inches in the row in a spacing experiment at the Fort Hays Branch Station, Hays, Kans., in 1920



[illegible] spaced [illegible] in the row [illegible] Hays, Kans., in 1926

KAFIR

The yields of Dawn, Sunrise, Reed, Pink, Dwarf, and Blackhull kafir grown in widely spaced rows at one or more experiment stations are shown in Table 12.

Table 12.—*[illegible] at different plant spacings [illegible] stated years, [illegible] of plants per acre grown in [illegible]*

DAWN KAFIR

[illegible]

TABLE 12.—*Annual and average yields of kafir varieties at different plant spacings in wide rows (80 to 88 inches apart) at six experiment stations in stated years, compared with average yields from the same number of plants per acre grown in ordinary rows*—Continued

Station, and distance of spacing in row	Acre yield (bushels) in—													Ordinary spacing, same years
	1914	1915	1916	1917	1918	1919	1920	1921	1922	1923	1924	1925	Average	
SUNRISE KAFIR														
Woodward, Okla.:														
3 inches				21.3	11.8	27.1	28.3	32.4					24.2	28.6
6 inches				24.1	11.9	23.9	32.6	33.3					25.2	29.5
9 inches				24.1	9.2	21.1	32.4	32.1					23.8	28.7
12 inches				23.4	13.7	25.7	32.8	26.1					24.3	28.3
15 inches				21.1	13.5	21.7	30.7	28.2					23.2	28.3
Average (25 comparisons)													24.1	28.7
REED KAFIR														
Lawton, Okla.:														
3 inches									2.8	22.8	27.1		17.0	16.4
6 inches									3.6	13.5	26.1		14.4	14.9
9 inches									3.9	10.7	23.3		12.6	15.1
12 inches									2.6	8.4	22.0		11.0	14.4
15 inches									1.8	4.5	21.0		9.1	12.6
Average (15 comparisons)													12.9	14.7
PINK KAFIR														
Hays, Kans.:														
3 inches						38.9	46.1	53.5	31.9	26.1	29.9	30.0	37.9	39.1
6 inches						36.8	34.6	46.3	31.8	30.4	33.5	29.6	34.7	37.3
9 inches						32.7	32.3	48.0	20.6	24.2	31.1	38.6	33.1	33.7
12 inches						38.0	30.2	45.3	24.7	18.9	31.4	25.1	30.5	32.1
Average (28 comparisons)													34.1	35.6
DWARF KAFIR														
Chillicothe, Tex.:														
4 inches					0	23.2	33.1	20.1	14.5				18.2	17.1
8 inches					4.5	22.9	31.4	15.9	16.0				18.1	16.9
8 inches (cowpeas between)					0	16.1	30.9	11.8	4.1				12.6	16.9
Average (10 comparisons)													18.2	17.0
BLACKHULL KAFIR														
Lawton, Okla.:														
3 inches				19.3									19.3	29.8
6 inches				17.9									17.9	20.5
9 inches				16.2									16.2	20.9
12 inches				13.8									13.8	19.1
15 inches				10.6									10.6	15.4
Average (5 comparisons)													15.6	22.3
Weighted average (130 comparisons, all kafir varieties)													24.8	27.7

Dawn kafir grown in ordinary and in widely spaced rows at Hays, Kans., is shown in Figures 4 and 5.

In the experiments with Dawn kafir the wide-row spacing was outyielded on the average by the ordinary row spacing in all comparisons except in the 3-inch and 9-inch plant spacings at Hays, Kans., and the

4½ inch spacing at Amarillo, Tex., The weighted average yield for all experiments in 15 station years is 25.7 bushels for the wide spacing of rows and 29.3 bushels for the ordinary spacing. This difference of 3.6 bushels shows that Dawn kafir can not utilize additional space to as great an extent as can milo. Dawn kafir apparently is not well adapted to growing in widely spaced rows, at least under favorable conditions, because the plants are too small.

Sunrise kafir was grown in widely spaced rows at Woodward, Okla., during five seasons and produced an average yield of 24.1 bushels per acre in comparison with 28.7 bushels in the ordinary spacing. Smaller differences were obtained with Reed, Pink, and Dwarf kafirs, but Blackhull kafir during one season at Lawton produced 6.7 bushels per acre more from ordinary than from wide spacing.

The weighted average yield of all of the 139 kafir experiments in widely spaced rows is 24.8 bushels per acre. The average for ordinary spacing of the rows under the same conditions is 27.7 bushels per acre. Under conditions similar to those under which these experiments were conducted a reduction of 10 per cent in the yield of kafir may be expected from growing it in widely spaced rows instead of ordinary rows. The reduction in yield may be wholly or partly made up, however, by the increased yield of the crop following the sorghums in the widely spaced rows.

The spacing within the row showed no regular or consistent effect upon the differences in yield from widely spaced and ordinary rows.

Stover and fodder yields of all grain sorghums usually are much lower from widely spaced than from ordinary rows (*9, 10, 12, 14*).

FETERITA

The yields obtained with Standard feterita in widely spaced rows at Chillicothe, Tex., are shown in Table 13. The average yields from the wide spacing are 2.6 bushels per acre less than from ordinary spacing. This is a reduction in yield of about 10 per cent. There is a much greater reduction if a row of cowpeas is grown in each blank row between the widely spaced rows.

TABLE 13.—*Annual and average yields of feterita grown at different spacings in wide rows 80 inches apart at Chillicothe, Tex., from 1918 to 1922, inclusive, compared with the average yields from the same number of plants per acre grown in ordinary rows*

Distance of spacing in rows	Acre yield (bushels) in—						
	1918	1919	1920	1921	1922	Average	Ordinary spacing, same years
4 inches	2.1	31.5	35.2	30.1	25.9	25.0	27.4
8 inches	3.3	28.0	32.8	22.1	27.9	23.0	25.8
8 inches (cowpeas between)	1.3	22.8	29.2	18.3	22.0	18.9	25.8

PAIRED ROWS DOUBLE SPACED

A variation of the wide spacing of rows consists in seeding rows in pairs at the ordinary spacing but leaving a double space between pairs. This provides one and one-half times as many rows as double spacing, but only two-thirds as many as ordinary spacing of rows.

Dwarf Yellow milo, Dwarf kafir, Pink kafir, and Standard feterita were grown in paired rows, widely spaced between pairs, at single stations during 3, 5, or 7 years. The yields in this experiment are shown in Table 14. The milo yielded 1.5 bushels, or 5.6 per cent less per acre than the ordinary rows; Dwarf kafir yielded 1.1 bushels, or 5.5 per cent less; pink kafir 0.2 bushel, or 0.6 per cent less; and feterita 4.1 bushels, or 12.7 per cent less from this method of spacing. There was a weighted-average decrease in yield of 1 bushel per acre or 3.2 per cent for all varieties as a result of the crop being grown in this way instead of in ordinary rows. In extremely dry seasons, when soil moisture is deficient or when stands are too thick, the yields sometimes are increased by sowing the crop in paired rows, double spaced between pairs, or by cultivating out every third row sown in the ordinary manner. Widely spaced rows for fields with a scanty moisture supply at seeding time have been recommended by Finnell (*4*).

TABLE 14.—*Annual and average yields of Dwarf milo, Dwarf kafir, Pink kafir, and feterita grown at different spacings in ordinarily spaced paired rows, double spaced between pairs, at three experiment stations in stated years, compared with the average yields from the same number of plants per acre grown in ordinary rows*

Station and distance of spacing in row	Acre yield (bushels) in—									
	1919	1920	1921	1922	1923	1924	1925	1926	Average	Ordinary spacing same years
DWARF MILO										
Woodward, Okla.:										
4 inches				6.8	6.1	20.6	23.3	46.5	22.5	25.0
8 inches				13.2	5.0	34.1	30.8	45.8	25.8	25.8
12 inches				10.1	7.7	34.5	33.2	47.6	26.6	27.3
16 inches				11.6	8.2	36.0	27.3	47.9	26.2	28.6
20 inches				10.6	11.1	31.8	24.3	44.7	24.5	20.2
Average									25.1	26.0
DWARF KAFIR										
Chillicothe, Tex.:										
6 inches		20.2	16.0	11.5					18.9	20.0
PINK KAFIR										
Hays, Kans.:										
4 inches	40.8	50.4	50.3	33.7	30.8	[illegible]	20.9		38.6	39.1
8 inches	[illegible]	33.9	49.2	33.0	30.7	35.6	36.6		37.7	37.3
12 inches	37.0	32.3	45.8	25.9	28.4	32.0	37.6		34.2	33.7
16 inches	30.4	31.6	44.2	25.9	24.0	30.5	31.5		31.2	32.1
Average									35.4	35.0
FETERITA										
Chillicothe, Tex.:										
6 inches		35.5	20.0	28.8					28.1	32.2

DATE-OF-SEEDING EXPERIMENTS

Date-of-seeding experiments with three or more varieties of grain sorghum are reported for each of the nine experiment stations. All seedings were made at 15-day intervals at all the stations with the exception of some at Hays, Kans., which were made at 10-day intervals. The dates shown are only the approximate dates of seeding, but in nearly all experiments the actual seeding was done within three days of the dates given. Dry or wet soil prevented the crop from being sown on all dates planned in some experiments.

YIELD RESULTS

DWARF YELLOW MILO

Dwarf Yellow milo was grown in date-of-seeding experiments during three years or more at all nine experiment stations. The yields obtained are shown in Table 15. Average yields from four or more dates of seeding are shown from all stations except Hays, Kans., and Amarillo, Tex. Seeding on May 15 produced the highest average yields at Lawton, Okla., Chillicothe, Tex., and Tucumcari, N. Mex.; that on May 25 at Hays, Kans.; that on June 1 at Garden City, Kans., and Amarillo and Big Spring, Tex.; and that on June 15 at Woodward, Okla., and Dalhart, Tex. This shows a range of one month for the optimum date of seeding in the entire area, with these dates centering around June 1. A difference of 15 days in seeding time affected the average yields only slightly at most stations. July 1 seeding is too late for all stations, especially where injury by chinch bugs or frost is likely to occur.

