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SHELLING PERCENTAGE IN GRAIN SORGHUM



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SHELLING PERCENTAGE IN GRAIN SORGHUM

BY

A. B. CONNER AND R. E. KARPER.

With the production of sixty million bushels of grain sorghum annually in Texas, a considerable portion of which is marketed in the head, and the development of the market for the surplus product, there has arisen a demand for information as to the turn-out of grain from the heads as harvested. Data on this point have accumulated at Substation No. 8, Lubbock, as a by-product of the variety and rate of seeding experiments with grain sorghums. They embrace a period of six years, and it is believed are reliable as to the grain content of heads in the different classes and varieties and under varying seasonal conditions. These data are presented here in the hope that they may prove of value to producers, consumers, and dealers in grain sorghum.

METHOD USED.

The data presented in this paper, in most cases, where a comparison of varieties is made, have been obtained from the average of two single-row plats 132 feet long. In a few instances only have the percentages relating to different varieties been obtained from plats as large as one-tenth acre. All the data for a period of six years accruing from the rate of seeding plats have been obtained from one-sixteenth-acre plats, comprising seven rows 132 feet long, the two outer rows of which have been discarded, leaving a net five rows, or one-twenty-second-acre plat, from which these records have been obtained.

The heads in the plats involved throughout have been harvested promptly each season as soon as the basal stems were yellow, or at most within a week of this time. All heads were harvested by hand and cut with stem lengths from $2\frac{1}{2}$ to $3\frac{1}{2}$ inches, which may be slightly shorter than the lengths cut by the average farmer; however, it may be stated that the writers believe them to be fairly representative of hand-harvested heads. The harvested heads were cured in each case until the stems were entirely dry and at that time each lot was weighed and threshed, and the net grain weighed. The weight of the net grain obtained divided by the weight of the heads gives the percentage of grain to head.

THE DATA.

The shelling percentages given for the different varieties for different years are the average of duplicate determinations, being the entire product of the plat in each case. The percentages for the milo and kafir grown at different thicknesses in the row are from single determinations.

Shelling Percentages of Different Varieties.

The following table shows the percentage of grain to head in the different varieties for a period of six years, 1916 to 1921, inclusive.

