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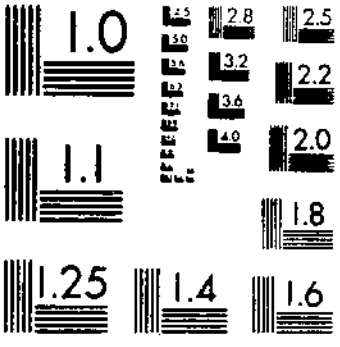

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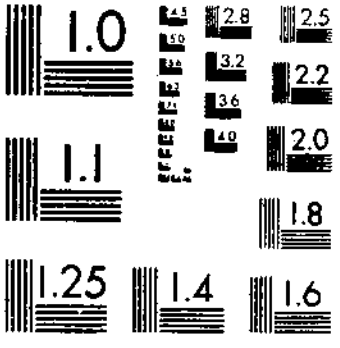

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STORAGE STUDIES OF SORGO

By Otto H. Coleman and I. E. Stokes

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STORAGE STUDIES OF SORGO

By OTTO H. COLEMAN and I. E. STOKES, *research agronomists, Crops Research Division, Agricultural Research Service*[1]

Procedures for harvesting and processing sorgo (*Sorghum vulgare* Pers.) for sirup production vary considerably throughout the sorgo-sirup belt in the Southeastern United States. Harvesting procedures include many local practices ranging from cutting with a knife to harvesting with a corn binder. Many sirup producers follow the practice of both harvesting and processing sorgo on the same day. The leaves may or may not be left on the stalks during the entire process. Other producers may store the cut stalks for several days before milling. Some producers strip and then cut the stalks immediately. Others strip and leave the stalks standing in the field for several days before cutting. Many producers take the entire plant to the mill for processing. Some farmers store the stalks in piles, whereas others shock them.

Since the effects of various storage procedures on yield and quality of sirup were not known, these studies were designed to determine the best way to handle the sorgo stalks in order to produce high yields of good-quality sirup. These investigations were conducted at Meridian, Miss., from 1947 through 1958.

GENERAL PROCEDURES

The varieties of sorgo used in these studies included Rex, Collier, Iceberg, White African, Sart, Tracy, and Wiley. Rex and Collier are sugar varieties and the other five are sirup varieties. Five samples of 10 to 20 sorgo stalks each were selected at random.

During 1947 the sorgo plants were cut, the leaves, heads, and peduncles were removed, and the stalks were stored. Samples were milled every day after cutting for 16 consecutive days and the resultant data were used as the basis for further study. The juice samples were analyzed each day of milling. In addition, from 1954 through 1958 composited juice samples for each treatment were frozen and analyzed several weeks or months after milling.

In 1954 the former Bureau of Agricultural and Industrial Chemistry of the U.S. Department of Agriculture made all the chemical analyses. During the remaining years the fresh-juice analyses were made at the U.S. Sugar Crops Field Station

[1] Acknowledgments are due Marvin Geiger and B. F. Barrentine, former and present head, respectively, of the Department of Chemistry, Mississippi Agricultural Experiment Station, who analyzed the frozen juice and the sirup.

at Meridian. From 1954 through 1958 the frozen-juice and sirup samples were analyzed at the Mississippi Agricultural Experiment Station at State College.

Extraction values were obtained by two methods. From 1947 through 1955 the extraction values were based on the weight of the juice in relation to the weight of the stalks at the time of milling. From 1956 through 1958 these values were based on the weight of the juice in relation to the weight of cut whole plants at the time of harvest; therefore, all treatments had the same basis for comparison.

Since sorgo-sirup standards for such characteristics as color, clarity, and viscosity had not been developed, there was no way of measuring them. The sirup trade has used rather crude but effective ways of evaluating sirups. Ratings were based on personal observations, but they were inconsistent from one area to another. Accurate, reproducible procedures were developed in 1956 to evaluate more critically the various storage techniques used in these studies.

Color ratings were determined by comparing the sirups with color standards. Each standard was made of 95 cc. of white Karo sirup and the following amounts (cc.) of flavoring: [2]

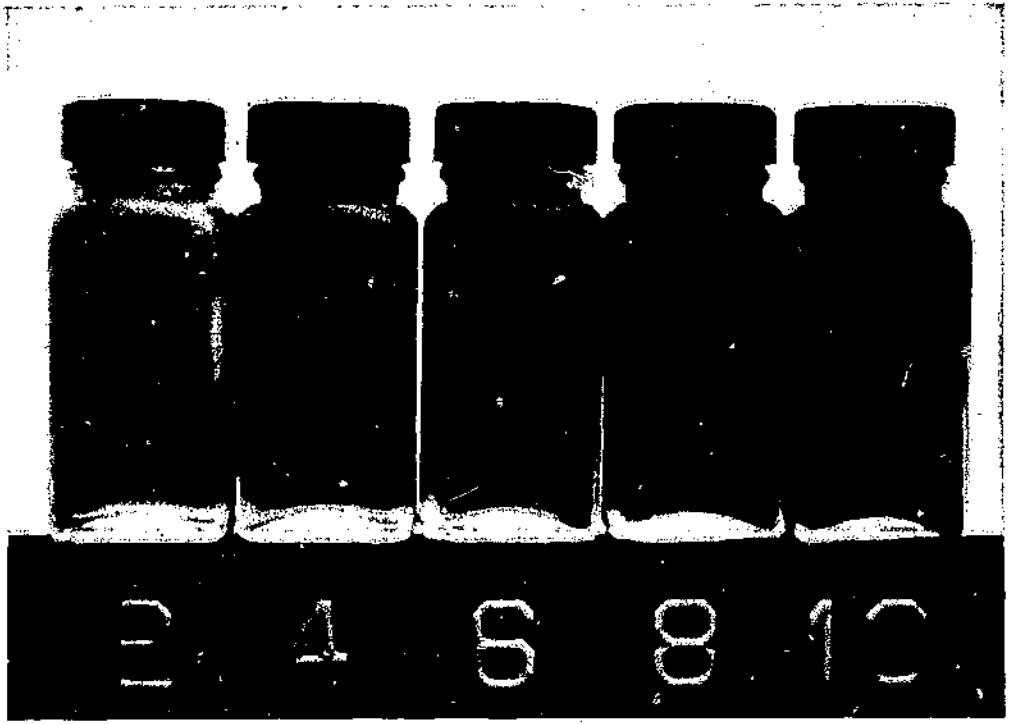
Grade No.	*McCormick maple flavoring*
2	0.3
4	.6
6	1.25
8	2.50
10	5.0

Plate 1, *A*, includes the color standards for the studies started after 1955.

Sorgo sirup usually is characterized by a colloidal suspension. This suspension can be measured by determining the clarity of the sirup. This was done in these studies by determining how small a spot could be seen through the sirup. The more nearly transparent the sirup, or less cloudy with suspension, the smaller the spot. Plate I, *B*, includes the spots used in determining clarity. The ratings ranged from 0 for no visible spots to 5 if all the spots were visible.

Equipment was not available to measure the true viscosity of these sirups in equipoises. However, good comparative data were obtained by bringing the sirup to a constant temperature of 30° C. in a warming oven. Each sample was removed from the oven and poured immediately into a glass tube, 10 mm. in diameter, to a height of 474 mm. A steel ball was dropped gently into the column of sirup. The time elapsing between its contact with the sirup and its hitting the bottom of the tube was measured in seconds. All viscosity data in this bulletin are reported in seconds.

[2] The mention of proprietary products does not constitute their endorsement by the U.S. Department of Agriculture.



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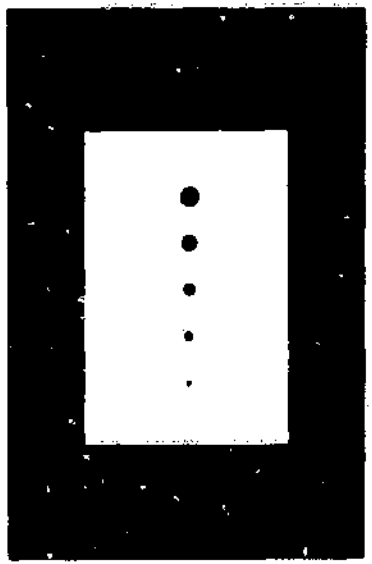

B

A, Sirup color standards; *B*, sirup clarity rating chart.

STORAGE TREATMENTS AND RESULTS

Rex and Collier—Stripped

Wet and Dry

Studies were made in 1947 of the effects of wet and dry treatments during storage on sugar yield and sucrose inversion of stripped Rex and Collier sorgo. The storage period lasted 16 days. Five samples were milled each day for each of the two treatments—(1) stored dry in the shed and (2) stored wet on the yard. The stalks of the wet sample were kept moist with a fine water spray. The data for these studies are included in figure 1.

During the 16 days' storage the extraction values for the wet stalks remained relatively constant, but they decreased gradually for the dry stalks from 55 to about 47 percent. The decrease in extraction for the dry stalks was reflected in an increase in the Brix value from 18° to more than 24° on the fifth day of storage. The Brix of the wet stalks remained approximately constant. The percentage of sucrose was about the same whether the stalks were kept wet or dry. However, the increase in Brix of the dry stalks was associated with a decrease in purity. The coefficient of apparent purity of the dry stalks varied from 73 percent for samples cut and milled the same day to 58 percent for samples stored for 16 days after cutting. The purity values for the wet stalks were rather variable but decreased only about 4 percent.

As the value of invert sugars approaches the value of the sucrose fraction, there is less tendency for the sirup to crystallize. Sirup made from the juice of dry stalks in this study would have less tendency to crystallize than that made from the juice of wet stalks.

Titratable acidity, determined by the cubic centimeters of sodium hydroxide (NaOH) required to neutralize the juice, is a factor that affects the flavor and quality of the sirup. Titratable acidity values were variable and no differences were indicated between treatments.