TABLE 15.—*Annual and average yields of Dwarf Yellow milo obtained in date-of-seeding experiments at nine experiment stations, in stated years*

Station and date of seeding	Acre yield (bushels) in—															
	1912	1913	1914	1915	1916	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	Average
Hays, Kans.:																
May 5											17.1	1.8				
May 15	11.6	---	25.6	43.3	---	---	---	30.5	44.3	25.4	15.6	5.1	31.0	42.1	0	[1] 27.3
May 25	15.9	---	17.6	57.3	---	---	---	37.6	31.3	---	18.7	2.7	---	38.4	0	[1] 27.4
June 5	0	---	23.2	40.0	---	---	---	32.5	25.0	20.5	13.8	19.4	53.9	37.4	---	[1] 25.0
June 15	---	---	---	---	---	---	---	---	---	---	0	20.7	35.8	---	4.8	---
Garden City, Kans.:																
May 15	---	---	---	---	---	---	---	---	---	12.3	2.2	21.4	28.8	0	4.0	[2] 10.9
June 1	---	---	---	---	---	---	---	---	---	24.1	11.2	19.7	33.0	1.8	7.6	[2] 14.7
June 15	---	---	---	---	---	---	---	---	---	16.8	10.3	15.2	34.0	2.7	3.3	[2] 13.1
July 1	---	---	---	---	---	---	---	---	---	---	11.6	11.6	26.3	0	10.8	[2] 12.0
Woodward, Okla.:																
Apr. 15	---	---	---	---	---	17.5	5.8	21.8	18.0	20.1	10.7	6.2	16.1	11.0	30.4	[3] 17.5
May 1	---	---	---	---	15.8	21.9	2.1	10.9	13.4	30.6	6.7	5.6	23.6	14.5	35.4	[3] 18.3
May 15	---	---	---	---	8.3	22.4	1.5	35.0	22.0	37.0	20.9	16.6	30.3	18.5	42.3	[3] 24.7
June 1	---	---	---	---	9.6	27.6	1.8	42.2	28.4	50.8	22.0	18.2	28.5	14.2	41.8	[3] 27.6
June 15	---	---	---	---	---	27.6	5.5	31.2	57.6	51.4	32.4	18.8	37.8	15.5	54.6	[3] 33.2
July 1	---	---	---	---	---	14.3	10.0	30.3	55.3	37.4	25.2	10.4	32.7	16.1	40.2	[3] 27.3
Lawton, Okla.:																
Apr. 15	---	---	---	---	---	4.7	---	43.3	12.8	---	---	---	---	---	---	20.3
May 1	---	---	---	---	---	4.8	---	42.7	20.3	---	---	---	---	---	---	22.6
May 15	---	---	---	---	---	4.8	---	42.2	24.0	---	---	---	---	---	---	23.7
June 1	---	---	---	---	---	3.8	---	38.2	15.3	---	---	---	---	---	---	19.1
June 15	---	---	---	---	---	3.5	---	26.6	12.2	---	---	---	---	---	---	14.1
July 1	---	---	---	---	---	0	---	13.8	18.4	---	---	---	---	---	---	10.7
Dalhart, Tex.:																
May 1	---	---	---	---	---	---	---	42.7	34.1	30.5	25.9	15.0	22.0	20.2	25.5	[4] 28.4
May 15	---	---	---	---	---	---	---	45.9	30.5	32.0	17.5	8.8	20.5	23.6	26.8	[4] 28.2
June 1	---	---	---	---	---	---	---	57.1	25.7	35.4	---	27.5	22.9	25.5	28.8	[4] 31.8
June 15	---	---	---	---	---	---	---	46.3	42.7	37.3	9.5	40.5	23.8	21.4	34.1	[4] 35.2
July 1	---	---	---	---	---	---	---	---	---	---	11.4	26.3	8.6	25.0	27.1	---
Amarillo, Tex.:																
May 15	---	---	30.0	60.9	3.2	38.8	3.0	20.0	---	---	---	---	---	---	---	26.1
June 1	---	---	31.4	72.9	10.0	17.9	5.0	50.4	---	---	---	---	---	---	---	31.3
June 15	---	---	28.0	63.0	8.4	37.5	3.6	23.4	---	---	---	---	---	---	---	27.5
Big Spring, Tex.:																
Apr. 15	---	---	---	---	---	---	---	65.6	---	22.2	0	13.4	7.9	---	10.3	---
May 1	---	---	---	---	---	---	---	48.6	---	---	39.8	36.7	9.6	4.0	23.7	[5] 27.1
May 15	---	---	---	---	---	---	---	62.9	---	---	27.2	28.2	18.7	11.8	28.8	[5] 29.6
June 1	---	---	---	---	---	---	---	48.3	52.8	20.8	32.5	38.6	14.1	14.5	30.2	[5] 29.7
June 15	---	---	---	---	---	---	---	44.6	50.2	25.2	27.6	38.4	0	17.8	35.3	[5] 27.3
July 1	---	---	---	---	---	---	---	34.0	44.3	10.7	6.2	17.6	0	19.5	26.3	[5] 17.3
July 15	---	---	---	---	---	---	---	---	---	---	---	11.0	---	---	---	---

[1] 8-year average, 1912, 1914, 1915, 1919, 1920, 1922, 1923, and 1925.
[2] 5-year average, 1922–1926.
[3] 10-year average, 1917–1926.
[4] 7-year average, 1919–1921 and 1923–1926.
[5] 6-year average, 1919 and 1922–1926.

TABLE 15.—*Annual and average yields of Dwarf Yellow milo obtained in date-of-seeding experiments at nine experiment stations, in stated years*—Continued

Station and date of seeding	Acre yield (bushels) in—															
	1912	1913	1914	1915	1916	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	Average
Chillicothe, Tex.:																
Apr. 1	---	10.9	28.2	17.1	16.5	1.8	---	---	---	---	---	---	---	---	---	14.9
Apr. 15	---	11.6	17.7	19.8	12.7	2.8	---	---	---	---	---	---	---	---	---	12.9
May 1	---	8.4	35.7	19.8	11.6	.8	---	---	---	---	---	---	---	---	---	15.3
May 15	---	1.6	37.7	28.4	7.6	6.6	---	---	---	---	---	---	---	---	---	16.4
June 1	---	0	29.3	39.3	0	6.7	---	---	---	---	---	---	---	---	---	15.1
June 15	---	0	47.0	0	0	3.7	---	---	---	---	---	---	---	---	---	10.1
July 1	---	0	55.0	0	0	7.3	---	---	---	---	---	---	---	---	---	12.5
Tucumcari, N. Mex.:																
May 1	---	---	---	---	13.3	---	---	---	---	---	10.5	11.6	21.0	---	6.5	---
May 15	---	---	---	---	10.8	---	---	14.7	14.5	---	12.3	11.4	12.0	6.7	14.3	[4] 12.1
June 1	---	---	---	---	19.0	6.0	---	12.6	16.3	22.9	10.5	3.8	12.7	5.4	12.7	[4] 11.6
June 15	---	---	---	---	14.0	16.7	---	14.6	9.4	19.0	7.8	5.9	9.8	10.5	12.5	[4] 10.6
July 1	---	---	---	---	17.0	23.8	---	9.4	6.7	19.0	8.4	5.4	12.9	8.3	12.0	[4] 10.0

[4] 8-year average, 1916, 1919, 1920, and 1922–1926.

DAWN KAFIR

Yield results with Dawn kafir obtained at eight experiment stations are shown in Table 16. May 1 proved to be the best date of seeding at Lawton, Okla., where chinch-bug injury occurs. Seeding on May 15 at Hays, Kans., Woodward, Okla., and Amarillo and Big Spring, Tex., produced the highest average yields, as did seeding on June 1 at Garden City, Kans., and Tucumcari, N. Mex., and in the experiments of the Office of Forage Crops and Diseases at Hays, Kans. Seeding on June 15 was best at Dalhart, Tex. Thus May 15 to June 1 appears to be the approximate optimum time of seeding for the entire area, in the absence of chinch bugs, as six of the eight stations produced the highest yields from seedings made during that period. The average yield from the June 15 seeding at Dalhart was only 2.3 bushels per acre higher than the average yield from the June 1 seeding.

TABLE 16.—*Annual and average yields of Dawn kafir obtained in date-of-seeding experiments at eight experiment stations in stated years*

[The data for 1913 are omitted because of crop failure]

Station and date of seeding	Acre yield (bushels) in—														
	1912	1914	1915	1916	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	Average
Hays, Kans.:															
May 5	---	---	---	---	---	---	---	---	---	21.3	3.1	---	---	---	---
May 15	30.0	---	62.4	---	---	---	26.9	49.2	34.8	11.8	6.9	36.1	39.8	0	[1] 32.4
May 25	20.3	---	59.3	---	---	---	35.3	45.5	---	11.3	7.1	---	38.1	0	[1] 31.8
June 5	11.4	---	37.2	---	---	---	31.1	27.8	29.1	9.0	23.4	47.9	20.4	---	[1] 23.8
June 15	---	---	---	---	---	---	---	---	25.0	7.5	11.2	51.6	---	2.7	---
Hays, Kans. (forage-crop experiments):[2]															
May 1	---	7.2	20.1	4.3	1.8	3.0	---	---	---	---	---	---	---	---	---
May 15	---	9.0	62.9	3.2	1.8	5.9	---	---	---	---	---	36.1	39.8	0	[3] 19.8
June 1	---	7.4	65.1	1.3	0	10.2	---	---	---	---	20.3	47.9	38.1	0	[3] 21.3
June 15	---	19.3	42.7	0	0	8.4	---	---	---	---	---	51.6	26.4	2.7	[3] 18.9
July 1	---	0	9.6	0	0	0	---	---	---	---	0	0	3.2	.9	[3] 1.7
Garden City, Kans.:															
May 15	---	---	---	---	---	---	---	---	14.3	4.5	21.0	30.2	0	4.1	[4] 13.2
June 1	---	---	---	---	---	---	---	---	27.0	13.0	21.4	35.7	2.3	4.1	[4] 15.3
June 15	---	---	---	---	---	---	---	---	20.9	9.9	18.8	34.8	2.5	5.0	[4] 14.3
July 1	---	---	---	---	---	---	---	---	---	6.8	22.3	25.0	0	0	[4] 10.8
Woodward, Okla.:															
May 1	---	---	---	---	---	---	12.2	35.1	32.7	4.0	---	---	---	---	21.0
May 15	---	---	---	---	---	---	23.5	30.1	38.6	7.5	---	---	---	---	27.2
June 1	---	---	---	---	---	---	25.3	36.8	34.8	11.3	---	---	---	---	27.1
June 15	---	---	---	---	---	---	22.5	38.4	29.4	18.2	---	---	---	---	27.1
July 1	---	---	---	---	---	---	---	23.6	---	---	---	---	---	---	---

[1] 7-year average, 1912, 1915, 1919, 1920, 1922, 1923, and 1925.
[2] Experiments conducted by R. E. Getty, Office of Forage Crops and Diseases.
[3] 8-year average, 1914–1918 and 1924–1926.
[4] 5-year average, 1922–1926.