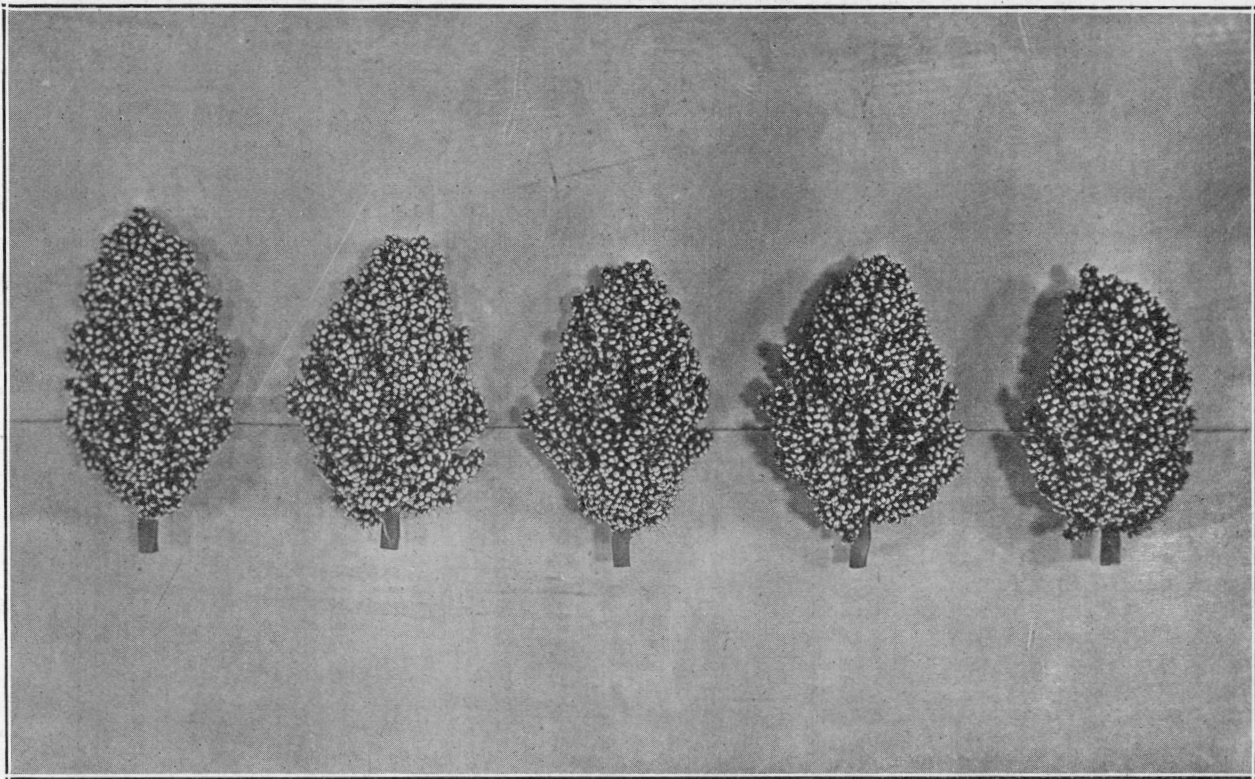


Figure 1.—Uniformity characterizes good breeding in milo and other grain sorghums, and increases the value of the crop.

Shelling percentage of grain sorghum varieties.

| Class | T. S. No. | Variety | 1916 | 1917 | 1918 | 1919 | 1920 | 1921 | Average of strains for six years | Average of classes |
|----------------|----------------|-----------------------|-------|-------|-------|-------|-------|-------|----------------------------------|--------------------|
| Feterita | 2840 | Dwarf Feterita | 78.6 | 77.34 | 74.21 | 80.22 | | | | |
| | 1647 | Feterita | 78.5 | 69.04 | | | | | | |
| | 2841 | Improved Feterita | 74.5 | 78.36 | 78.27 | 77.88 | 75.50 | 79.25 | 77.29 | |
| | 1651 | Feterita | 73.8 | 75.58 | | | | | | |
| | 1650 | Feterita | 78.5 | 71.87 | | | | | | |
| | 1652 | Feterita | 75.8 | 75.00 | 73.21 | 75.39 | 71.00 | 81.30 | 75.28 | |
| | 1650 | Feterita | 70.3 | | | | | | | |
| | 669 | Sudan Durra | 75.8 | 63.96 | | | | | | |
| | 1655 | Dwarf Feterita | | 61.81 | | | | | | |
| | 3232 | Spur Feterita | | | 75.09 | 76.37 | 68.50 | 79.80 | | |
| | 3231 | Leafy Feterita | | | 67.74 | 80.25 | 69.50 | 78.45 | | |
| 3297 | Dwarf Feterita | | | 74.70 | | | | | | |
| 5985 | Dwarf Feterita | | | | | | 81.66 | | | |
| | | Average | 75.7 | 72.62 | 73.87 | 78.02 | 71.12 | 80.09 | | 75.23 |
| Kaoliang | 1936 | Dwarf Red Kaoliang | 77.1 | 62.69 | 73.23 | 78.46 | 76.50 | 84.05 | 75.33 | |
| | 1934 | R. B. Seeded Kaoliang | 72.1 | 52.57 | 76.43 | 82.77 | 77.50 | 78.92 | 73.38 | |
| | 1935 | Brown Kaoliang | 79.0 | 60.38 | 74.51 | 75.91 | 78.50 | 80.46 | 74.79 | |