Rex—Stripped

In studies during 1949, 1952, and 1953 two treatments were used with stripped Rex sorgo. Some stalks were protected by a shed and others were left unprotected in the open. Each treatment was subdivided. One of the protected samples was kept dry and the other kept wet by spraying with water two or three times a day. The unprotected samples were handled the same way, except no attempt was made to protect them from the rain.

Protected and Unprotected

Figure 2 gives the results of comparing protected and unprotected stripped stalks. The 3 years' data indicate very little

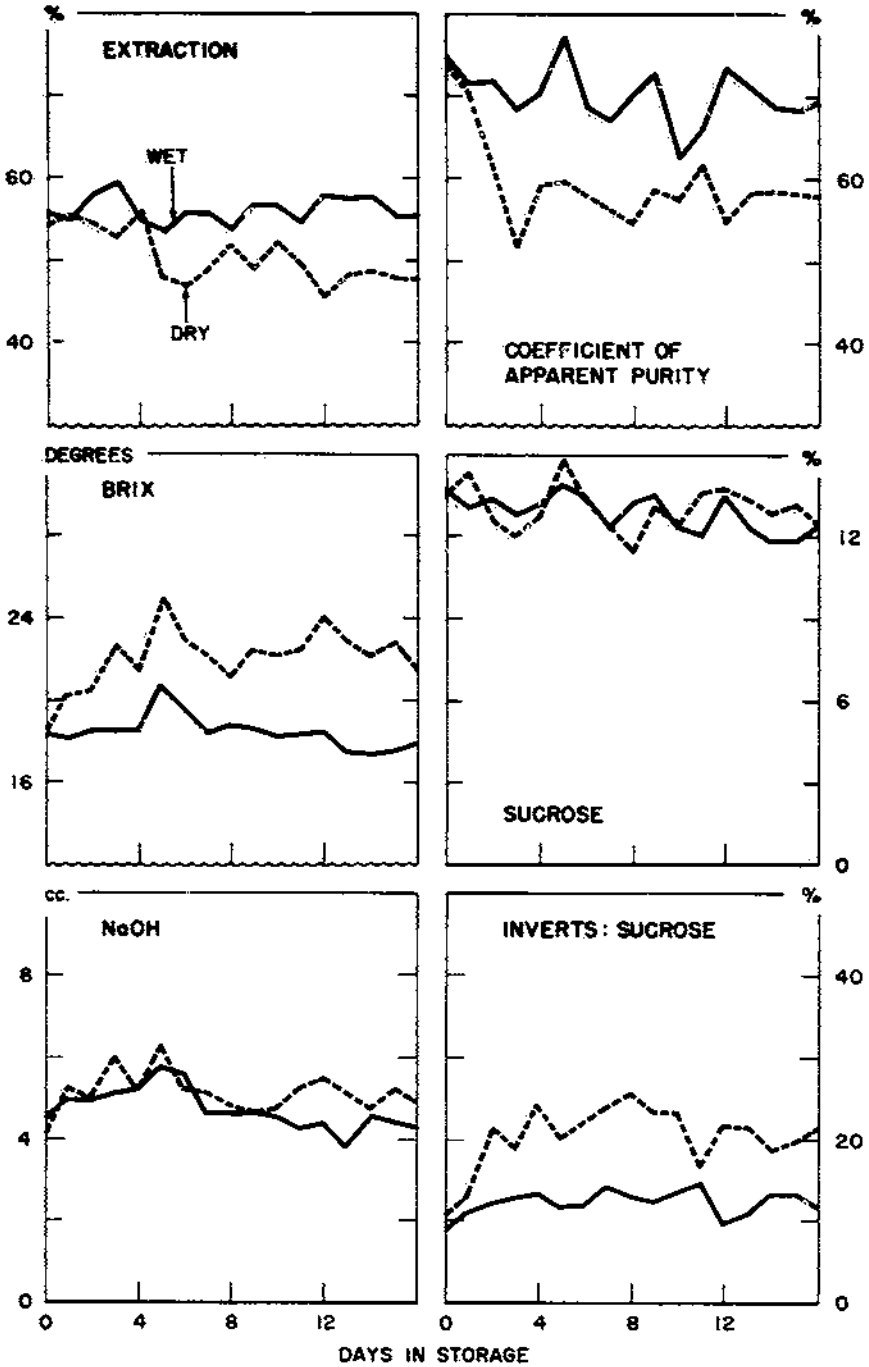

FIGURE 1.—Effect of wet and dry treatments on yield and quality of juice obtained from stripped Rex and Collier sorgo during 16 days' storage, 1947.

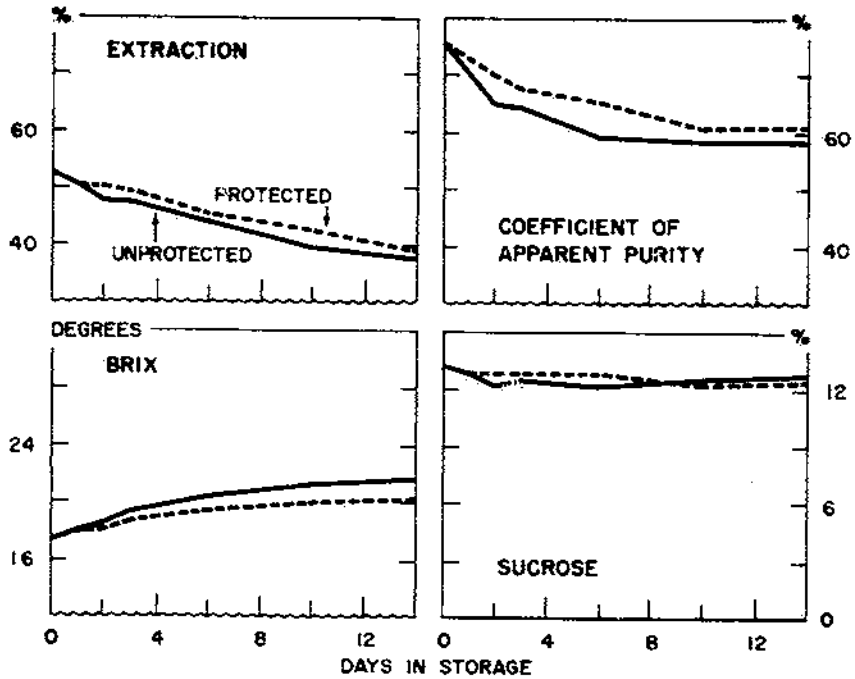

FIGURE 2.—Effect of protected and unprotected treatments on yield and quality of juice obtained from stripped Rex sorgo during 2 weeks' storage, 1949, 1952, and 1953.

difference in extraction between the protected and unprotected stalks. The Brix values for the unprotected stalks were slightly higher than for the protected. The increase in Brix may have been caused by an increase in evaporation in the open sunlight. Sucrose values for the two treatments were about the same. The protected stalks had slightly higher purity values than the unprotected. These values for both treatments decreased for the first 10 days of storage.

Protected Wet and Dry

Figure 3 shows a comparison between protected wet and dry treatments of stripped stalks of Rex sorgo. Under these conditions the extraction for the wet stalks increased slightly during the 2 weeks of storage, but extraction for the dry stalks decreased from about 52 to 39 percent. As expected, the Brix values for the dry stalks were considerably higher than for the wet stalks at the end of the storage period. Sucrose was also slightly higher for the dry than for the wet stalks. Purity values for the two treatments were similar to those reported in the previous study for the first 10 days. After 10 days the purity of both the wet and the dry stalks increased slightly. The loss of purity for the wet stalks after 2 weeks of storage was only 1 percent, but for the dry stalks it was 8.4 percent.

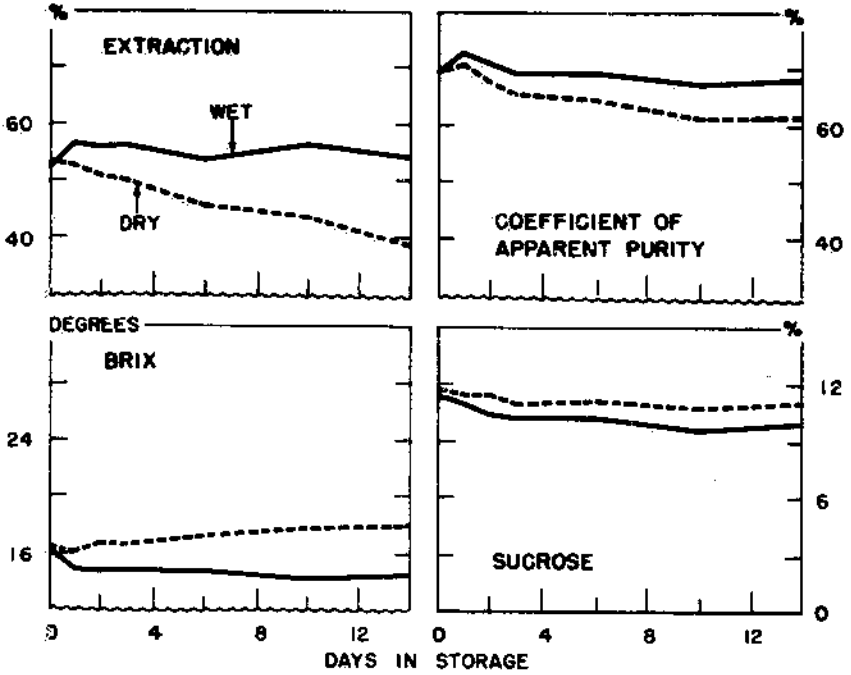

FIGURE 3.—Effect of protected wet and dry treatments on yield and quality of juice obtained from stripped Rex sorgo during 2 weeks' storage, 1948, 1952, and 1953.

Unprotected Wet and Dry

A comparison of unprotected wet and dry treatments of stripped stalks of Rex sorgo is included in figure 4. The extraction values decreased slightly for both, but the decrease was greater for the dry than for the wet stalks. The Brix of the dry stalks gradually increased during the 2 weeks' storage, but the Brix of the wet stalks remained about constant. Sucrose was similar for the two treatments but decreased during the 2-week period. Again, the wet stalks had slightly higher purity values than the dry ones.