TABLE 16.—*Annual and average yields of Dawn kafir obtained in date-of-seeding experiments at eight experiment stations in stated years*—Continued

[The data for 1913 are omitted because of crop failure]

Station and date of seeding	Acre yield (bushels) in—														
	1912	1914	1915	1916	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	Average
Lawton, Okla.:															
Apr. 15	----	----	----	----	7.8	----	20.3	19.2	11.0	1.8	15.8	22.9	----	15.2	15.4
May 1	----	----	----	----	10.4	----	27.5	20.5	34.8	7.5	7.5	20.9	----	19.1	19.7
May 15	----	----	----	----	13.0	----	34.2	33.5	13.1	8.6	3.2	22.6	----	18.8	18.4
June 1	----	----	----	----	18.0	----	35.5	35.6	11.0	2.7	0	10.1	----	19.4	17.7
June 15	----	----	----	----	21.0	----	21.1	28.2	0	0	0	26.8	----	16.1	14.2
July 1	----	----	----	----	0	----	12.5	16.7	0	0	0	0.9	----	21.4	7.6
Dalhart, Tex.:															
May 1	----	----	----	----	----	----	5.7	26.3	30.5	22.1	20.1	21.6	35.0	27.9	[5] 26.4
May 15	----	----	----	----	----	----	4.6	27.9	34.5	12.9	31.6	21.8	41.3	25.2	[5] 20.7
June 1	----	----	----	----	----	----	13.0	21.8	40.7	----	31.8	31.8	30.4	20.7	[4] 27.3
June 15	----	----	----	----	----	----	26.4	32.1	25.7	8.0	37.0	30.4	20.0	29.8	[5] 20.6
July 1	----	----	----	----	----	----	----	----	----	0	22.1	14.3	10.5	20.0	----
Amarillo, Tex.:															
May 15	----	20.8	50.3	0	21.2	2.1	36.2	----	----	----	----	----	----	----	23.8
June 1	----	15.8	57.1	4.0	5.4	1.3	34.3	----	----	----	----	----	----	----	19.7
June 15	----	17.0	40.6	7.5	10.0	1.6	37.8	----	----	----	----	----	----	----	22.2
Big Spring, Tex.:															
Apr. 15	----	----	----	----	----	----	42.3	----	11.0	0	15.0	1.8	----	9.4	----
May 1	----	----	----	----	----	----	38.9	----	----	21.6	23.5	2.7	12.2	16.3	[6] 22.5
May 15	----	----	----	----	----	----	45.3	----	----	10.9	15.9	4.9	15.4	19.0	[6] 22.6
June 1	----	----	----	----	----	----	33.0	34.8	20.9	21.6	15.4	9.6	14.8	23.7	[6] 21.7
June 15	----	----	----	----	----	----	30.3	22.3	0.4	14.3	21.6	----	14.0	24.8	[6] 21.0
July 1	----	----	----	----	----	----	22.0	32.5	4.0	2.3	17.7	----	20.4	17.7	[6] 16.0
July 15	----	----	----	----	----	----	----	----	----	----	9.9	----	----	----	----
Tucumcari, N. Mex.:															
May 15	----	----	----	----	----	----	15.6	17.1	----	----	----	----	----	----	----
June 1	----	----	----	----	1.4	----	15.4	16.2	21.9	----	----	----	----	----	14.5
June 15	----	----	----	----	10.3	----	11.1	13.1	16.8	----	----	----	----	----	14.3
July 1	----	----	----	----	17.9	----	0	0	0	----	----	----	----	----	4.5

[5] 7-year average, 1922 omitted.   [6] 5-year average, 1919, 1922, 1923, 1925, and 1926.

TABLE 17.—*Annual and average yields of Sunrise kafir obtained in date-of-seeding experiments at five experiment stations in stated years*

Station and date of seeding	Acre yield (bushels) in—											
	1916	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	Average
Garden City, Kans.:												
May 15	----	----	----	----	----	----	10.3	18.3	40.2	1.8	13.2	16.8
June 1	----	----	----	----	----	----	30.3	23.3	42.4	9.9	11.1	23.4
June 15	----	----	----	----	----	----	21.1	16.1	27.2	1.8	15.0	16.4
July 1	----	----	----	----	----	----	7.8	14.8	29.0	0	0	10.3
Woodward, Okla.:												
Apr. 15	----	28.9	2.6	10.4	17.0	31.5	8.6	8.5	13.7	11.0	23.6	15.6
May 1	17.1	25.9	7.2	12.5	24.6	32.0	4.3	4.2	15.1	14.5	27.9	[1] 16.9
May 15	11.3	31.2	6.5	28.7	41.0	37.0	6.7	9.6	13.0	15.8	33.2	[1] 22.3
June 1	9.9	28.3	9.3	26.8	30.5	37.5	11.3	13.4	25.2	20.1	37.0	[1] 23.9
June 15	----	15.4	4.3	25.0	40.2	28.2	17.7	12.9	33.1	20.2	44.7	25.1
July 1	----	7.8	3.6	25.9	25.0	25.4	10.2	9.4	34.7	9.3	35.9	18.7
Lawton, Okla.:												
Apr. 15	----	----	----	----	----	----	----	14.3	28.6	----	16.1	19.7
May 1	----	----	----	----	----	----	----	4.1	22.1	----	19.1	15.1
May 15	----	----	----	----	----	----	----	0	24.1	----	20.9	15.0
June 1	----	----	----	----	----	----	----	0	17.3	----	19.1	12.1
June 15	----	----	----	----	----	----	----	0	26.8	----	18.8	15.2
July 1	----	----	----	----	----	----	----	0	22.3	----	25.0	15.8
Dalhart, Tex.:												
May 1	----	----	----	----	----	----	----	----	----	30.4	25.9	28.2
May 15	----	----	----	----	----	----	----	----	----	33.0	23.6	28.3
June 1	----	----	----	----	----	----	----	----	----	33.4	20.2	26.8
June 15	----	----	----	----	----	----	----	----	----	27.3	24.1	25.7
July 1	----	----	----	----	----	----	----	----	----	10.3	13.0	16.2
Tucumcari, N. Mex.:												
May 1	----	----	----	----	----	----	8.0	12.9	22.1	----	12.1	----
May 15	----	----	----	----	----	----	12.1	12.8	14.8	20.1	16.5	15.2
June 1	----	----	----	----	----	----	6.5	9.5	15.6	11.4	15.9	11.8
June 15	----	----	----	----	----	----	3.5	2.9	18.3	8.0	15.9	9.7
July 1	----	----	----	----	----	----	5.8	2.0	12.5	3.1	7.0	6.1

[1] Averages for the 10 years, 1917–1926, inclusive.

SUNRISE KAFIR

The yields of Sunrise kafir obtained in date-of-seeding experiments at five field stations are shown in Table 17. The highest average yields were secured from seeding on April 15 at Lawton, Okla., on May 15 at Dalhart, Tex., and Tucumcari, N. Mex., on June 1 at Garden City, Kans., and on June 15 at Woodward, Okla. The results are not very definite, owing to an apparent range of two months in optimum dates of seeding at five stations, but in general May 15 to June 1 appears to be approximately the optimum time for seeding Sunrise kafir. The average yields from seeding before or after those dates probably are not significantly larger at any station, except at Lawton, where chinch bugs are the determining factor.

REED KAFIR

Reed kafir was grown in date-of-seeding experiments during five or six years at each of six stations. The results obtained are shown in Table 18. Seeding on May 1 produced the best yields at Lawton, Okla., that on May 15 at Dalhart and Big Spring, Tex., that on June 1 at Garden City, Kans., and Tucumcari, N. Mex., and that on June 15 at Woodward, Okla. The average best date for most stations where chinch bugs were not present probably would fall between May 15 and June 1.

TABLE 18.—*Annual and average yields of Reed kafir obtained in date-of-seeding experiments at six experiment stations in stated years*

Station and date of seeding	Acre yield (bushels) in—						
	1921	1922	1923	1924	1925	1926	Average
Garden City, Kans.:							
May 15	-------	9.9	13.0	40.6	0	8.5	14.4
June 1	-------	19.6	23.3	41.0	0	6.2	18.0
June 15	-------	18.3	17.5	31.3	4.0	3.5	14.9
Woodward, Okla.:							
Apr. 15	-------	-------	-------	-------	13.4	32.5	-------
May 1	38.0	8.8	4.4	25.4	20.4	45.6	23.8
May 15	40.7	15.0	15.2	18.9	16.4	39.6	24.3
June 1	41.5	19.8	25.4	25.5	15.0	41.6	28.1
June 15	31.6	20.0	27.6	34.0	29.5	40.8	33.1
July 1	-------	-------	-------	36.2	13.7	39.8	-------
Lawton, Okla.:							
Apr. 15	7.7	4.8	21.1	41.0	-------	28.3	20.6
May 1	25.0	16.1	10.4	34.0	-------	21.1	21.3
May 15	21.8	9.3	0	20.1	-------	24.4	10.9
June 1	1.8	3.0	0	26.3	-------	22.0	10.8
June 15	0	0	0	25.9	-------	26.8	10.5
July 1	0	0	0	18.8	-------	25.0	8.6
Dalhart, Tex.:							
May 1	-------	30.9	-------	34.8	28.8	28.9	[1] 30.8
May 15	-------	24.8	-------	42.5	32.7	25.2	[1] 33.5
June 1	-------	-------	-------	38.0	30.0	19.5	[1] 29.2
June 15	-------	8.9	-------	32.9	13.0	22.0	[1] 22.0
July 1	-------	0	-------	0	0	0	0
Big Spring, Tex.:							
Apr. 15	-------	0	21.0	5.1	-------	20.1	-------
May 1	-------	25.0	16.5	8.0	16.5	31.1	[2] 22.3
May 15	-------	26.4	16.5	12.5	18.5	37.3	[2] 24.7
June 1	-------	28.8	10.7	20.0	14.5	34.4	[2] 22.1
June 15	-------	17.3	20.7	-------	15.0	28.1	[2] 22.5
July 1	-------	6.8	19.0	-------	22.3	21.6	[2] 17.4
July 15	-------	-------	10.7	-------	-------	-------	-------
Tucumcari, N. Mex.:							
May 15	-------	11.6	13.3	20.0	-------	10.5	-------
June 1	-------	6.9	16.6	16.1	20.0	18.3	15.7
June 15	-------	8.5	8.7	20.6	13.4	19.4	14.1
July 1	-------	5.0	4.9	21.9	6.2	13.4	10.3
July 15	-------	5.7	2.0	13.0	1.2	0	4.4

[1] 3-year average, 1924–1926. [2] 4-year average, 1922–1923 and 1925–1926.

