

Sirup Sorghum Varieties

in

Oklahoma Sorghum

Performance Tests

1943-1948

OKLAHOMA AGRICULTURAL EXPERIMENT STATION

Oklahoma A. & M. College, Stillwater

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W. L. Blizzard, Director

Louis E. Hawkins, Vice Director

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UNITED STATES DEPARTMENT OF AGRICULTURE

Division of Cereal Crops and Diseases

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Recommended Varieties

The sweet sorghum varieties recommended for sirup-making in Oklahoma on the basis of the tests reported in this bulletin are *Leoti*, *Colman Y*, *Sumac 1712*, *Sugar Drip*, and *Honey*. These varieties, and others, are discussed more fully on pages 9 to 17.

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By JOHN B. SIEGLINGER, FRANK DAVIES,
and J. E. WEBSTER*

Sirup has been produced from sweet sorghums in Oklahoma since agricultural settlement, but the amount produced has declined as farm mechanization increased. Prior to World War II, sirup making was confined to farms in communities having a reliable fuel supply (wood or natural gas), a deep, fertile soil of light texture, and someone who knew the details of sirup making.

Wartime sugar shortages brought a renewal of farm sirup-making; and the search for new Oklahoma industries created an interest in the possibilities of producing sorghum sirup commercially. Thus there arose a demand and need for information on the quantity and quality of sirup to be expected from the different varieties of sweet sorghums when grown under Oklahoma conditions. Sirup varietal experiments were started at Stillwater in the 1943 season.

This bulletin reports the yields and quality of sirup obtained from the varieties tested. Chemical data, and a report of research on methods of sirup making, were presented in Oklahoma Agricultural Experiment Station Technical Bulletin No. T-25. Further research on the chemical phases of sorghum sirup production and methods is in progress, and varietal tests are being continued.

Breeding of sweet sorghum varieties for improved performance under Oklahoma conditions is also under way. The aims of sirup sorghum breeding are to combine the outstanding desirable characters of the several varieties. *Leoti* has earliness, tan plant color

* Mr. Sieglinger is in charge of sorghum research in Oklahoma under a cooperative agreement between the Oklahoma Agricultural Experiment Station and the Division of Cereal Crops and Diseases, Bureau of Plant Industry, Soils, and Agricultural Engineering, United States Department of Agriculture. Mr. Davies is in charge of sorghum variety tests for the Oklahoma Station; and Dr. Webster is plant chemist of the Station' Department of Agricultural Chemistry Research.

(non-reddening), and ease of processing. *Collier* is outstanding for its high sugar content. *Sugar Drip* is resistant to lodging and has high, dependable yielding ability. *Honey* has high yielding capacity of quality sirup, but is late, susceptible to chinch-bug injury, and tillers profusely. One exploratory line of sirup sorghum breeding now under way combines the sweet-seed factor (from a grain sorghum, and similar to sweet corn) with the sirup sorghums.

HOW THE TESTS WERE MADE

The sirup sorghum varieties were grown on the Experiment Station's Agronomy Farm west of Stillwater, on small (3.5 acre) fields in Cow Creek bottom. A 4-year rotation of annual legumes, cotton, corn, and sorghums was followed.

No replication of variety plots was practiced. In the earlier years, each variety was planted in 4-row plots, rows 42 inches apart and approximately 300 yards long. Later, as the number of varieties and selections was increased, some varieties were grown in 2-row plots and selections were tested in single rows; but each field plot was large enough for more sirup determinations than were necessary.

The field was plowed during early winter and leveled by double discing in April as preparation for planting. Planting was with a 2-row planter with sorghum plates, using gear and plate combinations to drop seed approximately 2 inches apart in the row. Planting was as early in May as weather conditions permitted, varying from May 2 in 1947 to May 14 in 1945. The plots were cultivated often enough to control weeds.