Iceberg and White African—Stripped

Protected Wet and Dry

Preliminary studies were made in 1947 on the effect of storage on the sirup varieties Iceberg and White African. Comparisons were made between stripped stalks kept dry and those kept wet in protected storage to simulate rainy weather for 16 days. The results were similar to those obtained for Rex and are shown in figure 5.

The extraction for the wet stalks remained rather constant, whereas that for the dry stalks had a sharp reduction from

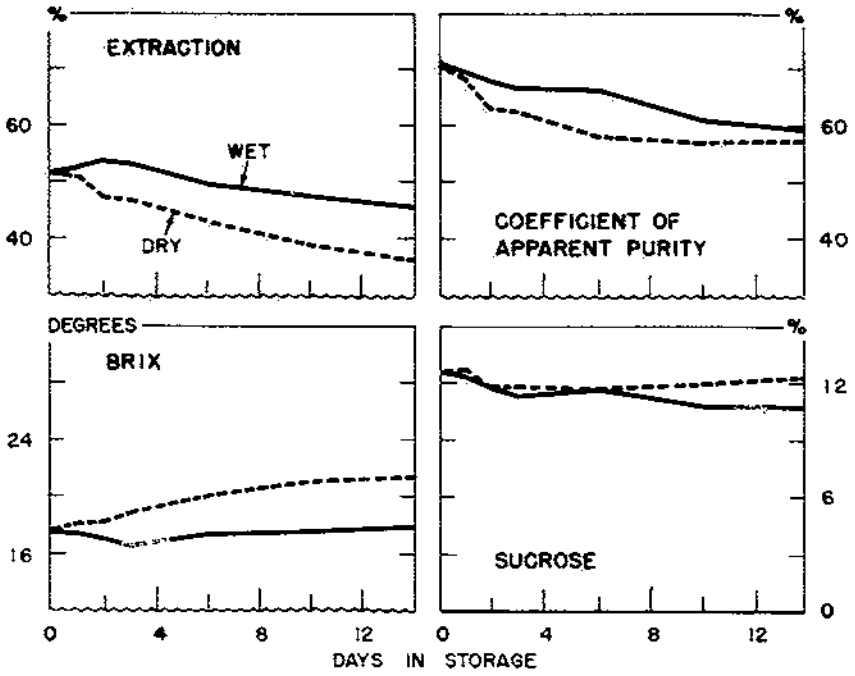

FIGURE 4.—Effect of unprotected wet and dry treatments on yield and quality of juice obtained from stripped Rex sorgo during 2 weeks' storage, 1952–53.

about 60 to 49 percent. The Brix value for the dry stalks increased from about 15° to 20°, whereas that of the wet stalks dropped from about 15° to 12.5°. The percentage of sucrose for the two treatments was similar throughout the storage period. There was a drop of about 2 percent in sucrose during the 16 days. The purity value for these varieties decreased from about 62 to 34 percent in 3 days when the stalks were dry. On the 10th day the purity value for the dry stalks increased to about 40 percent and remained constant during the remainder of the storage period. On the other hand, the purity of the wet stalks remained about constant during the entire period of storage.

The ratio of inverts to sucrose exhibited a reverse trend to that of purity and was more striking than for Rex. The ratio for the dry stalks increased from about 26 percent on the day of cutting to 49 percent on the third day of storage. The ratio for the wet stalks remained constant for the entire period of storage.

Titratable acidity remained about constant during the period of storage and there was little difference between the treatments.

Sirup was made of the juice of stripped Iceberg stalks, which were stored for various periods during 1947, and the results

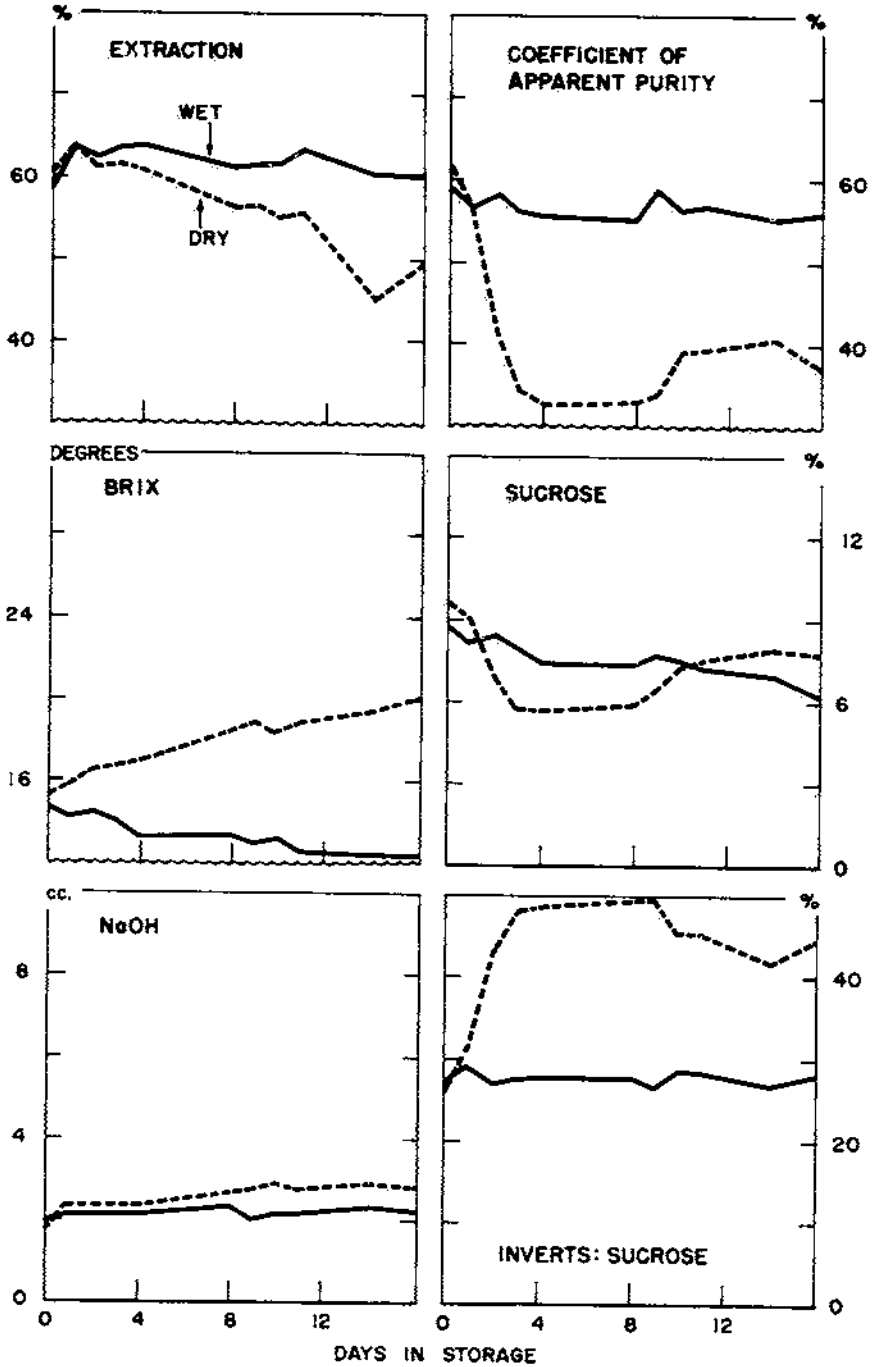

FIGURE 5.—Effect of protected wet and dry treatments on yield and quality of juice obtained from stripped Iceberg and White African sorgo during 16 days' storage, 1947.

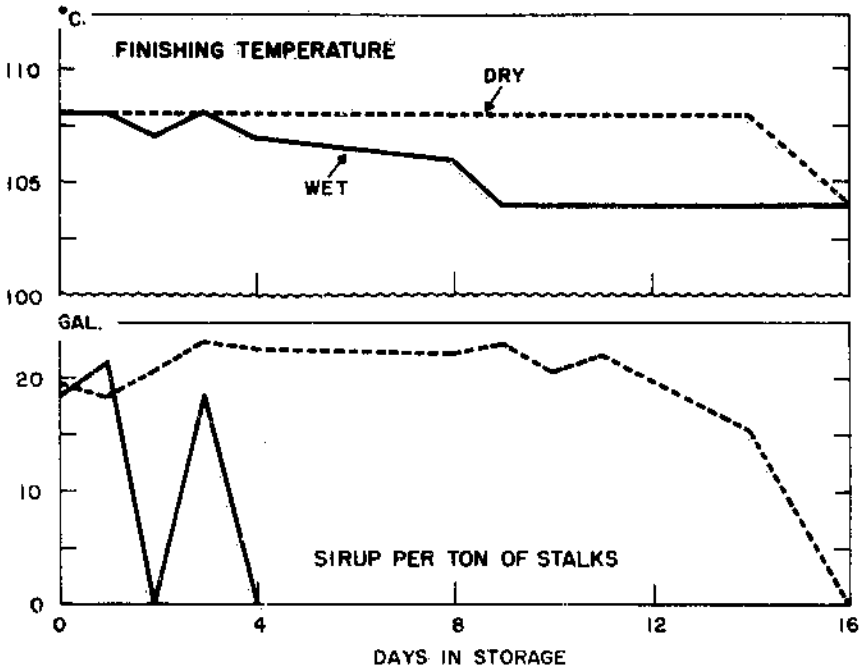

FIGURE 6.—Effect of protected wet and dry treatments on quality and yield of sirup made from stripped Iceberg sorgo during 16 days' storage, 1947.

are included in figure 6. Sirup samples in this study were boiled to 108° C. if possible. This was considered the standard finishing temperature for sirup. When interfering compounds prevented the sirup from reaching the standard temperature without scorching, the semisirup was removed from the pan and the temperature recorded. The sirup boiled down to the proper density when the stalks were stored dry for 2 weeks but failed on the 16th day of storage. However, when the stalks were stored wet, as during rainy weather, there was a gradual decrease in the quality until the ninth day. From the 9th to the 16th day the highest temperature obtained for the wet stalks was 104°. This is well below the temperature required to produce a sirup of the proper density and keeping qualities.