STANDARD FETERITA

Yields from date-of-seeding experiments with Standard feterita are shown for eight experiment stations in Table 19. Seeding on May 15 shows the highest average yields at Tucumcari, N. Mex., that on June 1 at Hays, Kans., and Dalhart, Tex., and on June 15 at Woodward, Okla., and Amarillo, Big Spring, and Chillicothe, Tex., and that on July 1 at Garden City, Kans. Thus the seeding on June 15 appears to give the best results at four of the eight stations, and the yields from other seedings at the remaining stations probably are not significantly greater.

Table 19.—*Annual and average yields of Standard feterita obtained in date-of-seeding experiments at eight experiment stations in stated years*

Station and date of seeding	Acre yield (bushels) in—															
	1912	1913	1914	1915	1916	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	Average
Hays, Kans.:																
May 1			16.8	20.6	9.8	8.6	6.3									
May 15	26.6		18.3	32.5	7.3	12.7	8.8						30.3	38.8	7.3	[1] 21.3
June 1	24.0		28.1	42.6	3.6	10.4	6.9					20.3	33.8	51.3	3.0	[1] 22.6
June 15	7.3		19.4	10.7	5.9	11.8	8.9						41.3	64.9	10.2	[1] 21.0
July 1			21.3	12.0	3.0	5.0	0					0	35.4	36.2	14.8	
Garden City, Kans.:																
May 15										14.6	0	20.5	21.4	0	0	[2] 8.4
June 1										39.3	7.1	17.0	30.1	0	0	[2] 12.0
June 15										31.6	18.8	16.1	29.0	6.1	17.0	[2] 17.4
July 1											16.5	16.1	34.4	0	21.9	[2] 17.8
Woodward, Okla.:																
Apr. 15															36.4	
May 1								18.7	25.2	39.2	5.6	6.0	16.1	2.4	39.0	[3] 19.1
May 15								35.7	37.5	39.2	5.6	16.1	10.4	6.7	34.2	[3] 22.2
June 1								27.6	30.2	39.2	13.7	15.5	20.4	15.8	34.2	[3] 25.4
June 15								25.3	46.6	41.2	28.4	18.8	32.9	16.8	48.2	[3] 33.3
July 1									43.4	28.3	19.6	12.9	30.3	13.3	29.0	[3] 26.7
July 15									41.7	19.7	15.4	6.4	33.4	9.4	24.9	[3] 21.6
Dalhart, Tex.:																
May 1										32.7	30.7	20.7	22.3	18.9	24.8	[4] 23.9
May 15										27.5	24.6	20.5	20.7	32.3	20.2	[4] 24.2
June 1										51.6		26.8	21.4	32.3	21.8	[4] 30.8
June 15										27.9	18.2	36.8	25.4	29.3	18.4	[4] 27.6
July 1											18.2	20.8	20.4	21.6	22.7	
Amarillo, Tex.:																
May 15			14.5	37.5	7.7	21.3	2.5	10.9								15.7
June 1			19.2	53.9	15.0	22.1	4.3	21.4								22.7
June 15			30.0	51.3	13.9	29.4	9.1	32.9								27.8
Big Spring, Tex.:																
Apr. 15											0	16.1	1.3		12.1	
May 1											20.3	21.6	.9	7.0	16.8	[2] 16.7
May 15											17.6	13.3	2.7	12.7	17.4	[2] 15.3
June 1											33.8	9.8	17.4	11.2	17.9	[2] 18.2
June 15											23.2	24.1		11.2	20.7	[5] 19.8
July 1											13.6	14.3		14.5	24.3	[5] 16.7
July 15												11.0				
Chillicothe, Tex.:																
Apr. 1		14.8	35.0	11.4	13.5	10.2										17.2
Apr. 15		12.7	44.8	14.3	17.3	3.2										18.5
May 1		13.6	20.0	29.3	16.8	7.4										17.8
May 15		3.9	33.3	33.6	15.2	7.9										18.8
June 1		0	33.3	30.4	22.3	8.3										18.9
June 15		0	26.6	37.0	10.5	12.4										19.1
July 1		0	48.4	0	0	11.3										11.9
Tucumcari, N. Mex.:																
May 1											12.3	12.7			14.5	
May 15											12.9	8.5	17.8	12.3	10.5	12.4
June 1											14.3	7.0	13.4	8.5	14.5	11.5
June 15											14.6	8.7	12.0	6.9	12.5	10.3
July 1											11.9	7.1	0.8	10.3	11.2	10.1

[1] Nine-year average, 1912, 1914–1918, and 1924–1926.
[2] Five-year average, 1922–1926.
[3] Seven-year average, 1920–1926.
[4] Five-year average, 1921 and 1923–1926.
[5] Four-year average, 1922, 1923, 1925, and 1926.

DWARF FETERITA

Dwarf feterita was included in date-of-seeding experiments during two or three years at each of five experiment stations. The yields obtained are shown in Table 20. The average yields are in favor of the May 1 seeding at Lawton, Okla., the June 1 seeding at Big Spring, Tex., and Tucumcari, N. Mex., and the June 15 seeding at Woodward, Okla., and Dalhart, Tex. If the results from Lawton, Okla., where chinch bugs are the determining factor, are omitted, the best date for seeding Dwarf feterita apparently lies between June 1 and June 15.

TABLE 20.—*Annual and average yields of Dwarf feterita obtained in date-of-seeding experiments at five experiment stations in stated years*

[The data for 1925 are omitted because of crop failure]

Station and date of seeding	Acre yield (bushels) in—			
	1923	1924	1926	Average
Woodward, Okla.:				
May 1	0	18.8	----------	9.4
May 15	15.7	12.6	----------	14.2
June 1	14.7	13.7	----------	14.2
June 15	20.9	30.1	----------	25.5
July 1	11.3	28.5	----------	19.9
July 15	4.5	23.8	----------	14.2
Lawton, Okla.:				
Apr. 15	13.8	16.4	3.3	11.2
May 1	13.1	31.3	11.0	18.5
May 15	12.5	27.8	14.3	18.2
June 1	14.8	22.4	13.4	16.9
June 15	11.3	19.4	18.1	16.3
July 1	0	13.1	17.0	10.0
Dalhart, Tex.:				
May 1	17.7	20.0	----------	18.9
May 15	29.6	20.7	----------	25.2
June 1	31.3	19.8	----------	25.6
June 15	28.0	23.6	----------	25.8
July 1	27.8	5.2	----------	16.5
Big Spring, Tex.:				
Apr. 15	11.4	9.1	----------	10.3
May 1	15.2	6.9	----------	11.1
May 15	15.8	16.1	----------	16.0
June 1	25.9	7.9	----------	16.9
June 15	18.7	----------	----------	----------
July 1	13.6	----------	----------	----------
July 15	11.0	----------	----------	----------
Tucumcari, N. Mex.:				
May 1	6.2	----------	----------	----------
May 15	11.6	8.7	----------	10.2
June 1	10.6	10.7	----------	10.7
June 15	6.1	12.7	----------	9.4
July 1	3.6	10.7	----------	7.2

MISCELLANEOUS VARIETIES

The yields obtained in date-of-seeding experiments with Blackhull kafir, Spur feterita, Manchu Brown and Blackhull kaoliangs, and Freed sorghum are shown in Table 21. These experiments are not very extensive with any variety, but the results are at least indicative. As might be expected, at Lawton, Okla., Blackhull kafir produced the highest average yields from the earliest seeding. At Chillicothe, Tex., Blackhull kafir yielded best from the June 1 seeding. Spur feterita at Big Spring, Tex., yielded best from the June 1 seeding.

TABLE 21.—*Annual and average yields of miscellaneous grain-sorghum varieties grown in date-of-seeding experiments at seven experiment stations in stated years*

Variety, station, and date of seeding	Acre yield (bushels) in—															
	1912	1913	1914	1915	1916	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	Average
BLACKHULL KAFIR																
Lawton, Okla.:																
Apr. 15										11.0	4.1	13.1	25.0		24.1	15.6
May 1										27.1	0.3	4.1	17.3		12.2	14.0
May 15										14.9	8.0	0	19.0		18.2	12.1
June 1										4.8	.9	0	20.3		18.4	8.9
June 15										0	0	0	27.5		23.3	10.2
July 1										0	0	0	13.1		26.8	8.0
Chillicothe, Tex.:																
Apr. 1			16.1	32.1	6.3	8.7										15.8
Apr. 15			14.8	38.0	3.4	6.2										15.6
May 1			47.1	25.9	0	4.5										19.4
May 15			47.0	39.8	0	.0										21.9
June 1			56.8	37.2	0	8.4										25.6
June 15			55.5	0	0	4.7										15.1
July 1			47.9	0	0	7.1										13.8
SPUR FETERITA																
Big Spring, Tex.:																
Apr. 15														12.0		
May 1														14.5	11.8	13.2
May 15														18.3	14.5	16.4
June 1														15.9	20.9	18.4
June 15														15.9	14.5	15.2
July 1														12.1	13.0	12.6
MANCHU BROWN KAOLIANG																
Hays, Kans.:																
May 15	32.0		28.4	38.2												32.9
May 25	19.3		25.9	50.4												31.9
June 5	7.4		31.0	23.0												20.5
Amarillo, Tex.:																
May 15			21.1	40.4	4.6	15.9	2.7	15.5								16.7
June 1			20.7	48.2	6.8	2.5	3.2	7.1								14.8
June 15			27.3	51.3	3.0	8.9	5.5	28.6								20.9
BLACKHULL KAOLIANG																
Woodward, Okla.:																
May 1								6.7	20.1	37.0	5.9					17.4
May 15								23.5	31.6	37.0	16.6					27.2
June 1								23.9	33.2	40.5	17.4					28.7
June 15								25.9	42.1	42.1	23.0					33.3
July 1									35.6	35.3	14.7					
July 15									35.3	24.4	15.8					
Dalhart, Tex.:																
May 1									26.3	35.5						30.9
May 15									30.4	30.9						30.7
June 1									26.8	21.6						24.2
June 15									31.6	31.4						31.5
FREED SORGHUM																
Hays, Kans.:[1]																
May 1			28.5	27.3	12.4	6.3	4.1									
May 15			25.4	23.1	9.6	5.2	15.2						20.5	19.3	12.0	17.0
June 1			26.5	22.3	11.6	7.3	13.9					23.8	21.8	19.8	10.0	16.7
June 15			31.5	26.4	14.6	7.0	10.7						21.2	27.0	14.6	19.2
July 1			27.4	20.9	14.3	6.4	9.8					19.6	27.9	18.2	13.7	17.3
Chillicothe, Tex.:																
Apr. 1		3.2	11.3	13.9	9.1	3.4										8.2
Apr. 15		0.1	15.5	21.4	12.1	6.0										12.0
May 1		6.3	18.4	20.8	17.0	7.1										15.1
May 15		5.0	20.9	30.5	15.0	6.6										16.0
June 1		5.0	24.7	25.7	15.0	12.4										16.7
June 15		1.6	11.3	0	10.8	10.1										6.8
July 1		0	14.8	0	5.4	5.6										5.2

[1]Experiments from 1914 to 1918 were conducted by R. E. Getty, Office of Forage Crops and Diseases, and reported in Department Bulletin No. 1260 (*14*).