Each variety was harvested when the seed in a majority of the main heads had reached the hard dough stage. For a sirup test, or run, a 100-foot section, (1/125 acre) of row was selected and plant and stalk counts were made. Total crop yields were taken for the first two years (1943 and 1944); but, starting with 1945, heading and stripping was done in the field before the stalks were cut, and the first weight determination was of clean, headed, and stripped stalks. After weighing, the stalks were run through a horizontal three-roller power mill and the weight of juice obtained was recorded.

Approximately five gallons of juice from each test row was used to make into sirup and for chemical analyses. A laboratory batch pan similar to one described by Walton and Ventre* was used for evaporating the juice to sirup. Various methods of juice

* Walton, C. F. and E. K. Ventre: "Evaporator for research in sirup manufacture." *International Sugar Jour.* 39: 430-31 (1937).

treatment were used in converting the juice into sirup (See Okla. Agri. Exp. Sta. Tech. Bul. T-25). The quantity of sirup from each test plot was determined; and, after storing, the quality of sirup from the different varieties was determined by taste and appearance tests. The yields of sirup reported in this bulletin are calculated to a uniform standard density (76° Brix).**

RESULTS OF THE TESTS

Sirup Yield

Yields of sirup from the varieties tested are shown in Table I.^o Although yields are important, other characteristics of the different varieties must also be considered. In products for human consumption, quality is an important factor. The ease of processing must also be taken into account. The Sugar Drip variety is an illustration of these considerations. It showed the highest average yield of any variety, and also showed less variation in yield from year to year than the other varieties. But the quality of sirup produced from Sugar Drip, and the ease with which sirup could be made from its juice, varied greatly from season to season.

Annual Variation in Yield

The seven varieties grown in each of the six years all showed wide variation in yield of sirup from season to season. In fact, for the seven varieties grown throughout the six-year period, the seasonal variation was greater than the difference between the varieties. The difference between the highest and lowest variety for the six years was 61.7 gallons per acre; but the annual average of the seven varieties ranged from 87.6 to 171.2 gallons per acre, a difference of 83.6 gallons.

In crop production it is desirable that variation of yield from year to year be low, particularly if good to high yields are also obtained. The last column of Table I shows the seasonal differences for the seven varieties grown all six years. Sugar Drip had the lowest variation, 46 percent. Leoti was second with an extreme variation of 71 percent of its average yield. White African showed the greatest variation, 97 percent.

Relation of Rainfall to Yield

Table II shows that there is a definite relationship between

** Brix density is explained on page 9.

^o In all tables, absence of a yield figure for a certain year indicates that the variety was not grown that year. Averages are in all cases for the number of years in which the variety was grown.

TABLE I.—Yield* of Sirup in Gallons Per Acre; Stillwater.

Variety	1943	1944	1945	1946	1947	1948	Av.	Extreme variation (Percent)**
Leoti	91.4	85.3	123.6	63.0	84.5	131.3	96.5	70.8
Collier	98.5	122.5	181.7	65.8	78.0	156.6	117.2	77.5
Red X	87.9	100.9	94.7	64.8	81.1	155.1	97.4	92.7
Sumac 1712	121.0	111.1	112.6	100.6	98.7	199.1	123.9	81.0
White African	135.1	120.0	163.3	69.0	111.4	198.4	132.9	97.4
Sugar Drip	148.0	166.8	135.8	145.0	145.1	208.2	158.2	45.8
Honey	109.2	155.3	213.8	105.3	118.7	149.7	142.0	76.4
Colman	66.5	51.4						
Kansas Orange		81.7	101.6	81.1	55.8	140.7	92.2	92.1
Iceberg		132.3	152.6	78.0	150.3	193.1	141.3	81.5
Honey (Chinchbug Resistant)			95.1	79.0	82.2	101.9	89.6	25.6
Gooseneck No. 1.....			142.1		71.9			
Gooseneck No. 2.....			143.0	63.3	79.5	166.5	113.1	91.2
Colman Y				88.3	86.6	202.3	125.7	92.0
African Millet (Sourless)				52.2	40.7			

* Sirup yields are calculated to a uniform density of 75° Brix (see page 8).

** "Extreme variation" is the difference between high and low annual yields as a percentage of the average yield for each variety.