The amount of sirup per ton of stalks was rather erratic, particularly for the stalks stored wet. After 4 days of storage none of these samples produced acceptable sirup. On the other hand, the stalks stored dry for 2 weeks produced an acceptable sirup.

Sart, Tracy, and White African—Stripped

During 1948–53 a series of studies was conducted with Sart, Tracy, and White African sorgo, in which all the stalks were stripped and the heads and peduncles removed. The treat-

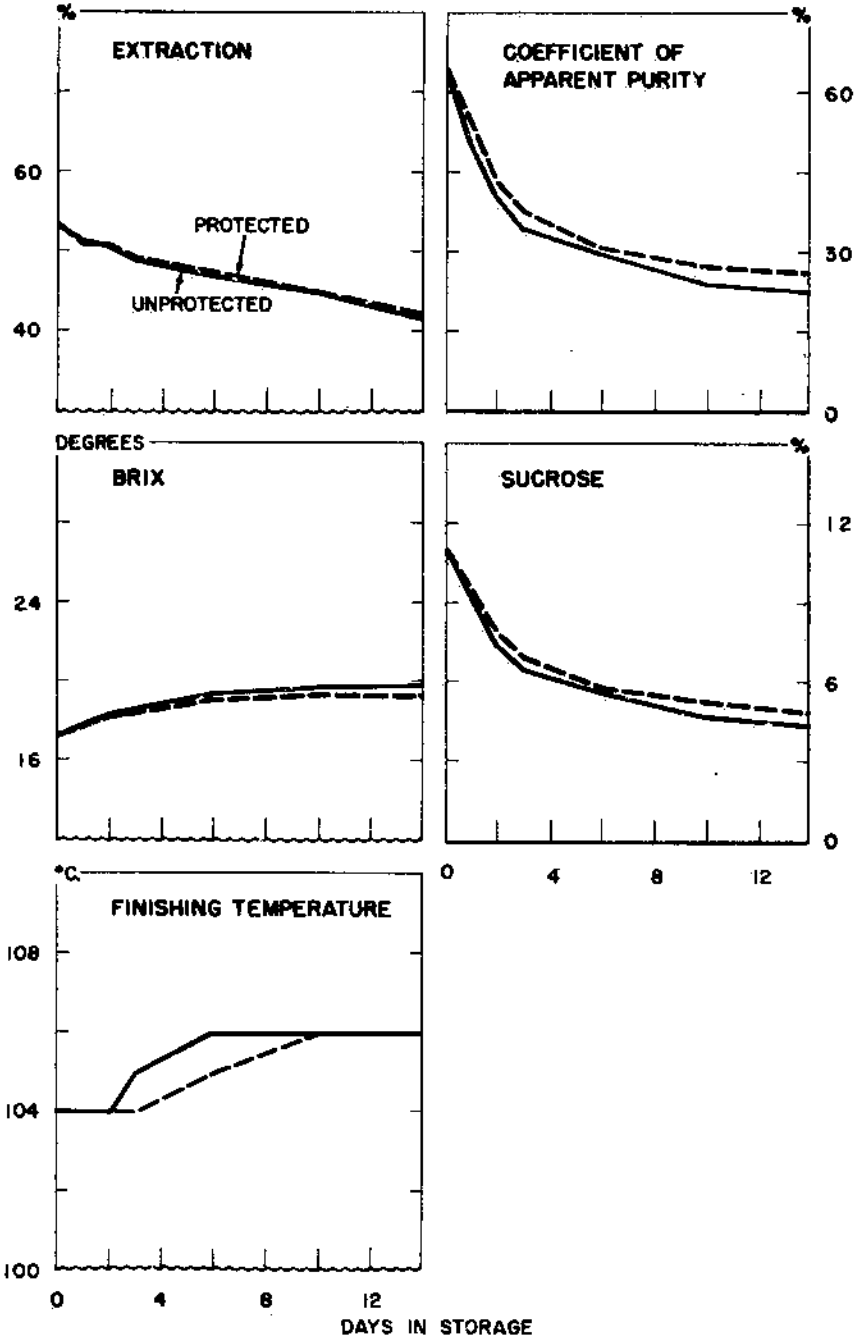

FIGURE 7.—Effect of protected and unprotected treatments on yield of juice and quality of juice and sirup obtained from stripped Sart, Tracy, and White African sorgo during 2 weeks' storage, 1949–53.

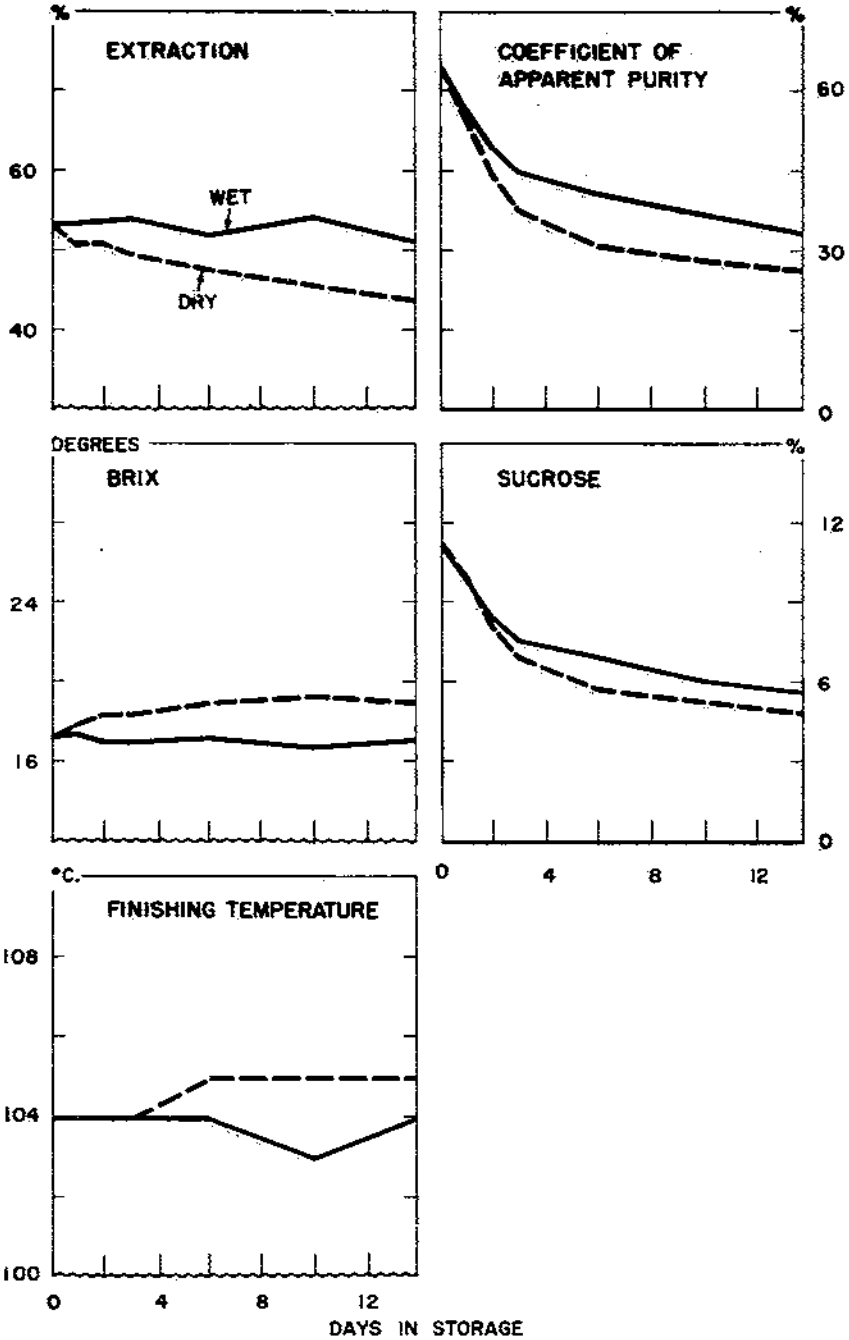

FIGURE 8.—Effect of protected wet and dry treatments on yield of juice and quality of juice and sirup obtained from stripped Sart, Tracy, and White African sorgo during 2 weeks' storage, 1948–53.

ments were protected and unprotected. Wet- and dry-storage conditions were included in these two treatments.

Protected and Unprotected

In figure 7 the protected and unprotected stripped stalks are compared. Protecting the stalks had no appreciable effect on extraction, Brix, sucrose, purity, or ultimate boiling temperature of the sirup under the relatively dry storage conditions during this study. The extraction decreased during the 2-week period from about 53 to 42 percent. The Brix increased from about 17° to 20°, the sucrose decreased from about 11 to 5 percent, and the purity dropped very rapidly for the first 3 days and continued to drop to the 10th day of storage. Most of the samples did not make acceptable sirup during the entire study. There was a slight benefit from more than 2 days' storage, and the average finishing temperature increased from 104° to 106° C. by the sixth day of storage.

Protected Wet and Dry

Figure 8 shows comparisons between the protected stripped stalks stored wet and those stored dry for the same three varieties. The results were in agreement with previous studies. During the 2 weeks of storage the extraction for the dry stalks dropped, Brix increased, and sucrose and purity dropped. The extraction and Brix for the wet stalks remained about constant during the 2-week period. The finishing temperature of the sirup remained at 104° C. or less for the wet stalks but improved to 105° on the sixth day of storage for the dry stalks.

Unprotected Wet and Dry

Figure 9 shows comparisons between unprotected stripped stalks stored wet and those stored dry. These results are similar to those for the protected stalks.

Sart, Tracy, and Wiley—Unprotected

Stripped, Unstripped Shocked Dry, and Unstripped Shocked Wet

In 1954 a new series of studies was made to include the varieties Sart, Tracy, and Wiley. All the stalks were stored exposed to outside weather conditions. Stripped stalks were compared with unstripped shocked stalks. The latter group was subdivided into stalks that were not sprinkled and those that were sprinkled two or three times daily and kept relatively moist to simulate rainy weather. The stripped stalks were left on the ground and were not sprinkled.