Manchu Brown kaoliang yielded best from the May 15 seeding at Hays, Kans., and the June 15 seeding at Amarillo, Tex. Blackhull kaoliang produced the highest average yields from the June 15 seeding at Woodward, Okla., and Dalhart, Tex. Thus at three of the four stations where kaoliangs were grown in the experiments, the June 15 seeding was most favorable.

Freed sorghum produced the highest average yields from the June 15 seeding at Hays, Kans., and the June 1 seeding at Chillicothe, Tex.

AGRONOMIC DATA

DWARF YELLOW MILO

The agronomic data from the date-of-seeding experiments with Dwarf Yellow milo at Woodward, Okla., are shown in Table 22. The actual spacings obtained indicate that there sometimes was difficulty in securing satisfactory stands from the April 15 seeding. Most of the stands obtained were too thick for the highest yields. When the average stands were similar, as shown by the spacings in the seedings from May 15 to July 1, inclusive, the average number of heads per plant was approximately the same, except in the July 1 seeding. The thinner stands of the April 15 and May 1 seedings resulted in more heads per plant than occurred in the later seedings.

TABLE 22.—*Annual and average agronomic data obtained in date-of-seeding experiments with Dwarf Yellow milo grown at Woodward, Okla., from 1917 to 1926, inclusive*

Date of seeding	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	Average
ACTUAL SPACING (INCHES)											
Apr. 15	18.84	62.38	16.54	14.26	10.40	18.30	21.09	9.33	14.00	15.18	20.04
May 1	14.67	14.08	17.20	8.37	13.10	8.06	10.17	7.68	7.38	11.03	11.26
May 15	9.70	11.27	9.93	7.02	8.03	10.58	6.62	10.39	8.52	12.80	9.49
June 1	9.64	8.43	11.65	6.45	6.64	7.97	6.48	10.62	8.19	13.23	8.93
June 15	9.19	8.14	7.78	6.65	8.17	7.62	6.07	6.84	8.66	12.60	8.16
July 1	10.22	10.77	7.77	6.15	7.77	9.10	8.19	6.79	6.77	12.47	8.40
HEADS PER PLANT											
Apr. 15	2.77	3.23	1.60	1.71	1.49	1.43	1.01	1.10	1.00	1.37	1.67
May 1	2.53	1.13	1.20	1.43	2.07	.95	.58	1.19	.97	1.35	1.34
May 15	1.72	.81	1.46	1.38	1.33	1.20	.79	1.41	1.07	1.45	1.24
June 1	1.38	.30	1.88	1.21	1.32	1.14	.97	1.50	.97	1.33	1.21
June 15	1.20	.64	1.22	1.23	1.45	1.08	1.05	1.41	1.03	1.65	1.20
July 1	1.35	.69	1.20	1.23	1.18	1.24	.94	1.07	.92	1.44	1.13
GRAIN PER PLANT (POUND)											
Apr. 15	0.130	0.142	0.142	0.101	0.119	0.077	0.052	0.059	0.060	0.204	0.109
May 1	.127	.011	.134	.044	.203	.021	.023	.071	.042	.147	.082
May 15	.086	.007	.137	.061	.117	.086	.043	.124	.062	.199	.092
June 1	.105	.006	.104	.071	.132	.068	.047	.110	.046	.211	.100
June 15	.100	.017	.095	.150	.165	.097	.044	.102	.053	.246	.107
July 1	.057	.046	.092	.134	.114	.091	.025	.087	.042	.163	.085
GRAIN PER HEAD (POUND)											
Apr. 15	0.047	0.044	0.089	0.059	0.080	0.054	0.051	0.054	0.060	0.149	0.069
May 1	.050	.010	.112	.031	.098	.022	.030	.060	.043	.109	.057
May 15	.050	.011	.094	.044	.088	.072	.055	.088	.058	.137	.070
June 1	.076	.010	.103	.059	.100	.060	.048	.070	.047	.150	.075
June 15	.083	.027	.078	.122	.114	.050	.042	.072	.051	.149	.083
July 1	.042	.067	.077	.109	.097	.073	.027	.081	.046	.113	.073

TABLE 22.—*Annual and average agronomic data obtained in date-of-seeding experiments with Dwarf Yellow milo grown at Woodward, Okla., from 1917 to 1926, inclusive*—Continued

HEADS PER ACRE

Date of seeding	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	Average
Apr. 15	20,960	7,381	13,700	17,095	20,307	11,140	6,826	16,808	10,183	12,866	13,736
May 1	24,687	11,441	9,946	24,356	22,526	16,804	8,130	22,090	18,737	10,005	17,468
May 15	25,279	7,717	20,060	28,025	23,611	16,160	17,013	10,347	17,903	16,150	19,217
June 1	20,407	6,088	23,006	26,743	28,340	20,391	21,340	20,136	16,885	14,332	19,767
June 15	18,616	11,209	22,355	26,369	25,301	20,206	25,073	29,387	16,956	18,683	21,416
July 1	18,831	9,134	22,016	28,511	21,649	19,426	21,649	22,400	19,373	16,402	19,952

DAYS FROM PLANTING TO MATURITY

Date of seeding	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	Average
Apr. 15	169	127	136	133	121	166	130	133	136	133	138
May 1	160	112	122	117	109	139	120	120	122	124	125
May 15	148	120	110	105	90	125	111	114	115	113	116
June 1	132	107	100	105	105	110	111	101	106	108	109
June 15	112	102	97	114	105	101	125	101	102	101	106
July 1	101	124	100	98	119	117	123	122	109	115	113

HEIGHT OF PLANTS (FEET)

Date of seeding	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	Average
Apr. 15	3.0	3.0	4.0	4.5	4.8	2.3	2.9	3.1	2.7	4.1	3.4
May 1	3.0	3.0	4.0	4.5	5.1	2.3	2.7	3.6	2.6	4.0	3.5
May 15	3.5	2.5	3.5	4.8	4.9	3.1	3.5	4.0	3.3	4.2	3.7
June 1	4.0	2.8	3.8	3.5	5.5	3.2	3.3	3.7	3.2	4.6	3.8
June 15	4.8	3.0	3.5	4.2	4.5	4.0	3.3	4.1	3.5	5.0	4.0
July 1	4.5	2.8	3.9	4.9	5.0	3.1	3.1	4.7	3.8	4.6	4.0

ERECT HEADS (PER CENT)

Date of seeding	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	Average
Apr. 15	59.0	91.3	80.4	70.8	75.6	88.8	95.9	99.1	80.8	70.6	84.8
May 1	62.2	90.7	94.0	93.8	68.7	93.7	100.0	98.4	94.5	80.0	89.2
May 15	67.4	98.8	99.4	90.0	90.6	93.4	99.2	98.2	81.3	71.5	88.9
June 1	52.0	100.0	95.8	98.4	93.6	91.6	97.3	97.5	94.5	78.4	90.3
June 15	70.5	100.0	99.5	94.7	61.0	94.1	98.3	94.9	100.0	83.6	89.7
July 1	74.2	81.8	98.6	70.3	96.1	99.2	92.1	90.7	96.4	82.8	88.2

ACRE YIELDS OF GRAIN (BUSHELS)

Date of seeding	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	Average
Apr. 15	17.5	5.8	21.8	18.0	29.1	10.7	6.2	16.1	11.0	36.4	17.3
May 1	21.9	2.1	10.9	13.4	30.8	6.7	5.6	23.8	14.5	35.4	18.3
May 15	22.4	1.5	35.0	22.0	37.0	20.0	16.6	30.3	18.5	42.3	24.7
June 1	27.6	1.8	42.2	28.4	50.8	22.0	18.2	28.5	14.2	41.8	27.6
June 15	27.6	5.5	31.2	57.6	51.4	32.4	18.8	37.8	15.5	54.8	33.2
July 1	14.3	10.9	30.3	55.3	37.4	25.2	10.4	32.7	16.1	40.2	27.3

ACRE YIELDS OF FORAGE (TONS)

Date of seeding	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	Average
Apr. 15	1.60	0.93	1.07	1.89	1.77	0.08	0.56	1.43	1.25	2.10	1.47
May 1	2.56	1.10	1.63	1.76	2.56	.86	.40	2.10	1.24	2.18	1.65
May 15	2.30	.94	2.81	2.93	2.63	1.54	1.61	2.25	1.58	2.63	2.13
June 1	2.56	1.31	3.49	3.86	4.05	1.46	2.51	2.23	1.40	2.99	2.59
June 15	2.78	1.35	3.01	5.55	3.79	2.29	2.06	2.97	1.94	3.51	2.98
July 1	2.67	1.77	2.50	4.69	3.09	1.95	1.84	3.40	1.51	3.48	2.69

WEIGHT PER BUSHEL (POUNDS)

Date of seeding	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	Average
Apr. 15			60.0	59.5	59.0	56.0	57.5	59.0	58.0	58.0	58.0
May 1			59.5	59.0	58.0	56.5	57.0	58.5	58.5	57.5	57.7
May 15			59.0	55.0	57.5	57.0	58.0	60.0	59.5	58.0	58.0
June 1			60.5	55.5	59.5	57.0	59.0	60.0	59.0	58.5	58.2
June 15			58.0	56.5	59.0	58.5	53.0	59.5	58.0	58.2	57.6
July 1			58.0	56.0	59.0	57.0	52.0	57.0	55.0	53.2	55.9

The size of heads and the number of heads per acre were greater for the seedings of May 15 and later dates than for those made on April 15 and May 1. The June 15 seeding produced the most and the largest heads and consequently the highest yield of grain. The tallest stalks and the greatest forage yields were produced from the June 15 and July 1 seedings. The differences in weight per bushel of grain were not significant except for the July 1 seeding, which produced some immature grain with a lower weight per bushel.

The number of days from planting to maturity decreased with later dates of seeding up to and including the June 15 seeding. The crop from the July 1 seeding headed and ripened during cooler weather and was slower in maturing than the June 1 and June 15 seedings.

Grain sorghums are tropical or warm temperate plants and make the best growth at rather high temperatures. Milo sown in April or early May makes its early growth under temperature conditions below the optimum. Early-sown milo reaches the heading stage during July when the temperatures are highest and moisture frequently deficient, and the crop matures before it is able to utilize late rains.