TABLE II. — Monthly Rainfall, April to September, and Sorghum Sirup Yield; 1943-1948, Stillwater, Okla.

Year	RAINFALL (inches)						Sirup Yield* (gal./acre)
	April	May	June	July	August	Sept.	
1943	1.08	13.99	1.10	0.60	1.68	3.10	113.0
1944	4.68	2.22	3.54	1.81	2.51	3.12	123.1
1945	3.48	0.45	7.42	2.77	0.95	14.04	146.5
1946	2.28	3.80	2.89	0.13	3.92	1.24	87.6
1947	8.22	6.68	2.80	1.64	0.37	2.64	102.5
1948	2.61	2.65	7.84	4.83	3.55	0.61	171.2

* Average of first seven varieties listed in Table I.

July rainfall and sirup yield. High yields were obtained in the years when July rainfall was most abundant.*

DESCRIPTION OF VARIETIES

The varieties and selections of sirup sorghums which have been tested in the Oklahoma Sorghum Performance Tests since 1943 are described on the following pages.

Two measurements frequently mentioned in discussing the different varieties are "degrees Brix" and "sugar ratio." The Brix scale indicates the amount of soluble solids in a juice by comparison with a solution of common table sugar in water. For example, a juice testing 10 degrees Brix contains as much solids as does a 10 percent sugar solution. Experience has shown that the actual sugar content of a juice sample will run about 85 percent of the degrees Brix.

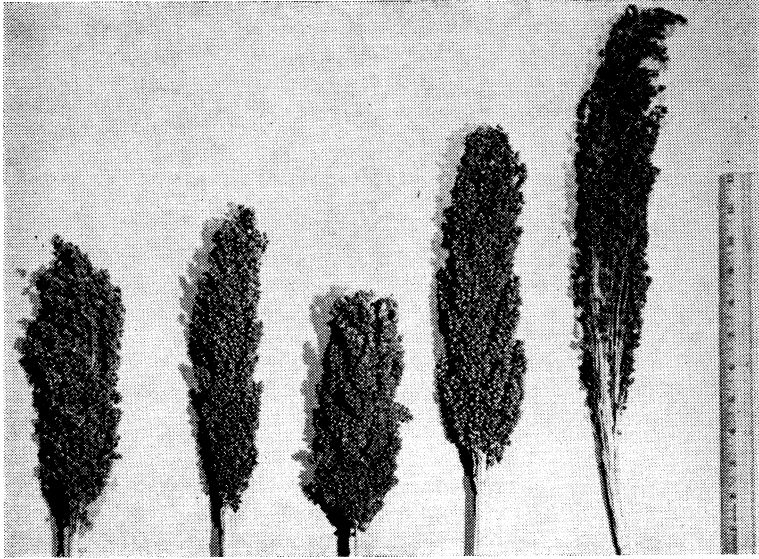
The sugar ratio refers to the proportion of reducing sugars (such as found in honey) to sucrose (table sugar). A sirup having considerably more sucrose than reducing sugar tends to crystallize after it has stood for a time. If the sucrose content is very high, as in the Collier sirup, crystallization ("sugaring") can be prevented only by special treatment. The sugar ratio is written with the reducing sugars first. For example, the ratio of 1:2 given for juice of Leoti means that it has twice as much sucrose as reducing sugars; and the ratio of 1:5 given for Collier means five times as much sucrose as reducing sugars. The ratio of 2:1 for sirup from Sumac 1712 means twice as much reducing sugars as sucrose is present in the finished sirup.

Leoti

Leoti is an early variety with stalks of medium size and height. It differs from most other varieties of sweet sorghums in that the seed starch is waxy and the plant color is tan.

In the Sirup Sorghum Performance Test at Stillwater, Leoti had an average sirup harvest date of 108 days from planting. It showed the earliest maturity date of any variety included in the experiment. The yield of juice and sirup varied considerably with seasonal conditions. The juice turn-out ranged between 6 and 8 thousand pounds per acre and had an average density of around 16° Brix. The sirup yields indicate that, on the average, 100 gallons of sirup per acre can be expected from Leoti. The sugars

* The correlation between July precipitation and the average sirup yield of the seven varieties grown throughout the six-year period is .943, significant at the 1 percent level.