| | | Average | 76.06 | 58.54 | 74.72 | 79.04 | 77.50 | 81.14 | | 74.50 |
| White Milo | 1645 | White Milo | 76.3 | 71.75 | 76.08 | 77.11 | 73.50 | 82.52 | 76.21 | |
| | 1643 | White Milo | 75.5 | 68.17 | 78.46 | 69.90 | 72.50 | | | |
| | 1644 | White Milo | 74.8 | 69.83 | 70.70 | 74.53 | 72.50 | | | |
| | 1926 | Dwarf White Milo | 69.3 | 67.00 | 74.77 | 74.61 | 75.50 | 79.46 | 73.44 | |
| | 3296 | Dwarf White Milo | | 71.59 | 71.75 | 67.98 | 66.00 | | | |
| | | Average | 73.9 | 69.66 | 74.35 | 72.82 | 72.00 | 80.99 | | 73.95 |
| Blackhul Kafir | 1940 | White Kafir | 68.9 | 63.85 | 74.53 | 75.30 | 76.50 | 81.13 | 73.36 | |
| | 1845 | Dwarf Kafir | 80.8 | 74.19 | 73.83 | 76.33 | 77.00 | 80.83 | 77.24 | |
| | 1939 | Early B. H. Kafir | 80.1 | 68.66 | 77.48 | 80.03 | 77.00 | 81.69 | 77.49 | |
| | 34 | Dwarf B. H. Kafir | 74.9 | 62.29 | 73.94 | 75.99 | 73.00 | 78.89 | 73.16 | |
| | 1937 | Dwarf Kafir | 73.7 | 70.61 | 72.05 | 73.15 | 74.50 | 78.94 | 73.82 | |
| | 673 | Dwarf B. H. Kafir | 78.0 | 70.39 | 72.72 | 75.24 | 75.50 | 79.42 | 75.21 | |
| | 1927 | Blackhul Kafir | 73.8 | 41.42 | 69.15 | 76.38 | 75.50 | 79.47 | 69.28 | |
| | 35 | Early B. H. Kafir | 71.0 | 59.61 | | 73.80 | 73.50 | 76.73 | | |
| | 44 | Standard B. H. Kafir | 62.9 | 55.51 | 66.66 | 74.95 | 75.00 | 82.32 | 69.55 | |
| | 1920 | White Kafir | 76.3 | 64.13 | 68.82 | 78.00 | 75.50 | 77.69 | 73.40 | |
| | 674 | Standard B. H. Kafir | 68.3 | 61.70 | 78.09 | 72.31 | 75.50 | 85.00 | 73.48 | |
| | 1942 | Swarf Hegari | 70.9 | 50.04 | 65.20 | 79.40 | | | | |
| | 3682 | Kafir | | | 77.66 | 76.19 | 72.50 | 80.32 | | |
| | 4224 | Dwarf Kafir | | | | 73.72 | 73.50 | | | |