Milo seeded in late May or in June makes its vegetative growth during the warmest weather. It usually reaches the heading stage in August after the temperature has decreased slightly and produces larger stalks and heads than the plants headed during the period of higher temperature. At Woodward the highest yields of Dwarf Yellow milo in the date-of-seeding experiments were obtained from seedings which headed during periods in which the average mean temperatures had dropped slightly below 80° F. during 8 of the 10 years.

SUNRISE KAFIR

The agronomic data for Sunrise kafir in date-of-seeding experiments at Woodward are shown in Table 23. Good stands were obtained on nearly all plots except the one sown April 15, 1918. The largest number of heads per plant and per acre was secured from the May 15 seeding. The largest heads and the tallest stalks were produced from the last three seedings. The seedings of May 15, June 1, and June 15 produced the highest yields of forage and the heaviest kernels.

TABLE 23.—*Annual and average agronomic data obtained in a date-of-seeding test with Sunrise kafir grown at Woodward, Okla., from 1917 to 1926, inclusive*

Date of seeding	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	Average [1]
ACTUAL SPACING (INCHES)											
Apr. 15	11.79	180.00	16.74	20.35	12.60	12.17	12.97	13.30	17.90	13.17	33.23
May 1	17.20	21.07	10.32	12.76	14.89	10.52	13.10	12.84	14.31	16.61	15.06
May 15	11.08	16.57	13.18	11.54	14.66	10.70	12.05	12.90	13.41	12.00	13.00
June 1	13.42	16.29	13.76	12.00	11.22	9.51	12.49	13.50	15.60	15.75	13.41
June 15	(2)	15.83	12.17	12.32	12.09	11.18	11.92	12.04	13.06	14.65	12.87
July 1	(2)	15.92	12.70	11.94	12.40	11.13	13.28	11.94	14.14	15.59	13.24
HEADS PER PLANT											
Apr. 15	2.54	2.86	1.14	1.85	1.10	0.97	0.87	1.31	1.01	1.19	1.37
May 1	2.90	1.08	1.16	2.41	1.52	.96	.72	1.57	1.10	1.56	1.41
May 15	2.41	1.28	1.09	2.51	1.91	1.31	.91	1.84	1.30	1.10	1.55
June 1	1.77	1.07	1.15	1.88	1.52	1.03	1.21	1.78	1.10	1.39	1.35
June 15	(2)	.76	1.50	1.61	1.13	1.10	.99	1.48	1.59	1.37	1.31
July 1	(2)	.55	1.30	1.08	1.45	1.01	1.15	1.00	.93	1.30	1.13

[1] Nine-year average (1918-1926) for actual spacing, heads per plant, grain per plant, grain per head, and heads per acre.
[2] Not mature; no counts taken.

TABLE 23.—*Annual and average agronomic data obtained in a date-of-seeding test with Sunrise kafir grown at Woodward, Okla., from 1917 to 1926, inclusive*—Continued

Date of seeding	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	Average
GRAIN PER PLANT (POUND)											
Apr. 15	0.152	0.186	0.068	0.137	0.155	0.042	0.044	0.071	0.077	0.035	0.091
May 1	.176	.060	.095	.123	.193	.018	.022	.077	.081	.178	.094
May 15	.135	.042	.149	.186	.212	.028	.046	.066	.083	.144	.106
June 1	.149	.060	.145	.150	.164	.042	.065	.134	.123	.199	.120
June 15		.027	.119	.195	.140	.078	.060	.157	.149	.226	.127
July 1		.023	.131	.117	.125	.044	.049	.164	.052	.177	.098
GRAIN PER HEAD (POUND)											
Apr. 15	0.053	0.065	0.060	0.074	0.134	0.043	0.050	0.054	0.076	0.020	0.065
May 1	.050	.036	.082	.051	.127	.019	.030	.040	.074	.114	.065
May 15	.056	.033	.088	.074	.111	.021	.050	.036	.064	.121	.068
June 1	.084	.056	.126	.080	.108	.041	.054	.073	.112	.143	.088
June 15		.035	.079	.121	.124	.067	.061	.106	.094	.140	.092
July 1		.041	.087	.108	.086	.044	.043	.150	.056	.127	.082
HEADS PER ACRE											
Apr. 15	30,714	2,265	9,708	12,959	13,230	11,363	9,563	14,042	8,044	12,882	10,451
May 1	24,781	11,367	8,560	26,925	14,552	13,909	7,782	17,432	10,958	13,380	13,775
May 15	31,007	11,013	18,279	31,009	18,575	17,453	10,766	20,334	13,820	14,137	17,265
June 1	18,803	9,364	11,914	21,270	19,313	15,441	13,811	18,797	10,052	12,581	14,727
June 15		6,845	17,571	18,629	12,694	14,791	11,840	17,525	17,356	15,278	14,725
July 1		4,925	16,710	12,895	16,589	12,937	12,345	13,015	9,376	12,710	12,390
DAYS FROM PLANTING TO MATURITY											
Apr. 15	170	127	139	137	121	150	143	132	131	133	140
May 1	163	112	124	121	115	139	126	120	119	120	127
May 15	150	119	110	106	110	125	111	106	110	118	117
June 1	132	105	101	105	106	110	119	102	115	108	110
June 15	112	130	97	114	105	101	125	112	110	101	112
July 1	101	133	103	98	119	117	123	128	109	123	115
HEIGHT OF PLANTS (FEET)											
Apr. 15	5.5	5.0	6.0	6.5	6.0	3.7	4.5	5.7	4.2	5.9	5.3
May 1	5.5	4.8	5.5	6.5	6.2	3.5	3.9	5.7	4.4	6.1	5.2
May 15	5.8	4.5	5.3	6.0	6.5	3.6	4.4	5.5	5.0	5.9	5.3
June 1	6.0	4.5	5.0	6.2	6.1	4.6	4.1	5.4	5.0	6.9	5.4
June 15	6.0	3.8	5.0	5.9	5.7	5.2	4.4	6.2	5.8	6.8	5.5
July 1	6.0	4.0	6.0	6.3	5.0	4.0	4.8	6.4	4.6	6.4	5.4
ACRE YIELDS OF GRAIN (BUSHELS)											
Apr. 15	28.0	2.6	10.4	17.0	31.5	8.6	8.5	13.7	11.0	23.0	15.6
May 1	25.0	7.2	12.5	24.6	32.9	4.3	4.2	15.1	14.5	27.9	16.9
May 15	31.2	6.5	28.7	41.0	37.0	6.7	9.6	13.0	15.8	33.2	22.3
June 1	28.3	9.3	26.8	30.5	37.5	11.3	13.4	25.2	20.1	37.0	23.9
June 15	15.4	4.3	25.0	40.2	28.2	17.7	12.9	33.1	29.2	44.7	25.1
July 1	7.8	3.6	25.0	25.0	25.4	10.2	9.4	34.7	9.3	35.9	18.7
ACRE YIELDS OF FORAGE (TONS)											
Apr. 15	3.49	0.34	1.60	2.19	2.05	1.27	1.00	1.80	1.25	2.33	1.73
May 1	3.63	.08	1.38	3.11	2.14	.04	.50	2.44	1.74	3.04	2.00
May 15	4.22	1.55	2.42	3.70	3.30	1.24	1.16	2.29	1.86	2.93	2.48
June 1	3.43	1.10	2.28	3.19	2.60	1.58	2.06	2.44	2.59	3.41	2.49
June 15	2.81	.64	2.45	3.23	1.88	2.21	1.39	3.63	3.13	3.68	2.51
July 1	2.63	.76	2.50	2.14	2.44	1.43	1.61	3.30	1.52	4.46	2.30
WEIGHT PER BUSHEL (POUNDS)											
Apr. 15			61.0	58.0	61.0	57.5	58	60.5	59	58.0	59.1
May 1			60.0	59.0	61.5	55.0	58	59.5	60	59.0	59.0
May 15			61.5	59.0	61.5	56.5	57	59.5	60	60.0	59.4
June 1			62.0	60.5	61.5	56.0	59	61.0	60	61.0	60.1
June 15			60.5	62.0	60.5	58.0	59	61.0	60	61.0	60.3
July 1			60.0	57.0	61.5	60.0	56	62.0	57	55.5	58.6

The period from planting to maturity decreased with later seeding dates until the June 1 seeding, after which the period from planting to maturity increased.

The conditions affecting Sunrise kafir are very similar to those mentioned in connection with Dwarf Yellow milo. Sunrise kafir required one to six days longer to reach maturity at Woodward and even longer elsewhere. It makes a better germination and growth at low temperatures, and, therefore, probably should be sown a few days earlier than Dwarf Yellow milo.

REED KAFIR

The agronomic data for Reed kafir in date-of-seeding experiments at Woodward are shown in Table 24.

TABLE 24.—*Annual and average agronomic data obtained in a date-of-seeding test with Reed kafir grown at Woodward, Okla., from 1922 to 1926, inclusive*

Date of seeding	1922	1923	1924	1925	1926	Average
ACTUAL SPACING (INCHES)						
Apr. 15				13.73	7.96	
May 1	11.02	12.81	14.10	12.46	8.63	11.82
May 15	11.10	12.08	12.85	12.80	6.90	11.15
June 1	10.06	12.20	14.53	13.26	7.31	11.47
June 15	10.63	11.73	11.61	13.29	6.36	10.72
July 1			11.65	14.10	6.75	
HEADS PER PLANT						
Apr. 15				.98	1.04	
May 1	.85	.79	1.08	1.04	1.08	.97
May 15	.95	.91	1.13	1.01	1.08	1.02
June 1	1.01	1.02	1.04	.96	1.05	1.02
June 15	.96	.96	1.09	1.34	1.10	1.00
July 1			1.00	.86	1.06	
GRAIN PER PLANT (POUND)						
Apr. 15				0.073	0.102	
May 1	0.038	0.022	0.141	.100	.154	0.091
May 15	.066	.072	.095	.082	.107	.084
June 1	.079	.121	.146	.078	.120	.109
June 15	.108	.128	.155	.154	.124	.134
July 1			.175	.076	.100	
GRAIN PER HEAD (POUND)						
Apr. 15				0.074	0.098	
May 1	0.045	0.028	0.131	.096	.143	0.089
May 15	.069	.079	.084	.081	.099	.082
June 1	.078	.119	.140	.081	.114	.106
June 15	.113	.133	.142	.115	.113	.123
July 1			.175	.068	.100	
HEADS PER ACRE						
Apr. 15				10,175	18,626	
May 1	10,996	8,792	10,851	11,899	17,841	12,076
May 15	12,201	10,739	12,636	11,240	22,314	13,808
June 1	14,313	11,919	10,203	10,321	20,477	13,447
June 15	12,675	11,067	13,384	14,374	24,657	15,391
July 1			12,237	8,695	22,367	

TABLE 24.—*Annual and average agronomic data obtained in a date-of-seeding test with Reed kafir grown at Woodward, Okla., from 1922 to 1926, inclusive*—Continued