HERE ARE FIVE RECOMMENDED VARIETIES

Leoti, left, Colman Y, Sumac 1712, Sugar Drip, and Honey are the sweet sorghum varieties recommended for sirup-making in Oklahoma. They are recommended on the basis of the tests reported in this publication. Discussion of these and other varieties is found on pages 9 to 17.

of both juice and sirup approximated a 1:2 ratio. In some years the sirup contained enough sucrose to cause crystal formation on aging.

The sirup made from Leoti rated medium to high in quality. It was mild flavored, reddish-brown colored, and medium viscous. Leoti can be recommended as a commercial and farm sirup variety for Oklahoma because of its sureness of production and the ease with which its juice can be processed into sirup.

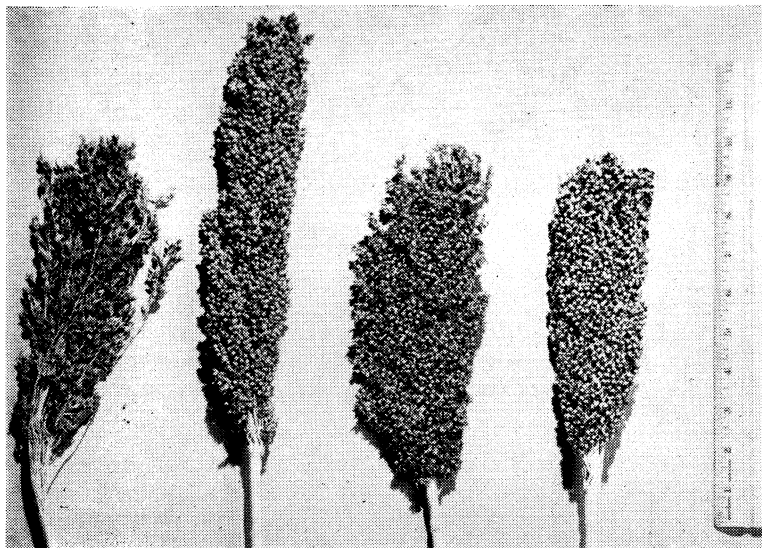
Collier

Collier is a medium-early variety with tall slender stalks which stand well even under adverse weather conditions. The plants are not inclined to tiller; but, if conditions are favorable, side branches develop from the upper nodes of the stalks.

The average date of harvest for Collier was 109 days from planting. Juice yields ranged from 4.5 to 11.5 thousand pounds per acre and had an exceptionally high average density of 20°

Brix. The average sirup yield of Collier was around 100 gallons per acre. The sugar ratios in both juice and sirup were extraordinarily high. Readings only rarely were as low as 1:5, and samples often show ratios as wide as 1:15. A high content of sucrose was always present in the juice; and this, combined with high juice nitrogen and high titratable acidity, probably accounts for the difficulty found in processing the juice.

The sirup from Collier is strongly acid and tangy and generally jells or clabbers upon standing. Quality rating of the sirup was poor to very poor. The variety definitely is not suited for utility sirup use; however, because of the high sugar content of the juice,



FOUR VARIETIES IN SORGHUM PERFORMANCE TESTS

Here are close-ups of the heads of four varieties in the Oklahoma Sorghum performance tests. The varieties are Collier, left, Red X, Iceberg, and White African. None of the four is included in the recommended list for sirup-making in Oklahoma.

it has been retained in the experiment and is also being used as a parent in the sirup sorghum breeding improvement program.

Red X

Red X is a medium-maturing variety with rather slender, tall stalks. Its average maturity date was 112 days from planting.

The production of juice ranged from 5 to 10 thousand pounds per acre and showed an average density of 16° Brix. Average sirup yield was around 100 gallons per acre. The sugars in both juice and sirup showed a high proportion of sucrose, with an average ratio of 1:3 in the juice and 1:2 in the sirup. Crystallization of the sirup occurred frequently.