Comparisons of the three basic treatments for the three varieties are included in figure 10. Extraction values dropped off about the same and rather consistently during the 2-week storage period for the stripped dry and unstripped wet stalks, whereas the unstripped dry stalks had lower extraction values.

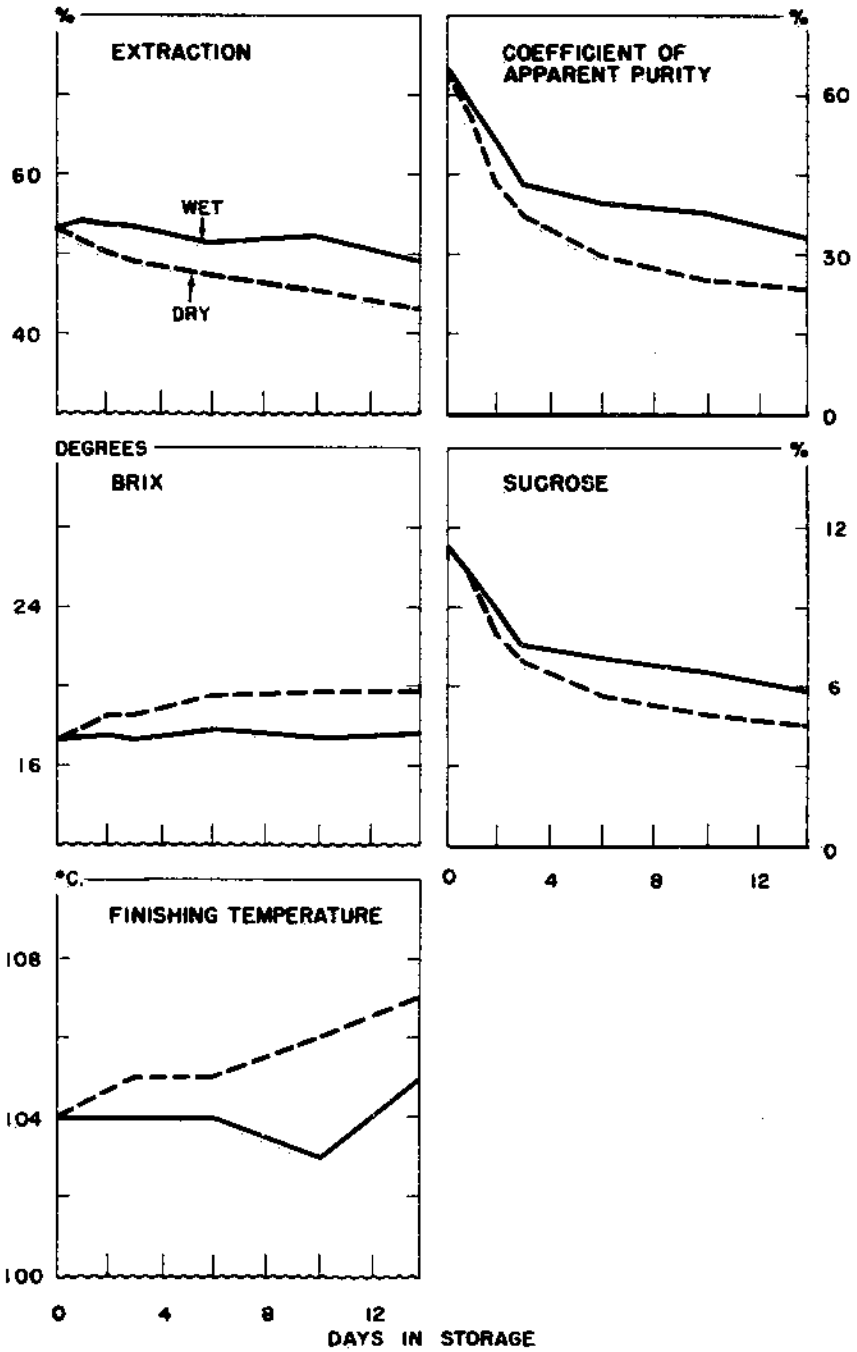

FIGURE 9.—Effect of unprotected wet and dry treatments on yield of juice and quality of juice and sirup obtained from stripped Sart, Tracy, and White African sorgo during 2 weeks' storage, 1948–53.

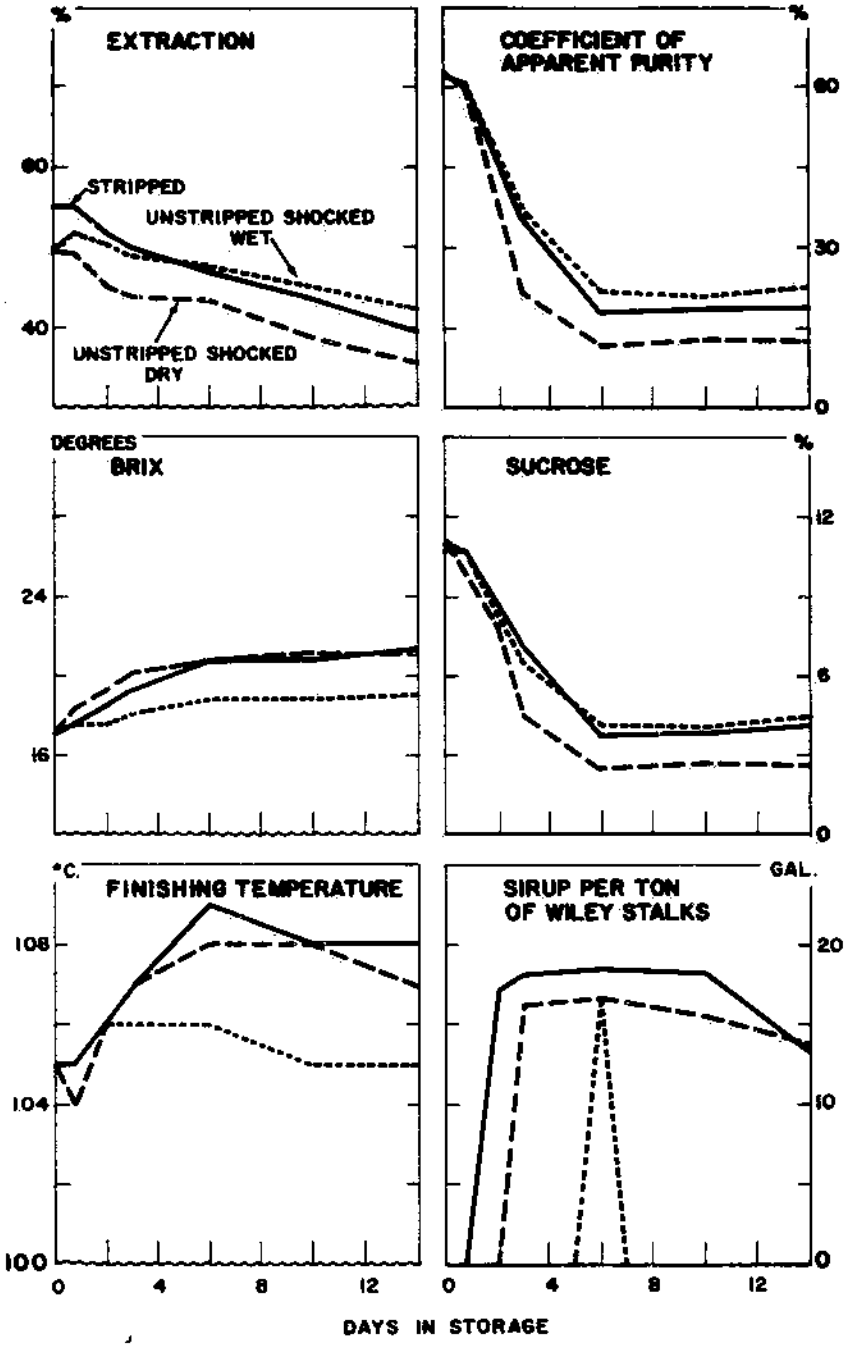

FIGURE 10.—Effect of three different treatments on yield and quality of juice and of sirup obtained from Sart, Tracy, and Wiley sorgo during 2 weeks' unprotected storage, 1954–55.

The Brix values of the unstripped dry and stripped stalks increased during the storage period. This increase was from about 17.2° to 21.3°. The unstripped wet stalks increased in Brix for the first 6 days and then remained constant. This increase amounted to only about 1.5°. Sucrose dropped off rather rapidly for all three treatments for the first 3 days and remained constant after the sixth day of storage. Purity decreased rapidly from about 63 percent on the day of cutting to only about 19 percent after about the sixth day of storage. Here, again, the purity values remained constant for the remainder of the storage period. The purity values for the unstripped dry were lower than for the other treatments.

Storage did not increase the finishing temperature of the sirup for the unstripped wet stalks. However, the finishing temperature did improve for the stripped and the unstripped dry stalks during the first 6 days of storage. There was a slight indication that the stripped stalks made better sirup than the unstripped dry stalks on the sixth day. Wiley was the only variety from which sirup was made in this test, and the sirup from unstripped wet stalks was inferior. The amount of sirup per ton of stalks was erratic for the wet stalks, but it increased from 0 to about 17 gallons on the second and third day of storage, respectively, for the stripped and unstripped dry. The amount of sirup was greater for the stripped than for the unstripped dry stalks for 10 days of storage, but the results of both treatments were similar after 14 days of storage.

Stripped and Unstripped

Figure 11 shows a comparison of stripped and unstripped stalks of Sart, Tracy, and Wiley during 1953–55. When the actual weight of the stalks at milling is used as the basis for calculation, as was done in these studies, the stripped stalks consistently have higher extraction values than the unstripped ones. Extraction reductions were similar for stripped and unstripped stalks. Both treatments resulted in about the same Brix, which increased from about 17.3° to 21.3° during the 2-week storage period. Sucrose dropped rapidly during the first week of storage and then remained constant during the second week for both treatments. Purity dropped rapidly during the first 4 days of storage, reached a minimum after 6 days of storage, and remained constant thereafter.