Date of seeding	1922	1923	1924	1925	1926	Average
DAYS FROM PLANTING TO MATURITY						
Apr. 15				131	133	
May 1	139	126	120	117	128	126
May 15	125	111	100	108	115	113
June 1	110	112	100	102	108	106
June 15	101	105	109	101	101	103
July 1			128	109	123	
HEIGHT OF PLANTS (FEET)						
Apr. 15				3.22	5.47	
May 1	3.22	3.32	5.05	3.35	4.07	3.98
May 15	3.53	3.80	4.87	3.53	5.15	4.18
June 1	4.20	3.97	4.48	5.10	5.03	4.68
June 15	4.78	3.78	5.03	5.00	5.90	4.90
July 1			5.20	4.10	5.42	
ACRE YIELDS OF GRAIN (BUSHELS)						
Apr. 15				13.4	32.5	
May 1	8.8	4.4	25.4	20.4	45.0	20.9
May 15	15.0	15.2	18.0	16.4	39.6	21.0
June 1	19.8	25.4	25.5	15.0	41.6	25.5
June 15	26.0	27.6	34.0	29.5	49.8	33.4
July 1			38.2	13.7	39.8	
ACRE YIELD OF FORAGE (TONS)						
Apr. 15				1.46	3.32	
May 1	1.09	0.51	2.03	1.58	3.73	1.79
May 15	1.50	1.36	1.86	1.91	3.15	1.96
June 1	1.95	2.88	1.60	2.32	3.38	2.44
June 15	2.40	2.30	2.86	2.43	4.33	2.88
July 1			2.00	1.49	5.06	
WEIGHT PER BUSHEL (POUNDS)						
Apr. 15				60.5	58.5	
May 1	54.5	56	61.0	60.0	59.5	58.2
May 15	57.5	57	61.0	61.0	59.0	59.1
June 1	55.0	58	61.5	59.5	61.0	59.0
June 15	57.0	58	62.5	60.0	59.5	59.4
July 1			59.5	57.0	55.0	

The average spacings secured were too great for the highest yields of Reed kafir. The plants produced very few suckers from any seeding. The greatest number of heads per plant and per acre, the largest heads, and the tallest stalks were produced from the June 15 seeding. This date of seeding produced the highest acre yields of Dwarf Yellow milo and Sunrise kafir, as well as of Reed kafir, at Woodward. Reed kafir matures in about the same length of time as Dwarf Yellow milo at Woodward, but in other localities it requires considerably longer than does Dwarf Yellow milo.. It probably can grow at a somewhat lower temperature than milo and may be sown earlier without reduction in the yield of grain in most sections.

EFFECT OF VARIETY

Varieties of grain sorghums differ in time of maturity, in growth at low temperatures, and probably in responses to light. Feterita is especially sensitive to low temperature during germination and early growth, whereas Freed sorghum and kaoliangs can grow at lower temperatures than the other grain sorghums. In time of maturity the order of earliness for the grain-sorghum groups is about as follows: Freed, kaoliang, feterita, milo, and kafir. The earlier the variety the later it can be sown and still have time to mature.

Kafirs should be sown earlier than the other grain sorghums mentioned in order to bring the crop to maturity in ample time. Kafir can withstand lower temperatures during germination than can milo and feterita. The later the variety of kafir the earlier it should be sown. Dawn, Sunrise, and Reed kafir are only slightly later than Dwarf milo and need not be sown more than a few days earlier. Feterita and kaoliang should be sown at the same time as or a few days later than the optimum for milo.

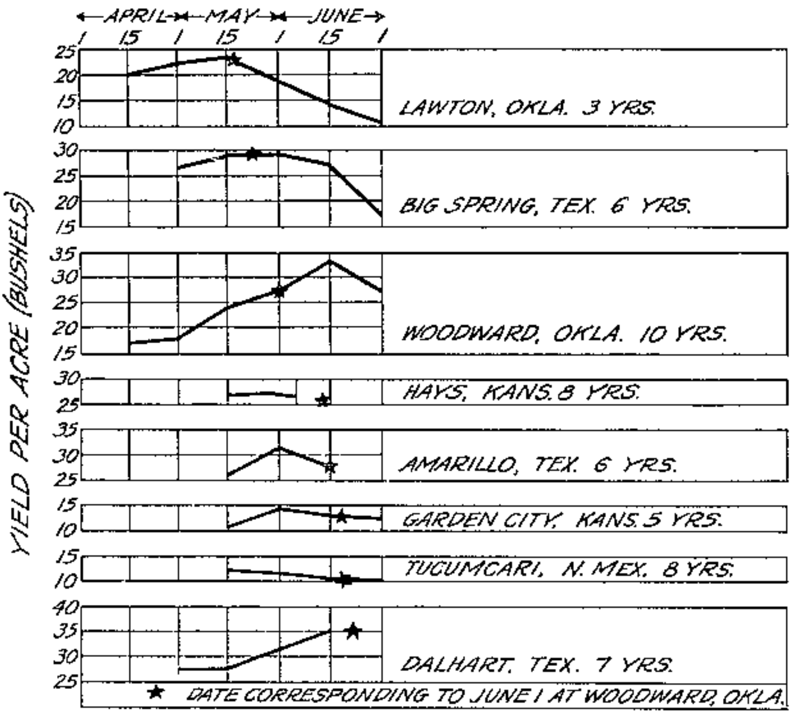


FIGURE 6.—Average yields of Dwarf Yellow milo grown in date-of-seeding experiments during 3 to 10 years at eight experiment stations

Grain sorghums should not be sown so late that there is danger of frost before the crop will mature, but in general the seeding should be delayed as long as frost injury can safely be evaded in the northern portion of the grain-sorghum region. Farther south the seeding should be done late enough so that the crop will not head until some time in August. Sufficient time should be allowed to permit the crop to recover and resume growth after periods of drought, which often occur. Seeding also should be early enough to permit reseeding if a stand is not obtained. The land should be prepared early and kept free from weeds to conserve moisture while seeding is being postponed. Delayed seeding may be of no advantage if the reserve moisture has been exhausted by weed growth.

EFFECT OF LOCATION

The average yields from the date-of-seeding experiments with milo presented in Table 15 are shown graphically in Figure 6. The stations are arranged in the order of the "corresponding date," the earliest station, Lawton, Okla., being shown at the top. The graph shows that milo may be sown too early as well as too late. There appears to be some relation, but not a very definite one, between the optimum seeding date for milo and the "corresponding date" or temperature conditions at the various stations. In the absence of insects or other disturbing factors Dwarf Yellow milo may be seeded

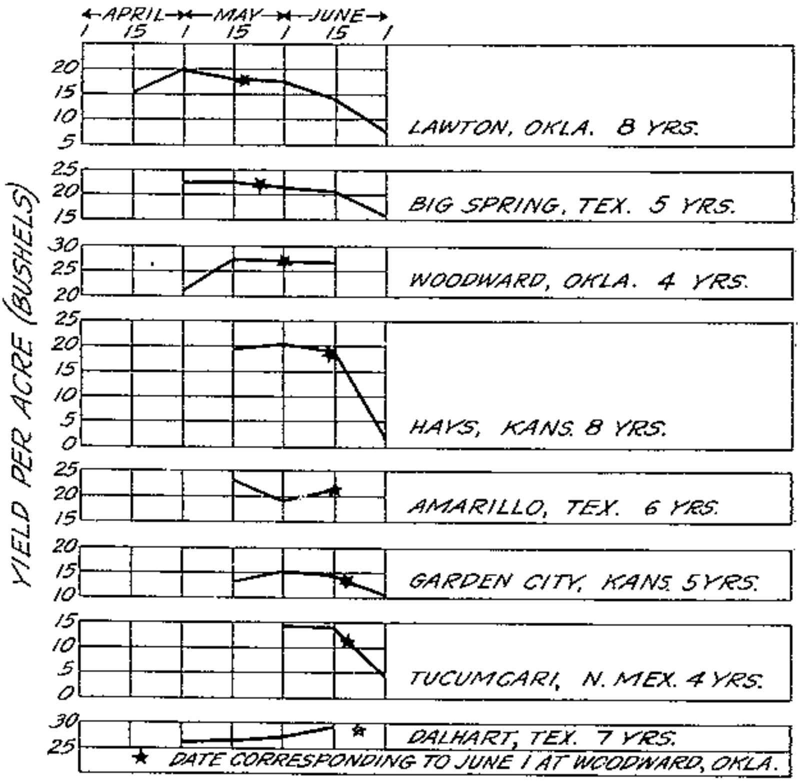


FIGURE 7.—Average yields of Dawn kafir grown in date-of-seeding experiments during 4 to 8 years at seven experiment stations

June 1 to June 15 throughout the southern Great Plains with the expectation of obtaining close to the maximum yield for the season.

The average yields of Dawn kafir, presented in Table 16 and Figure 7, show results similar to those obtained with milo, except that the optimum date of seeding tends to be earlier and the relation between date of seeding and optimum date is more definite. The highest yield was produced from seedings made on either May 15 or June 1 at six of the eight stations.

There appears to be some relation between location and the best date of seeding for grain sorghums in the southern Great Plains. However, the air and soil temperatures are lower at the more northern stations at what has proved to be the best seeding time. Early seeding is necessary at these stations because there is a greater necessity for speeding up the maturity of the crop, in order to avoid injury from cool fall weather or frost. Too early seeding at the southern stations brings the crop into head during too hot weather for best development, and the crop matures without benefiting from any late rains which may occur.

Early-sown grain sorghums frequently produce a second crop of grain in the southern part of the United States when moisture is ample, and the plants send up new stalks from the roots after the first crop has been cut.

MOISTURE

The moisture supply during the heading period is an important factor affecting the yields from seedings made on different dates in any single experiment with grain sorghums. Sieglinger (*10*) showed that rains usually occurred during the heading period of those milo plots which made the highest yields in date-of-seeding experiments.

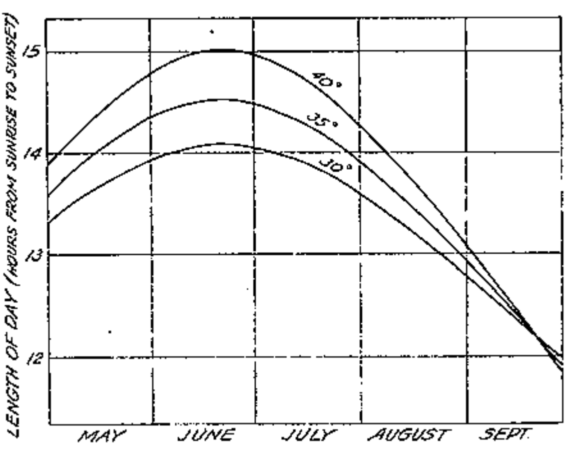


FIGURE 8.—Length of day (sunrise to sunset) at latitudes 30°, 35°, and 40° north, from May 1 to September 30

Rainy weather produces effects in addition to increasing the moisture supply, such as lowering the temperature, decreasing evaporation, and prolonging the period of heading of the crop. Rainfall is very irregular in its distribution, however, and can not be depended upon to favor seedings made on definite dates. If the crop is sown rather late on soil in which the moisture has been conserved it may benefit from late rains which the early sown crop misses entirely.