The sirup from Red X can be rated as average. It was viscous, commonly jells, and sometimes clabbered on standing. The taste was found acceptable, being slightly tangy to neutral in flavor. Clay treatment of the juice improved the quality of the sirup. If sirup yield can be increased, the variety shows promise of becoming one of the better medium-maturing varieties for sirup production.

Sumac 1712

Sumac 1712 is a medium-late selection of Sumac Sorgo. The stalks are heavy and short. The plants have a tendency to produce a few tillers that approximate the main stalk in height and maturity. The average sirup harvest date was 115 days from planting.

Juice yield of Sumac 1712 fluctuated between 6 and 13 thousand pounds per acre with an average of 16° Brix. The sugar ratios of the juice and sirup were 1:1 and 2:1 respectively. This variety was the only one in the experiment in which the sirup consistently contained more reducing sugars than sucrose.

Sirup made from Sumac 1712 was usually dark red in color, very liquid, non-crystalline, and often contained a slight amount of sediment. The taste of the sirup was somewhat tangy and acid. However, it was generally rated average to good. The most serious defect of Sumac 1712 for use as a commercial sirup variety is its inability to produce a thick, viscous sirup even when processed to a high density.

White African

White African is a medium-late variety with extra heavy, large, tall stalks and little tendency to tiller. Its average harvest date in the test was 116 days from planting. Juice and sirup yield fluctuated widely, with the juice yields ranging from 7 to 13 thousand pounds per acre and the sirup production varying from 70 to 200 gallons per acre. The juice density averaged around 15° Brix. Sugar ratios for the juice and sirup ranged around 1:2 and 1:1, respectively. Non-crystallization of the sirup possibly in part can be attributed to the near 1:1 ratio of the sugars.

The sirups from White African were dark, strong flavored and often showed clabbering on standing. It is doubtful if this variety becomes widely accepted commercially because of the dark color and strong flavor of its sirup.

Sugar Drip

Sugar Drip is a medium-late variety with a tall, large stalk. The plants have an extensive root system; and this, combined with a stout, stiff stalk, probably accounts for the high lodging resistance observed in the variety.

The average sirup harvest date for Sugar Drip was 115 days from planting. High yields of both juice and sirup were obtained. The production of juice ranged from 8 to 12 thousand pounds per acre with an average density of 18° Brix. The average sirup yield was the highest of any variety in the experiment. Sugar ratios of the juice and sirup averaged around 1:2. However, in some years the sirup contained enough excess sucrose to cause some crystal formation.

Sirup made from Sugar Drip varied widely in quality from year to year. Some seasons it clabbered badly and carried an objectionable flavor. In recent years an acceptable sirup with a mild flavor was made by treating the juice with clay. The variety shows a high potential as a sirup variety in Oklahoma. It possesses the desirable characteristics of wide adaptation, resistance to lodging, and high sirup yield. The chief fault of Sugar Drip was the variable quality of the sirup produced.

Honey

Honey is a late variety with tall, thick stalks and is inclined to tiller. The average date of harvest was 123 days from planting, which was the latest date of any variety included in the experiment. The juice yield varied from 6.5 to 15 thousand pounds per acre for the six years and had an average density of 15° Brix. The sirup production indicates that Honey can be expected to yield around 150 gallons per acre. Sugars of both juice and sirup were consistently around the 1:1 ratio. Excessive sucrose was never evident, which probably accounts for non-crystallization of the sirup.

The sirup from Honey was relatively viscous, of a sweet to slightly tangy taste, and generally jelled to some extent on aging. Quality ratings on the sirup were most satisfactory in the majority



THIS VARIETY PRODUCED HIGHEST AVERAGE SIRUP YIELD

Sugar Drip production of juice ranged from 8 to 12 thousand pounds per acre with a mean of 18° Brix. It had the highest average sirup yield in the experiment. This variety has high lodge resistance, which is probably due to the extensive root system combined with a stout, stiff stalk. The chief fault of Sugar Drip was the variable quality of sirup produced.

of instances. The major defects of the variety are its susceptibility to lodging under dry weather and chinchbug conditions and the presence of many unripened tillers at the time the main stalk is ready to harvest. Honey is recommended as a sirup sorghum in southeast Oklahoma where the limiting factors are less likely to develop.