The presence or absence of leaves on the stalks did not affect the finishing temperature of the sirup. In both treatments a maximum finishing temperature was obtained by the sixth day of storage. During these studies a finishing temperature of 110° C. was established as the optimum value for sirup. However, 107° was considered acceptable for a commercial grade of sirup. The stripped stalks of Wiley made a sirup of acceptable density 1 day of storage sooner than did the unstripped stalks, and because of the difference in extraction they produced about 1 gallon more of sirup per ton of stalks for each day of the storage period until the last day. Wiley was the only

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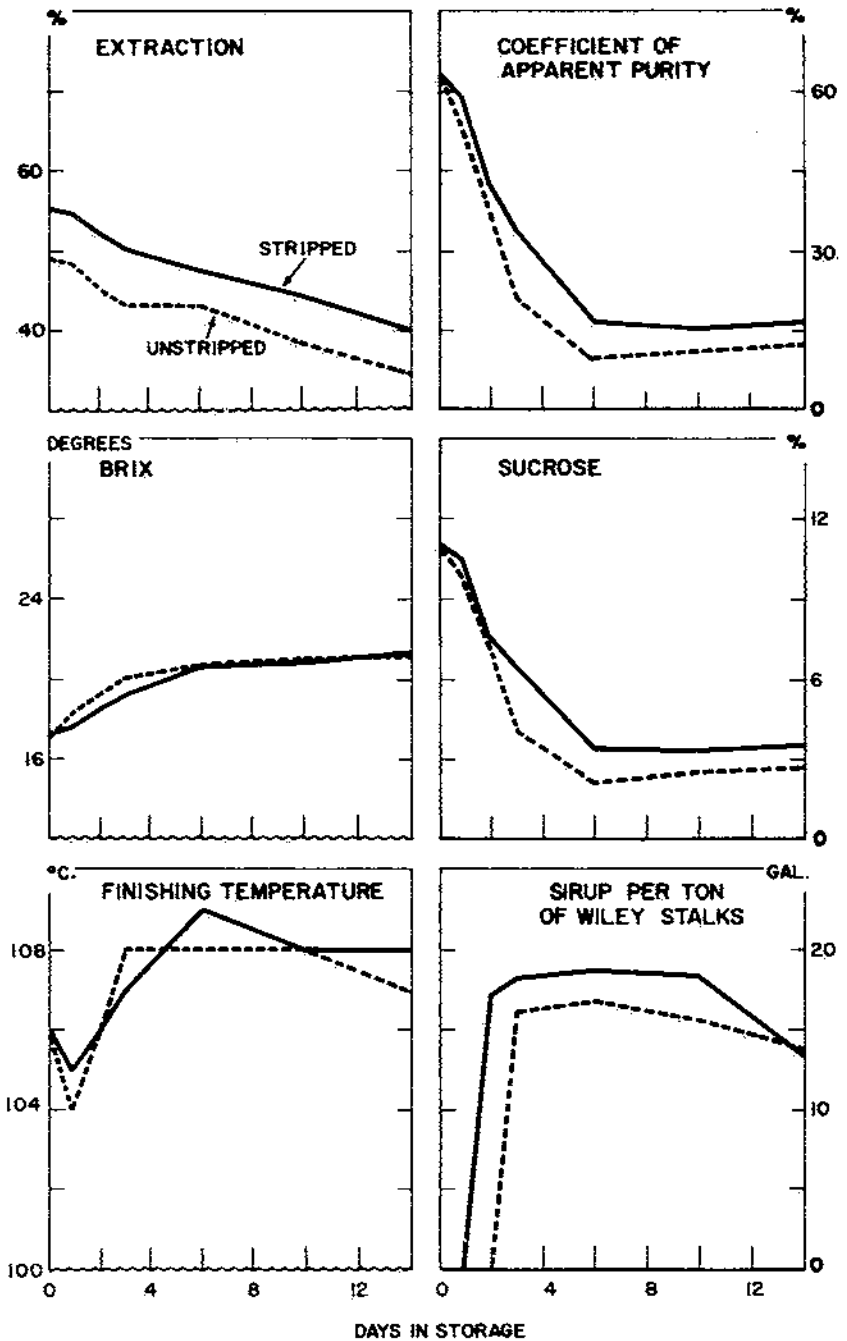

FIGURE 11.—Effect of stripped and unstripped treatments on yield and quality of juice and of sirup obtained from Sart, Tracy, and Wiley sorgo during 2 weeks' unprotected storage, 1953–55.

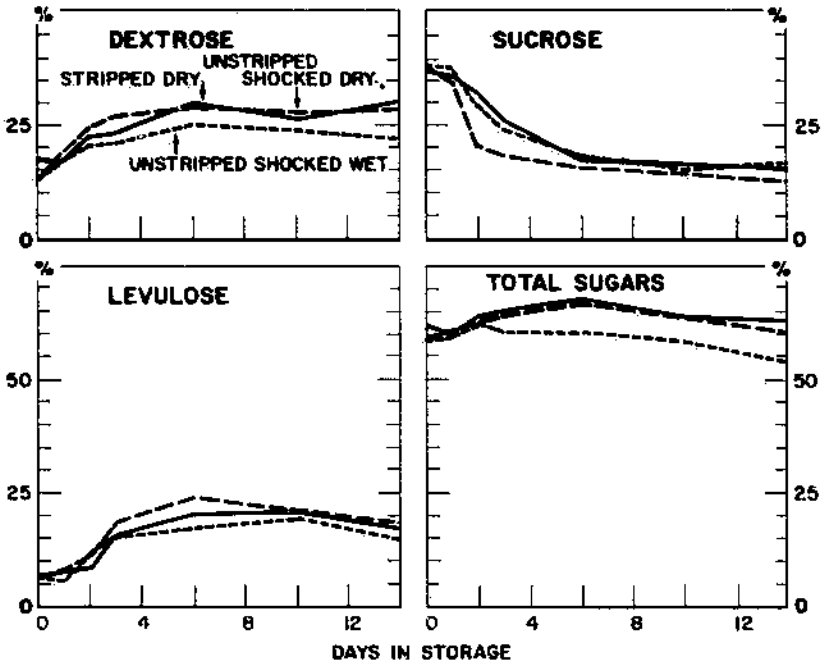

FIGURE 12.—Effect of three different treatments, based on sirup analyses, on Sart, Tracy, and Wiley sorgo during 2 weeks' unprotected storage, 1954–55.

variety that made an acceptable sirup in this test, and consequently these were the only data reported for sirup yields.

Sirup and Juice Analyses

Sirup data pertaining to dextrose, levulose, and sucrose for the three varieties during 1954–55 are included in figure 12. The results of all three treatments were similar. Dextrose increased to a maximum on the sixth day and remained relatively constant during the remainder of the storage period. Levulose also increased until about the 6th day and remained constant until the 10th day of storage but decreased during the last 4 days of storage. In general, the percentage of sucrose dropped rapidly during the first 6 days and then leveled off for the remainder of the storage period.

There is a possibility that further inversion or changes in the relationships of the various sugars might take place after the juice is boiled to sirup density. Figure 13 is apropos of this possibility and includes the results of studies with Sart and Wiley during 1954–55, in which the three major sugars are compared with the total sugars in the juice and in the sirup. The percentages of dextrose, levulose, and sucrose are the same in the juice as in the sirup. Also, most of the inversion took place during the first 3 or 4 days of storage in the stalk but not in the sirup.

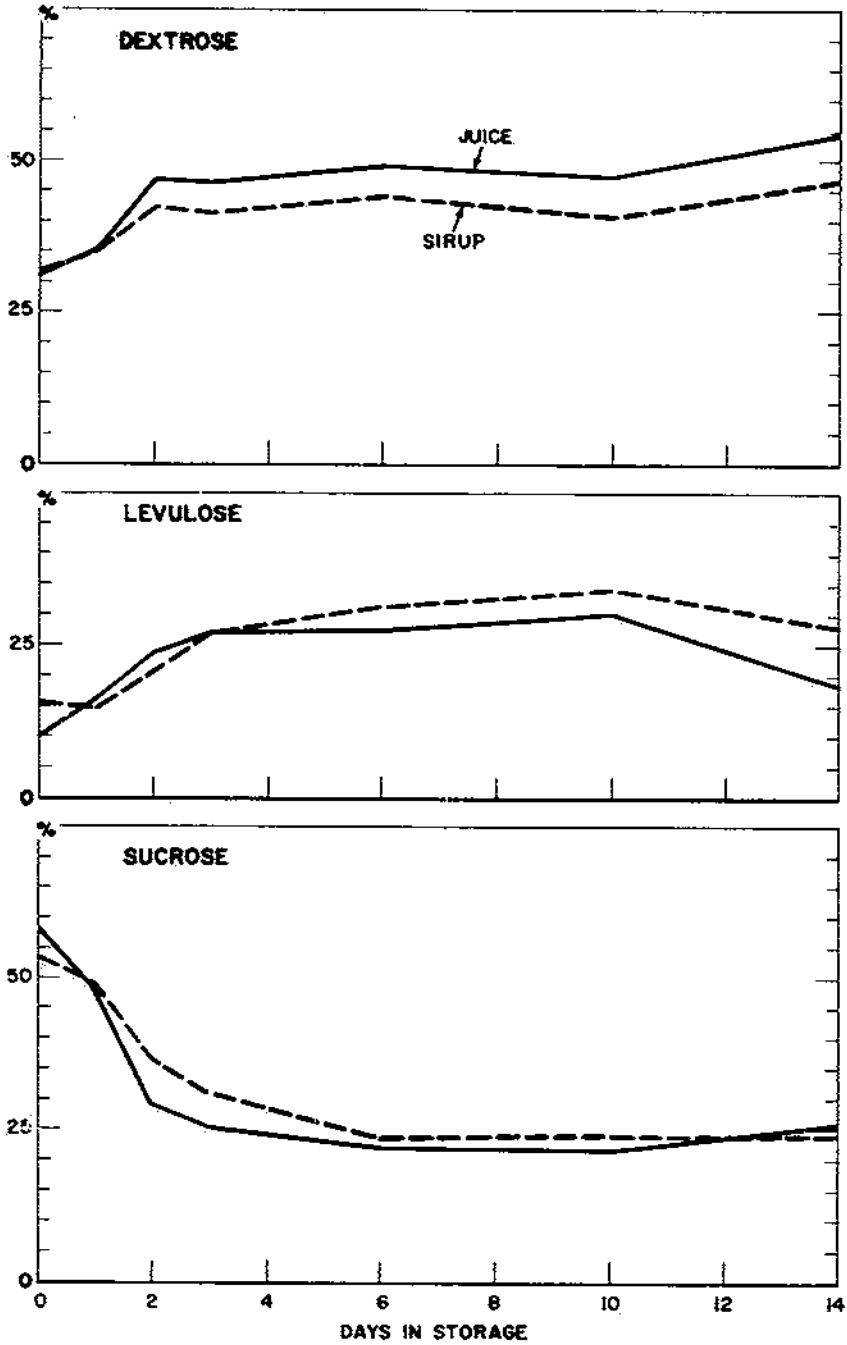

FIGURE 13.—Comparison of three sugars, in percent of total sugars, in frozen juice and sirup made from Sart and Wiley sorgo during 2 weeks' storage, 1954–55.