LENGTH OF DAY

The length of day, or photoperiodism, has a marked effect upon the growth and time of flowering and maturity of many plants including sorghums (*5*). The length of day during the growing period of sorghums at three latitudes is shown in Figure 8. It will be seen that in order to have the same length of day for any seeding time previous to June 21 the seeding would need to be done much earlier in the northern latitudes than in the southern ones. On the other hand, seeding would be done much later in the northern latitudes to have crops reach the heading stage during the same day length as in the South. The crop would need to be seeded earlier in the South in order to receive the same number of hours of daylight. The extreme variation in latitude between any two of the nine stations for which data are shown is about 6° 43′ between Big Spring, Tex., and Hays, Kans. There is a difference of about 32 minutes in day length during the longest days. This is equivalent to only about 3.7 per cent more light at Hays than at Big Spring when the difference is greatest. Such small differences in amounts of light can not be detected by the response of the sorghum crop grown in another locality.

The yields previously presented demonstrate that the best time of seeding within the southern Great Plains bears only a partial relation to latitude. The data available, therefore, show no certain relation between the optimum date of seeding and the length of day at seeding or heading time within the area where the experiments were conducted.

TEMPERATURE

In limited experiments under irrigation at Sacaton, Ariz., and Bard, Calif., it has been found that higher yields are obtained from seeding grain sorghums after June 1 than before that date. The heads from June seedings at Sacaton are larger than from May seedings just as was the case at Woodward, Okla. The difference is not due to soil moisture, because that factor is largely eliminated by irrigation. Grain sorghums seeded in May usually reach the heading stage in July during the hottest weather of the season, while the June seedings usually head in August when the temperature is somewhat lower. A comparison of the temperature at heading time with the yield of Dwarf Yellow milo grown at Woodward, Okla., is shown graphically in Figure 9. The highest yields of grain were obtained from seedings which headed during or immediately following periods in which the mean temperature had dropped slightly below 80° F., in 8 of the 10 years. The crops of 1919 and 1921 were the exceptions to the above condition. A similar comparison for several years at Tucumcari, N. Mex., does not show any relation between yields and temperature, but the temperatures there seldom were above a mean of 80° F. for any extended period, and the yields usually were low, owing to drought. Apparently temperature is an important factor controlling the development of grain sorghums during the vegetative period. It probably accounts for most of the variation in the yield of grain sorghums in date-of-seeding experiments which are not affected by drought or insects.

EFFECT OF INSECT INJURY

Chinch bugs usually cause severe injury to grain sorghums at Lawton, Okla., and occasionally at Hays, Kans. Chinch bugs will attack grain sorghums during any part of the vegetative period of the plants, but the older and less tender plants are better able to withstand the attacks. The plants in the earlier seedings at Lawton have been largest at the time the chinch bugs migrate to the sorghum fields and, consequently, show the least injury and produce the highest yields. The late seedings at Lawton frequently have been entirely destroyed.

Just as the chinch bug determines the date of seeding grain sorghums in some localities, the sorghum midge is the chief factor to be considered throughout the Gulf coast district. In that district the grain sorghums should be seeded as early as possible, in order to be past the blooming period before many of the midges have emerged (*8*). The earliest seedings usually show the highest yields under conditions of heavy midge infestation, although the crop would be much better

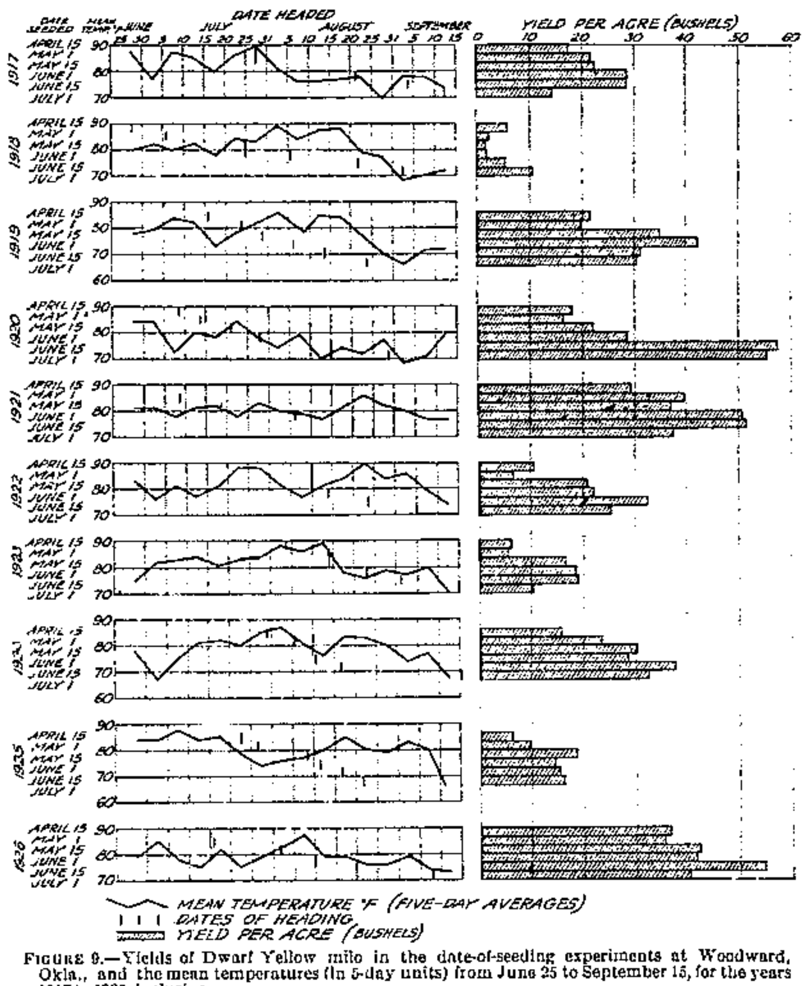


FIGURE 9.—Yields of Dwarf Yellow milo in the date-of-seeding experiments at Woodward, Okla., and the mean temperatures (in 5-day units) from June 25 to September 15, for the years 1917 to 1926, inclusive

from later seedings if the midges were not present. Late varieties of grain sorghum sometimes can best be sown in July, so that blooming occurs after most of the midges have ceased oviposition.

SUMMARY

The results of spacing and date-of-seeding experiments with several varieties of grain sorghums at nine field stations in the southern Great Plains are reported.

The average optimum spacings between plants for the production of sorghum grain in rows 40 to 44 inches apart are about 18 inches for Dwarf Yellow milo, 12 inches for Sunrise kafir, 9 inches for feterita, and 6 inches for Freed sorghum and for kafirs other than Sunrise.

Wide spacing of plants in the rows increases the number of heads per plant and the size of heads but decreases the number of heads per acre. There is a slight increase in the size of the kernels with wide spacing. Wide spacing delays maturity of the crop by an average of one to three days, but has no consistent effect upon the height of the crop. The highest yields of forage are obtained from a narrow spacing of kafir plants in the row and a medium or narrow spacing of milo. The percentage of erect heads in Dwarf Yellow milo is increased by narrow spacing.

The best spacings for the different varieties of grain sorghum depend largely upon the number of heads produced per plant under conditions favorable for tillering. Varieties which tiller freely, such as Dwarf Yellow milo and Sunrise kafir, show less effect from variable spacing than varieties which tiller sparingly, such as Reed kafir.

The best spacing for any variety probably can be calculated by growing the variety along with standard varieties for which the optimum spacing is known, in 6-inch and 24-inch spacings, and determining the "spacing index." The spacing index is the product of two ratios—(1) the number of heads per plant in the 24-inch spacing divided by the number from the 6-inch spacing and (2) the weight of grain per head in the 24-inch spacing divided by the weight in the 6-inch spacing. The spacing required is nearly proportional to the spacing index.

The yields of Dwarf Yellow milo from 6-inch and 12-inch spacings are lower than from the 18-inch spacing, regardless of the moisture supply. The yields of Dawn kafir are higher from the closer spacings under average conditions and when moisture is abundant, but the 18-inch spacing outyields the closer spacings in dry seasons. Kafir plants should be spaced about 12 inches apart where severe drought is likely to occur, in order to insure some production of grain.

Narrow spacing for all varieties is necessary where the sorghum midge is abundant.

The yields of Dwarf Yellow milo were reduced about 2 per cent by growing the plants in widely spaced rows (80 to 88 inches apart) when the number of plants per acre was the same as in rows 40 to 44 inches apart. Kafir and feterita yields are about 10 per cent less from the widely spaced than from the ordinary rows. The lower yields from the widely spaced rows with the same number of plants per acre occur at all spacings of the plants within a row.

Stover and fodder yields of all grain sorghums usually are decreased considerably by growing the crop in widely spaced rows.

The average yield of all varieties of grain sorghums grown in pairs of rows widely spaced between pairs was 4.5 per cent less than the average yield from the ordinary rows.

The general optimum dates for seeding the grain-sorghum varieties, where insect injury is not probable, are about May 15 for Dawn, Sunrise, and Reed kafirs; June 1 for Dwarf Yellow milo; June 15 for Standard and Dwarf feterita; and June 15 for kaoliangs.

Medium-late seeding results in better stands, taller stalks, larger heads, and shorter growing periods than does early seeding.

The optimum date of seeding is related to the time of maturity of the variety. The earliness of seeding should be inversely proportional to the earliness of maturity. Milo and feterita are very sensitive to low temperatures at seeding time and ordinarily should not be sown until the soil is warm.

There is some relation between the optimum date of seeding grain sorghums and the latitude, corresponding vegetative season, or length of day within the southern Great Plains. The distribution of rainfall has a pronounced effect upon the crop from various dates of seeding in a given experiment, but it is too irregular to be depended upon for determining dates of seeding in any locality. Ample moisture at heading time is necessary for high yields.

The temperature during heading time is an important factor in determining the yields of grain sorghums. Mean temperatures higher than 80° F. during heading result in shorter stalks, smaller heads, and lower yields than do mean temperatures slightly lower than 80° F.

Seeding as early as it is possible to get a stand is advisable where severe injury from chinch bugs or sorghum midge is likely to occur.

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