Kansas Orange

Kansas Orange is a medium-maturing variety with tall stalks and is non-tillering. It lodges badly when seasons are slightly unfavorable and chinchbugs are present. Processing dates averaged 113 days after planting. Juice yields ranged from 6 to 7 thousand pounds, of 15° Brix density. Sirup yields were low, averaging less than 100 gallons per acre. Sugar ratios of juice and sirup were 1:1 and 1.5:1 .

Quality sirup with tangy taste has always been made from the variety. However, low yield and tendency to lodge eliminate Kansas Orange from the recommended varieties.

Iceberg

Iceberg is a medium-late variety developed at the Federal Sugar Station, Meridian, Mississippi. It produces tall, heavy stalks which are inclined to lodge when unfavorable weather conditions and when chinch bugs occur.

The average sirup harvest date for Iceberg was 120 days from planting. Juice yields were high, ranging from 6 to 12 thousand pounds per acre and having an average density of around 18° Brix. Sirup yields of 150 gallons per acre can normally be expected, with maximum production approaching the 200 gallon per acre mark. The sugar ratios averaged 1:2 for both juice and sirup.

Iceberg showed excellent sirup-making qualities. The sirup was of pleasing mild flavor and had a desirable, light reddish-brown color. The variety shows promise where weather conditions and chinchbugs are not a problem.

Honey

(Chinchbug resistant)

This is an early selection from ordinary Honey which showed considerable resistance to chinchbug injury. Processing date



COLLIER — HIGH SUGAR CONTENT; COLEMAN Y — EXCELLENT SIRUP
Ratios of sugar for Collier, left, in both juice and sirup were extraordinarily high. The sirup is strongly acid and tuncy, and generally jells or clabbers upon standing. Average date of harvest for Collier was 109 days from planting. Colman Y produces a mid-short heavy stalk of medium early maturity. The sirup was excellent, having a natural red color, viscous and free of sediment and crystallization. This variety can be recommended for its quality sirup, but the yield is not dependable.

averaged 109 days from planting. Juice yields averaged slightly more than 7 thousand pounds per acre with an average density of 13° Brix. Maximum sirup yield was 102 gallons per acre, with the average about 90. Sugar ratios were 2:1 for juice, and sirup sugar ratios ranged from 3:1 to 1:1.

The sirup was dark and liquid with a tendency to jellying. Quality was poor and there was some crystallization.

This selection does not possess the qualities to be recommended highly as a sirup variety, even with the high degree of chinchbug resistance.

Gooseneck

(Selection No. 2)

This is a fixed selection made at the Experiment Station from a mixed lot of Gooseneck seed. The plants are mid-tall and normally produce few tillers. The average maturity date was 110 days. Yields of juice ranged from 6 to 13 thousand pounds per acre, and averaged 14.5° Brix. Sirup yields ranged from 64 to 165 gallons per acre. The sugar ratio averaged 1:2 for juice and 1:1.5 for the sirup.

The sirup was average or above in taste and appearance. It was of medium brown color, usually liquid, showed little crystallization and no appreciable sedimentation or clabbering upon standing.

The variety lodges badly in dry seasons when chinchbug infestations are severe. This fault combined with medium yielding ability makes the selection of doubtful value for commercial sirup production in central Oklahoma.

Colman Y

Colman Y is a selection grown here only since 1946. It produces a mid-short heavy stalk of medium early maturity. The average processing date was 114 days after planting. Juice yields ranged from 6.5 to 14 thousand pounds per acre, with an average Brix of around 15°. Sirup yields varied from 87 to 202 gallons per acre. The ratio of sugars in the juice was 1:2, and in the sirup it was 1:1.5.