Shelling percentage of grain sorghum varieties—Continued.

| Class | T. S. No. | Variety | 1916 | 1917 | 1918 | 1919 | 1920 | 1921 | Average of strains for six years | Average of classes |
|--------------------------------|-----------|----------------------|------|-------|-------|-------|-------|-------|----------------------------------|--------------------|
| Blackhul Kafir. (Continued) | 6022 | Blackhul Kafir | | | | | 75.50 | 81.04 | | |
| | 3215-646 | Blackhul Kafir | | | | | 76.50 | 80.01 | | |
| | 3215-223 | Blackhul Kafir | | | | | 75.50 | 81.67 | | |
| | | Average | 73.3 | 61.85 | 72.51 | 75.77 | 75.06 | 80.34 | | 73.13 |
| Red Kafir | 46 | Red Kafir | 71.3 | 60.95 | 61.90 | 80.31 | 77.00 | 81.49 | 72.15 | |
| | 1928 | Red Kafir | 62.9 | | 70.00 | 81.36 | 79.00 | | | |
| | 1938 | Red Kafir | 70.1 | 62.50 | | | | | | |
| | | Average | 68.1 | 61.72 | 65.95 | 80.83 | 78.00 | 81.49 | | 72.68 |
| Yellow Milo | 672 | Standard Yellow Milo | 75.4 | 68.42 | 67.02 | 75.75 | 68.00 | 78.79 | 72.23 | |
| | 670 | Dwarf Yellow Milo | 73.6 | 63.25 | 71.07 | 65.07 | 73.00 | 75.65 | 70.27 | |
| | 671 | Dwarf Yellow Milo | 66.6 | 69.90 | 73.69 | 68.71 | 66.50 | | | |
| | 1646 | Dwarf Yellow Milo | 71.6 | 66.18 | 71.20 | 71.66 | 71.00 | 75.54 | 71.19 | |
| | | Average | 71.8 | 66.93 | 70.74 | 70.29 | 69.37 | 76.66 | | 70.96 |
| Darso | 2897 | Darso | 75.7 | 65.34 | 64.91 | 73.80 | 70.00 | 74.19 | 70.65 | |
| | | Average | | | | | | | | 70.65 |
| | | | | | | | | | | |
| Schrock Kafir | 1923 | Schrock Kafir | 73.0 | 53.28 | 63.32 | 80.32 | 71.50 | 75.12 | 69.42 | |
| | 2450 | Schrock Kafir | | 52.77 | 66.18 | 81.37 | 73.50 | | | |
| | | Average | 73.0 | 53.02 | 64.75 | 80.84 | 72.50 | 75.12 | | 69.87 |
| Pink Kafir | 1929 | Pink Kafir | 64.6 | 44.23 | | 78.83 | 78.00 | | | |
| | 45 | Pink Kafir | 63.8 | 46.42 | 56.88 | 78.92 | 76.50 | 81.53 | 67.34 | |
| | 3295 | Pink Kafir | | | 82.74 | 80.10 | 76.50 | 81.67 | | |
| | | Average | 64.2 | 45.32 | 69.81 | 79.28 | 77.00 | 81.60 | | 69.53 |
| Shallu | 1653 | Shallu | 77.0 | | 64.54 | 76.62 | 68.00 | 74.81 | | |
| Acuff | 1654 | Acuff | 60.0 | 55.00 | 68.20 | 72.02 | 68.00 | | | |
| Hoover | 2899 | Hoover | 80.4 | 75.66 | 68.29 | 76.63 | | | | |
| Freed | 41 | Freed | | | 69.28 | 83.52 | 77.50 | | | |

It should be stated that the relatively low-shelling percentages of the later-maturing varieties in 1917 was due in part to immaturity, as the season was a dry one and these late varieties failed to properly mature seed. This affected not only the percentage of grain to head, but the yield of grain. The same was true in the season of 1918, but to a lesser extent. The appended table on page 11 shows the monthly rainfall from 1916 to 1921, inclusive, and the dates of killing frost each year.

It is seen from the above table that the shelling percentage varies in the different classes of grain sorghum, ranging, for example, from 75.23 per cent. in feterita, to 69.53 per cent. in Pink kafir. Feterita, Kowliang, and Blackhul kafir, and White milo rank high in shelling percentages, and White milo has consistently shown higher turn-outs of grain than Yellow milo.

It is evident that there is almost as wide variation in different strains within a class as in the classes themselves, indicating the possibilities of developing higher grain-bearing strains. In fact, this is well illustrated in the case of the Blackhul kafir class, in which two strains, Nos. 1845, Dwarf kafir, and 1939, Early Blackhul kafir, both highly improved strains, have a shelling percentage of 77, while No. 44 Standard Blackhul kafir, unimproved, has a shelling percentage of 69.

The following table shows several classes of grain sorghums and their shelling percentages, based on the averages taken from the detail table. It also shows the rank of each class based on shelling percentage and the net grain turn-out per ton of heads based on these percentages.

Shelling percentages of grain sorghums.

| Class | Shelling percentage | Rank | Pounds grain to the ton of heads |
|---------------------|---------------------|------|----------------------------------|
| Feterita..... | 75.23 | 1 | 1504 |
| Kowliang..... | 74.50 | 2 | 1490 |
| White Milo..... | 73.95 | 3 | 1479 |
| Blackhul Kafir..... | 73.13 | 4 | 1462 |
| Red Kafir..... | 72.68 | 5 | 1453 |
| Yellow Milo..... | 70.96 | 6 | 1419 |
| Darso..... | 70.65 | 7 | 1413 |
| Schrock Kafir..... | 69.87 | 8 | 1397 |
| Pink Kafir..... | 69.53 | 9 | 1390 |

It will be seen that as between 75.23 per cent. and 69.53 per cent. the two extremes in the classes shown, there is a difference of 114 pounds of grain to the ton of heads.