Sart, Tracy, and Wiley—Storage Treatments and Stages of Maturity, 1956–58

During 1956–58 new experiments were designed to study the effect of various storage treatments on the quality of sirup made from Sart, Tracy, and Wiley when the sorgo was harvested at different stages of maturity. Material was not available to study all three varieties at the three stages of maturity—anthesis, milk, and dough—for all 3 years. Previous data indicated that 6 days were about as long as sorgo should be left in storage at Meridian. Consequently, only 0 and 6 days for storage periods were used.

During 1956 and 1957 the treatments used were as follows: (1) The stalks were cut and the head and peduncle removed; (2) the stalks were cut and the head, peduncle, and leaves removed; (3) the top fourth of the stalk was removed; (4) the top fourth of the stalk and the leaves were removed. Treatments 3 and 4 were included because previous data reported by C. F. Walton et al.[3] indicated that the top part of the stalk contained more starch than the rest of the stalk and was detrimental to the production of high-quality sirup. Also, the effect of leaves on the sirup required more critical evaluation.

Sometimes there was enough plant material to study stalks standing in the field for 7 to 14 days after treatment. The following treatments were used: (1) The head, peduncle, and leaves were removed; (2) the top fourth of the stalk was removed; (3) the top fourth of the stalk and the leaves were removed. These treatments were included in order to determine the advisability of stripping or topping, or both, the stalks standing in the field before harvesting. The stalks treated and left standing in the field were milled and processed the same day that they were harvested.

The extraction values during these 3 years were based on the original weight of the whole plants as they were brought from the field in order that the yield of sirup per ton of stalks would be comparable for all treatments, except for stalks left standing in the field.

Variance Analyses

The variance analyses for Sart and Wiley are included in tables 1–6 in the appendix. There were highly significant differences between years, but no differences between treatments and between days for gross weights on the day of harvest (table 1). Random sampling, therefore, was excellent.

Highly significant differences between treatments for net weights were indicated for both varieties at all stages of maturity, as would be expected (table 2).

[3] WALTON, C. F., JR., VENTRE, E. K., and BYALL, S. EFFECTS OF LOW TOPPING AND DIASTATIC MALT EXTRACT ON COMPOSITION AND QUALITY OF SORGO SIRUP. Jour. Agr. Res. 60: 427–432. 1940.

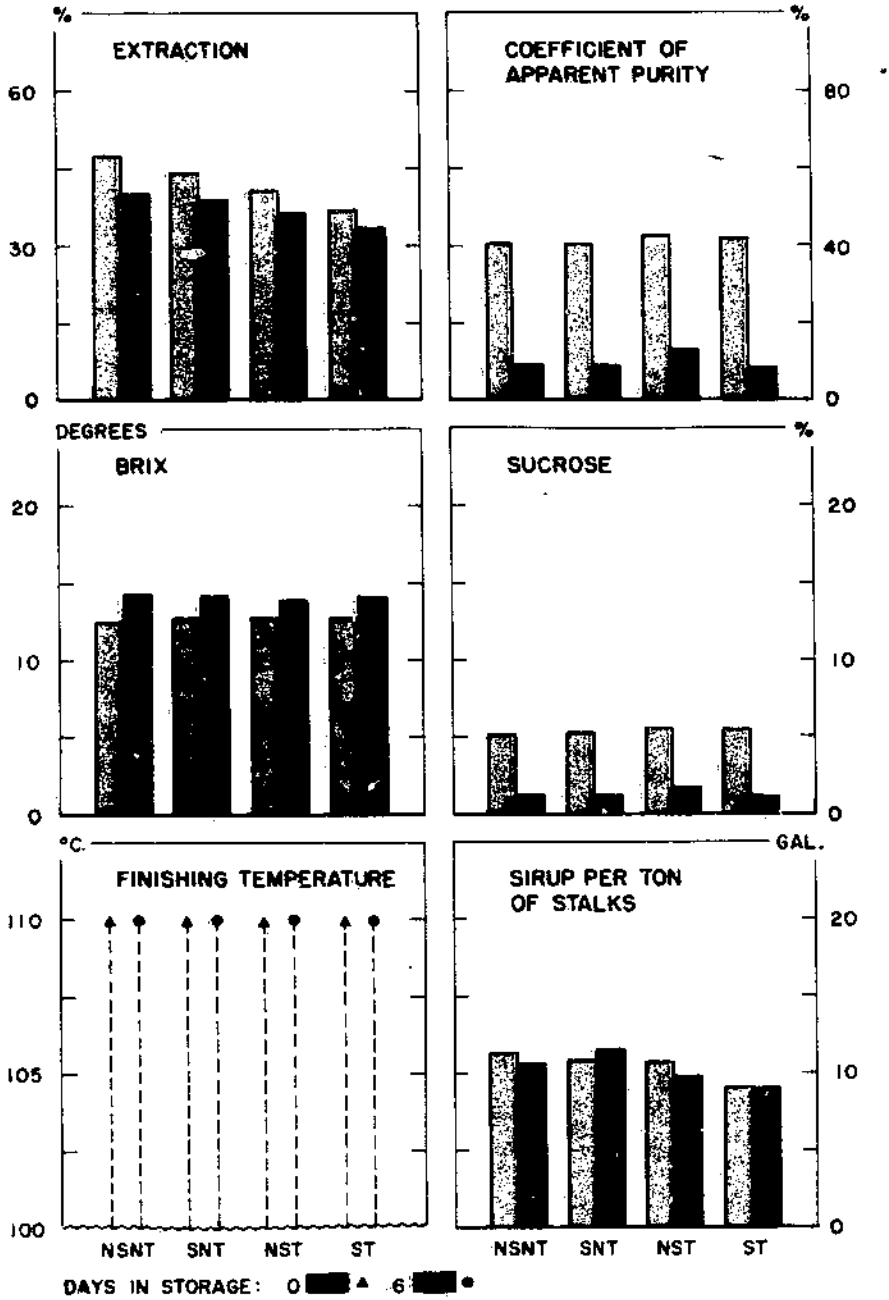

FIGURE 14.—Effect of various treatments on yield and quality of juice and of sirup obtained from Sart and Wiley sorgo harvested in the anthesis stage of maturity and stored for 0 and 6 days, 1956–58. (Parts removed before milling: NSNT—head, peduncle; SNT—head, peduncle, leaves; NST—top one-fourth of stalk; ST—top one-fourth of stalk, leaves.)

First-order interactions were significant for extraction of both Sart and Wiley, except days × years for Wiley in the dough stage of maturity (table 3).

The major effects of treatments and days in storage were highly significant for Brix for both varieties (table 4), and first-order interactions were highly significant for Sart.

Highly significant differences between years and between days of storage for sucrose were indicated for both varieties at all stages of maturity (table 5). Also, treatment differences were highly significant for both varieties for all stages of maturity, except Wiley in the dough stage.

The variance analyses for coefficient of apparent purity were similar to those for sucrose (table 6).

Anthesis Stage of Maturity

The data for Sart and Wiley during 1956–58 for the anthesis stage of maturity are included in figure 14. One of the noteworthy results, as shown in this figure, is that although there was a consistent loss in extraction during the 6 days of storage, there was also a loss of extraction related to stripping. There was no instance where the extraction of stripped stalks was greater than that for those not stripped. This is an important economic consideration in the production of sirup. Most operators have thought that leaves would interfere with extraction, but this does not appear to be true.

Brix values appear to be about the same whether the entire stalk is used or parts of it are removed. There was, of course, an increase in Brix during the 6-day storage period.

The loss of sucrose during the 6 days of storage is similar for all treatments. Purity values were about the same for all treatments and also dropped rapidly during the 6 days' storage. Average finishing temperature indicates that good-quality sirup can be produced from all treatments even when processing was done on the day of harvest.

Sirup per ton of stalks remained rather constant when based on the gross weight of stalks whether or not the leaves were left on. As expected, there was a reduction in sirup per ton of stalks when the top fourth of the stalk was removed and the lowest yield was that obtained from the stripped and topped stalks. In general, storage had no detrimental effect on the yield of sirup per ton of stalks.