The sirup was average or above in taste and appearance. It and free of sediment and crystallization. The ratings were uniform to excellent. The variety can be recommended for its quality sirup, but the yield varies too greatly with seasonal conditions to be dependable.

APPENDICES

I. Relation of Total Forage to Cleaned Stalks

APPENDIX TABLE I shows the total forage yield, and the proportion of total yield which was made up of cleaned and headed stalks ready for pressing for the years 1943 and 1944.

II. Percentage of Juice in Stripped Stalks

APPENDIX TABLE II shows the percentage of juice, by weight, extracted from the cleaned and headed stalks for the different varieties.

III. Sirup Sorghum Variety Tests at Lone Grove, Oklahoma, 1930 to 1933

A sorghum sirup variety experiment was conducted at the Southern Oklahoma Soil Improvement Station at Lone Grove in 1930, 1931, and 1933. The sirup yields of the varieties used varied greatly with the seasons. The yield of sirup in gallons per acre for the varieties of sorghum in 1930, 1931, and 1933 at Lone Grove, as recorded by the research workers in charge of the test, is shown in Appendix Table III.

APPENDIX TABLE I. — Total Forage Yield, and Percentage of Forage Yield Which Was Cleaned and Headed Stalks; Stillwater, 1943 and 1944.

Variety	Total Crop (pounds per acre)		Cleaned Stalks (Pct. of total crop)		
	1943	1944	1943	1944	Average
Leoti	18,646	21,563	65.92	68.41	67.2
Collier	19,719	24,625	66.82	72.08	69.5
Red X	19,925	24,500	68.88	68.11	68.5
Sumac 1712	28,042	30,667	65.53	70.92	68.2
White African	29,292	32,125	73.68	74.58	74.1
Sugar Drip	30,928	31,333	70.10	72.47	71.3
Honey	31,813	36,833	74.07	73.64	73.9
Kansas Orange		23,500		67.55	
Iceberg		28,375		68.94	

APPENDIX TABLE II. — Juice from Stripped and Topped Sorghum Stalks; Stillwater, 1943 to 1948.
(Percentage of Cleaned Stalks, by Weight)

Variety	1943	1944	1945	1946	1947	1948	Av.
Leoti	50.81	45.76	50.16	44.77	43.10	50.54	47.52
Collier	42.30	42.26	44.44	37.44	34.49	44.93	40.98
Red X	45.99	43.45	46.84	37.31	37.66	49.41	43.44
Sumac 1712	46.83	43.39	48.31	43.20	39.18	51.45	45.39
Wh. African	43.82	41.04	50.46	38.78	37.14	47.80	43.17
Sugar Drip	50.36	46.97	49.35	45.64	41.39	49.27	47.16
Honey	44.89	44.85	52.78	47.98	37.88	47.97	46.06
Kansas Orange		41.73	46.32	40.08	39.41	46.78	42.86
Iceberg		44.41	49.91	39.06	38.54	48.22	44.03
Honey (Chinchbug Resistant)			49.60	39.38	38.29	46.25	43.38
Gooseneck No. 2			50.56	36.67	36.09	45.49	42.20
Colman Y				44.87	41.27	57.28	47.81
African Millet (Sourless)				36.42	29.52		

APPENDIX TABLE III. — Sorghum Sirup Variety Test at Lone Grove, Oklahoma; 1930-1933.
(Yields of sirup in gallons per acre)

Variety	1930	1931	1933	Average
Orange	25.5	89.4		57.5
Black Amber	7.7	43.9		25.8
Red Amber	22.0			
Red X	14.3	90.7	39.7	48.2
Sugar Drip	33.5	122.6	66.6	74.2
White African	25.9	96.4	78.2	66.8
Honey	43.3	100.7	43.4	62.5
Gooseneck	43.9	163.4	159.1	122.1
Sumac	23.7		44.1	33.9
Kansas Orange	33.4		43.2	38.3
African Millet (Sourless)	23.0		38.0	30.5