It should be stated that the shelling percentage in milo is perhaps slightly lowered as compared to feterita and kafir, because of the fact that the seed are held more securely by the glume or hull. This would, naturally, lower its shelling percentage, as more of the seed would pass through the machine with the "pummies." Such loss, however, would not be encountered if the crop were utilized in the head. This tendency for milo heads to hold their seed would actually be advantageous when the heads are handled excessively before threshing, as less shattering would take place than in feterita undergoing the same treatment.

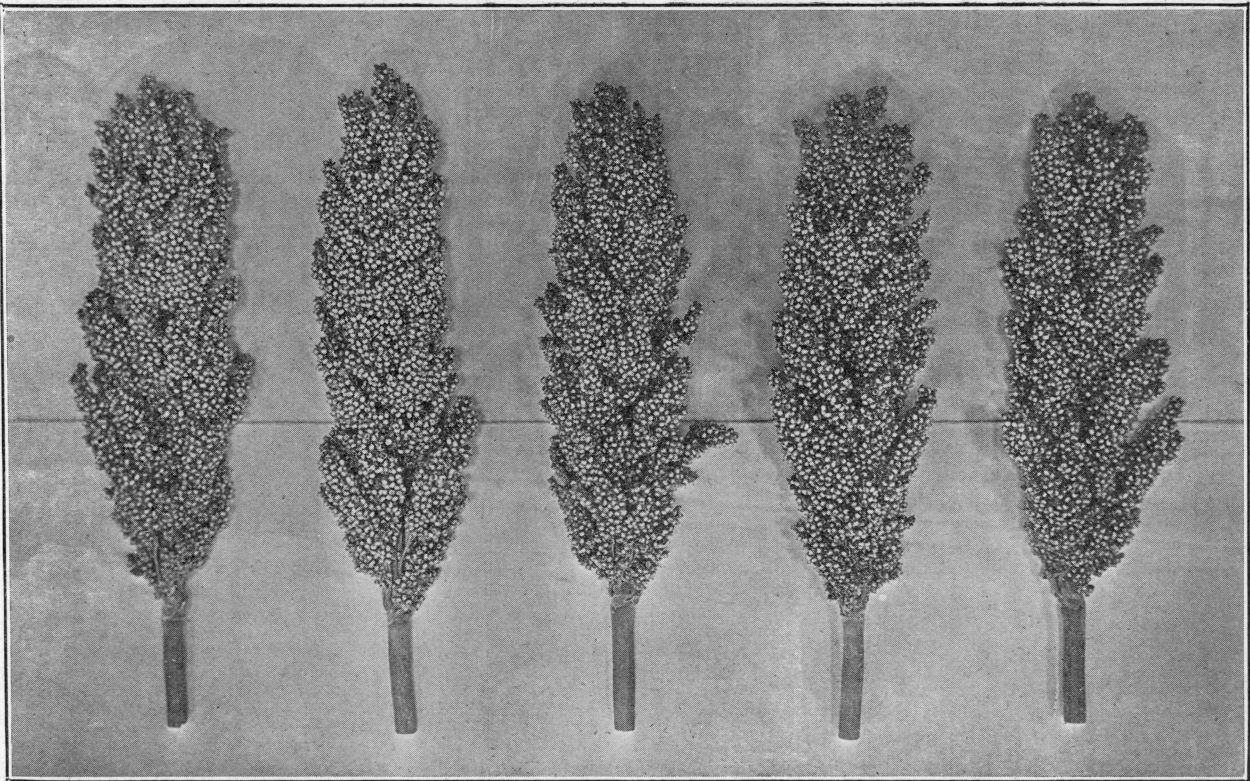


Figure 2.—Kafir heads of such uniformity turn out high percentages of grain.

Shelling Percentage as Affected by Environment.

With the knowledge that different classes and strains of grain sorghums show different shelling percentages there arises the question as to the effect varying seasonal conditions may have on the shelling percentage or turn-out of grain. Some light is given on this point by the following tables, showing the shelling percentages from year to year when milo and kafir are planted at varying thicknesses, and hence, subjected to varying opportunities for development.

Shelling percentage yellow milo spacing test, 1916-1921, inclusive.

| Distance in inches between plants in row | Shelling percentages | | | | | | Shelling per cent average |
|--|----------------------|-------|-------|-------|-------|-------|---------------------------------|
| | 1916 | 1917 | 1918 | 1919 | 1920 | 1921 | |
| 3..... | 84.70 | 69.78 | 56.25 | 65.81 | 65.00 | 70.95 | 68.74 |
| 6..... | 81.80 | 64.40 | 67.85 | 65.62 | 72.00 | 73.64 | 70.88 |
| 9..... | 78.50 | 68.46 | 76.71 | 45.77 | 73.00 | 72.09 | 69.08 |
| 12..... | 79.40 | 69.69 | 52.50 | 64.25 | 72.00 | 71.56 | 68.23 |
| 15..... | 80.70 | 71.68 | 64.28 | 75.06 | 72.00 | 65.74 | 71.57 |
| 18..... | 82.00 | 82.85 | 59.09 | 72.87 | 70.00 | 70.51 | 72.88 |
| 21..... | 82.30 | 71.08 | 63.81 | 67.71 | 67.00 | 68.55 | 70.07 |
| 24..... | 77.10 | 72.61 | 64.65 | 66.04 | 70.00 | 70.90 | 70.21 |
| 27..... | 80.60 | 72.43 | 63.12 | 66.59 | 69.00 | 69.13 | 70.14 |
| 30..... | 79.50 | 73.78 | 67.64 | 66.74 | 68.00 | 70.42 | 71.01 |
| 33..... | 82.70 | 73.25 | 69.00 | 69.29 | 70.00 | 73.85 | 73.01 |
| 36..... | 80.10 | 75.00 | 71.18 | 66.58 | 70.00 | 72.98 | 72.64 |
| Average..... | 80.78 | 72.08 | 64.67 | 66.02 | 69.83 | 70.86 | 70.70 |

Shelling percentage blackhul kafir spacing test, 1916-1921, inclusive.

| Distance in inches between plants in row | Shelling percentages | | | | | | Shelling per cent average |
|--|----------------------|-------|-------|-------|-------|-------|---------------------------------|
| | 1916 | 1917 | 1918 | 1919 | 1920 | 1921 | |
| 3..... | 71.00 | 71.73 | 74.14 | 76.48 | 86.00 | 79.89 | 76.54 |
| 6..... | 72.00 | 66.36 | | 77.63 | 76.00 | 74.25 | 73.24 |
| 9..... | 71.00 | 72.44 | | 78.70 | 77.00 | 80.45 | 75.91 |
| 12..... | 71.00 | 74.63 | 74.70 | 75.85 | 77.00 | 79.79 | 75.49 |
| 15..... | 71.00 | 73.88 | 78.07 | 77.38 | 76.00 | 80.12 | 76.07 |
| 18..... | 71.00 | 75.38 | 75.14 | 75.11 | 75.00 | 77.73 | 74.89 |
| 21..... | 71.00 | 75.47 | 73.83 | 76.88 | 76.00 | 76.95 | 75.02 |
| 24..... | 71.00 | 73.45 | 73.83 | 75.82 | 75.00 | 78.26 | 74.56 |
| 27..... | 64.00 | 75.31 | 74.02 | 77.62 | 74.00 | 80.39 | 74.22 |
| 30..... | 66.00 | 74.21 | 75.88 | 75.00 | 74.00 | 80.08 | 74.19 |
| 33..... | 66.00 | 77.94 | 76.66 | 68.97 | 75.00 | 77.88 | 73.74 |
| 36..... | 65.00 | 72.81 | 75.00 | 73.57 | 75.00 | 79.79 | 73.52 |
| Average..... | 69.16 | 73.63 | 75.12 | 75.75 | 76.33 | 78.79 | 74.78 |

The above tables, covering a period of six years, in which milo under varying conditions each year and from year to year is directly compared to kafir, show an average shelling percentage of 74.78 for kafir and 70.70 for milo. With the year 1918 eliminated in each instance on account of missing data in the kafir series in that year, the remaining years show an average shelling per cent. for kafir of 74.73 as compared to 71.91 for milo. The evidence here is very closely in line with the shelling percentages of these two classes as shown in the variety data, both indicating a higher turn-out of grain from Blackhul kafir than from milo heads.

In the milo data presented above there is only a slight correlation ($+0.1348 \pm 0.0780$) between the amount of space allowed and the shell-

ing percentage. Similarly, in the kafir spacing test the correlation between the amount of space allowed and shelling percentage is very slight ($-.1602 \pm .0786$). It seems questionable whether there is any relation between the thickness of seeding and the shelling per cent. within the limits of this spacing test. There is, however, an indication, since these two crops have reacted in opposite directions with respect to turn-out of grain from the different seeding rates, that kafir is better adapted to thick seeding than milo, in so far as shelling percentage of grain is concerned.

The variation in shelling percentage of grain from year to year in either milo or kafir is much greater than the variation of the shelling percentage from different spacings within a single season, as shown by the following coefficients of variability:

| | |
|-------------------------|--------|
| Yearly variation—milo | =7.29% |
| Yearly variation—kafir | =4.14% |
| Seasonal spacings—milo | =2.15% |
| Seasonal spacings—kafir | =1.45% |

Further, it would appear from these data that milo is much more variable from year to year or from different spacings within a season than is kafir, further indicating that kafir is more constant under varying conditions than is milo.

SUMMARY.

Inasmuch as the grain sorghum market is being rapidly extended, information as to the shelling percentages of heads is of increasing importance to growers, consumers, and dealers.

Data extending over a period of six years show that the grain content of heads varies according to class from 69.53 to 75.23 per cent., or, in other words, from 1390 to 1504 pounds to the ton of heads, a range of 114 pounds.

Individual strains within a class show considerable variation emphasizing the value of certain improved strains from the standpoint of shelling percentage.

The data relating to the influence of rate of seeding on turn-out of grain show that the rate of seedings embraced in these experiments had little effect on the percentage of grain contained in heads.

The fact that kafir and milo have reacted in opposite directions with respect to shelling percentages of grain when each was grown at varying thickness in the row, indicates that kafir is better adapted to thick seeding than milo, in so far as shelling percentage is concerned.

The milo class, which predominates on the market, shows much wider variation in shelling percentage from year to year than kafir.

It would seem that the determination of shelling percentages from the different classes for a locality any given year would form a reasonably safe basis for the shelling percentage ratings during the same year.

Monthly rainfall at Lubbock 1916-1921, inches.

| | 1916 | 1917 | 1918 | 1919 | 1920 | 1921 |
|----------------|-------|------|-------|-------|-------|-------|
| January..... | .17 | .35 | .84 | .12 | .90 | .14 |
| February..... | .00 | .05 | .58 | .25 | .11 | .45 |
| March..... | 1.15 | .21 | .05 | 3.39 | .24 | 1.47 |
| April..... | 2.63 | .58 | .72 | 3.53 | .15 | .24 |
| May..... | .39 | 1.07 | 1.67 | 2.10 | 2.91 | .43 |
| June..... | 1.52 | .64 | 2.95 | 3.52 | 3.66 | 7.71 |
| July..... | .36 | 1.42 | .53 | 2.28 | 2.19 | .84 |
| August..... | 2.45 | 1.16 | .79 | 2.83 | 2.64 | .92 |
| September..... | 2.79 | 3.03 | .79 | 5.70 | 1.63 | 4.50 |
| October..... | 2.91 | .14 | .51 | 7.34 | 1.43 | .02 |
| November..... | .55 | .08 | .69 | .36 | 2.21 | .00 |
| December..... | .11 | .00 | 2.03 | .19 | .09 | .00 |
| Total..... | 15.03 | 8.73 | 12.15 | 31.61 | 18.16 | 16.72 |

Dates of first killing frost—1916—October 19
1917—October 19
1918—November 9
1919—November 12
1920—November 2
1921—November 9