Frozen-juice and sirup data for these two varieties at anthesis during 1956–58 are included in figure 15. Dextrose and levulose increased about 2 percent in the juice during the storage period and about 10 percent in the sirup. On the day of harvest the percentage of sucrose in the juice was about the same for all four treatments and the relative values for the sirup were also similar. However, there was a slight indication that the percentage of sucrose after 6 days of storage was higher in the whole stalk with the leaves intact than for the other treatments. In both comparisons the stalks with leaves

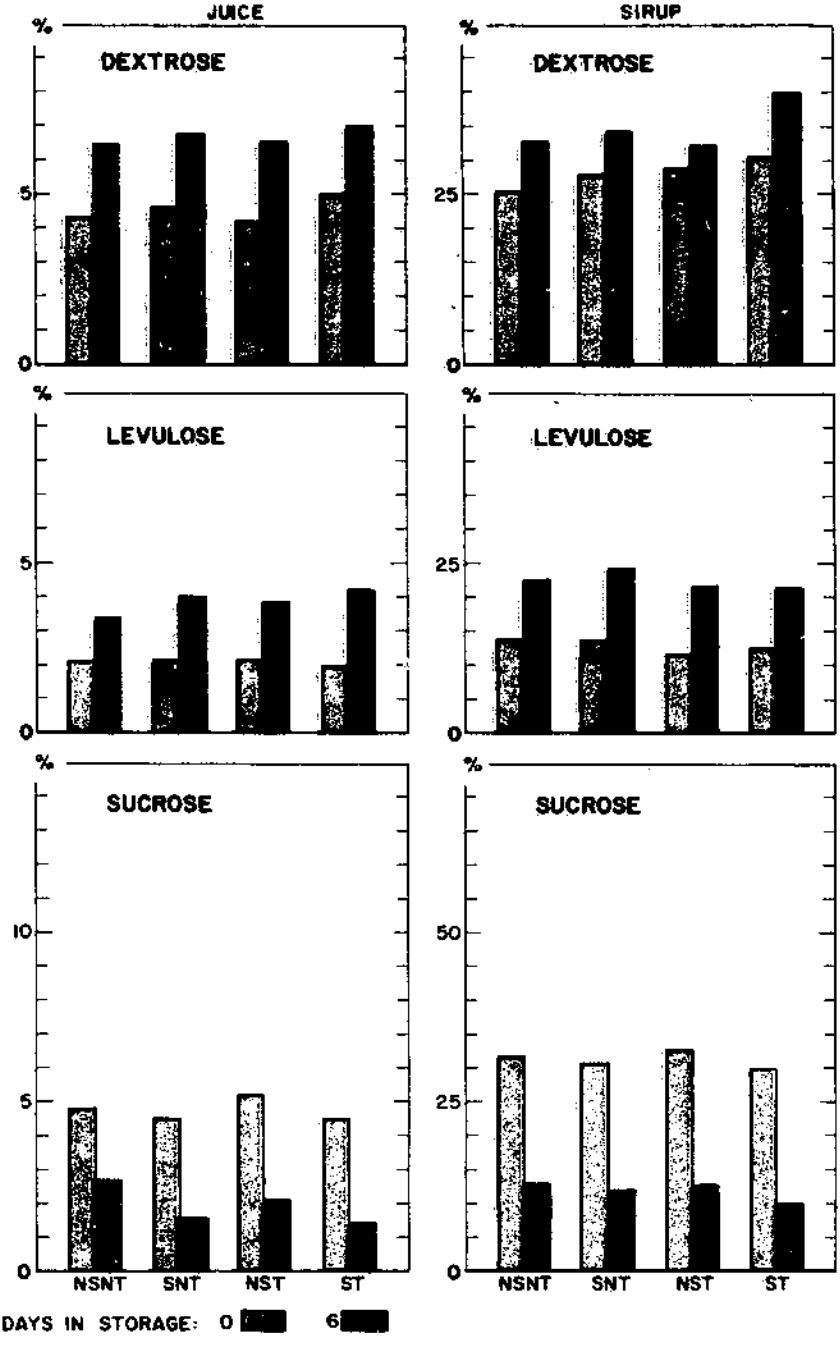

FIGURE 15.—Effect of various treatments, based on frozen-juice and sirup analyses, on Sart and Wiley sorgo harvested in the anthesis stage of maturity and stored for 0 and 6 days, 1956–58. (For explanation of letter symbols, see legend for figure 14.)

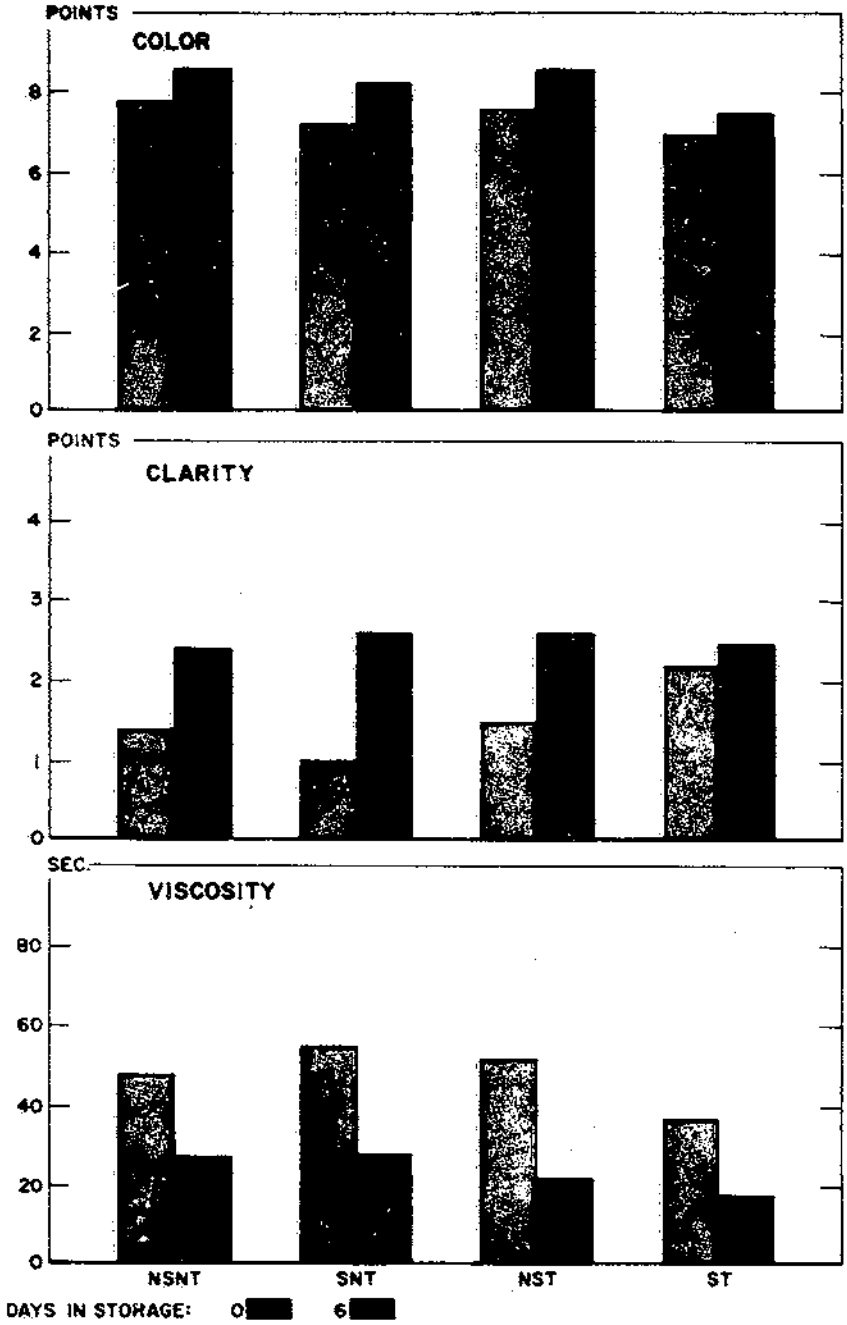

FIGURE 16.—Effect of various treatments on quality of sirup made from Sart and Wiley sorgo harvested in the anthesis stage of maturity and stored for 0 and 6 days, 1956–58. (For explanation of letter symbols, see legend for figure 14.)

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had slightly higher sucrose values than the stalks without leaves.

Figure 16 includes the results of color, clarity, and viscosity evaluations for sirups made from Sart and Wiley in the anthesis stage of maturity. The color of sirup made from unstripped stalks was slightly darker than that from stripped stalks. Storing the stalks for 6 days darkened the sirup by about 1 point in the color scale. At the same time, however, clarity was increased. The highest clarity rating of sirup made from stalks milled on the day of harvest was for the stripped and topped treatment, but after 6 days of storage all treatments resulted in about the same rating. Without exception, 6 days' storage decreased the viscosity by about one-half.

Milk Stage of Maturity

The comparison of the various treatments for Sart and Wiley in the milk stage of maturity is included in figure 17. The results on extraction are almost identical with those for anthesis. Stripping the stalks did not enhance the extraction values but usually reduced them. Brix values were approximately 2° higher than at anthesis but were in the same order. Sucrose values were approximately 5 percent higher in the fresh stalks than in those stored for 6 days. The highest sucrose value for fresh stalks was for the stripped not topped stalks, but the unstripped topped stalks had the highest sucrose after 6 days of storage. These interactions were highly significant. The lowest sucrose value after 6 days of storage was for the stalks that were stripped and topped. Similar results were obtained for purity.

The temperature of the boiling sirup made from stalks stored for 6 days reached the optimum of 110° C. On the first day of harvest, however, sirup made from stalks stripped and topped was the only one that reached a finishing temperature of 110°, whereas the other treatments reach a maximum of only 108°. These data indicate that if stalks are to remain in storage for about 6 days a very acceptable and high-quality sirup can be obtained without stripping. Storing the stalks for 6 days actually increased the yields for all treatments, except the stripped and topped stalks. The highest yield per ton was obtained from the two treatments in which the entire stalk was stored for 6 days.

Figure 18 includes the frozen-juice and sirup data for Sart and Wiley in the milk stage of maturity. There does not appear to be any difference in dextrose between the treatments when the stalks are milled on the day of cutting. After 6 days of storage, however, the whole stalk had more dextrose than that topped. On the other hand, after 6 days of storage the highest percentage of levulose was obtained from the stalks that were stripped. The highest percentage of sucrose for stalks milled on the day of cutting was for the stripped and

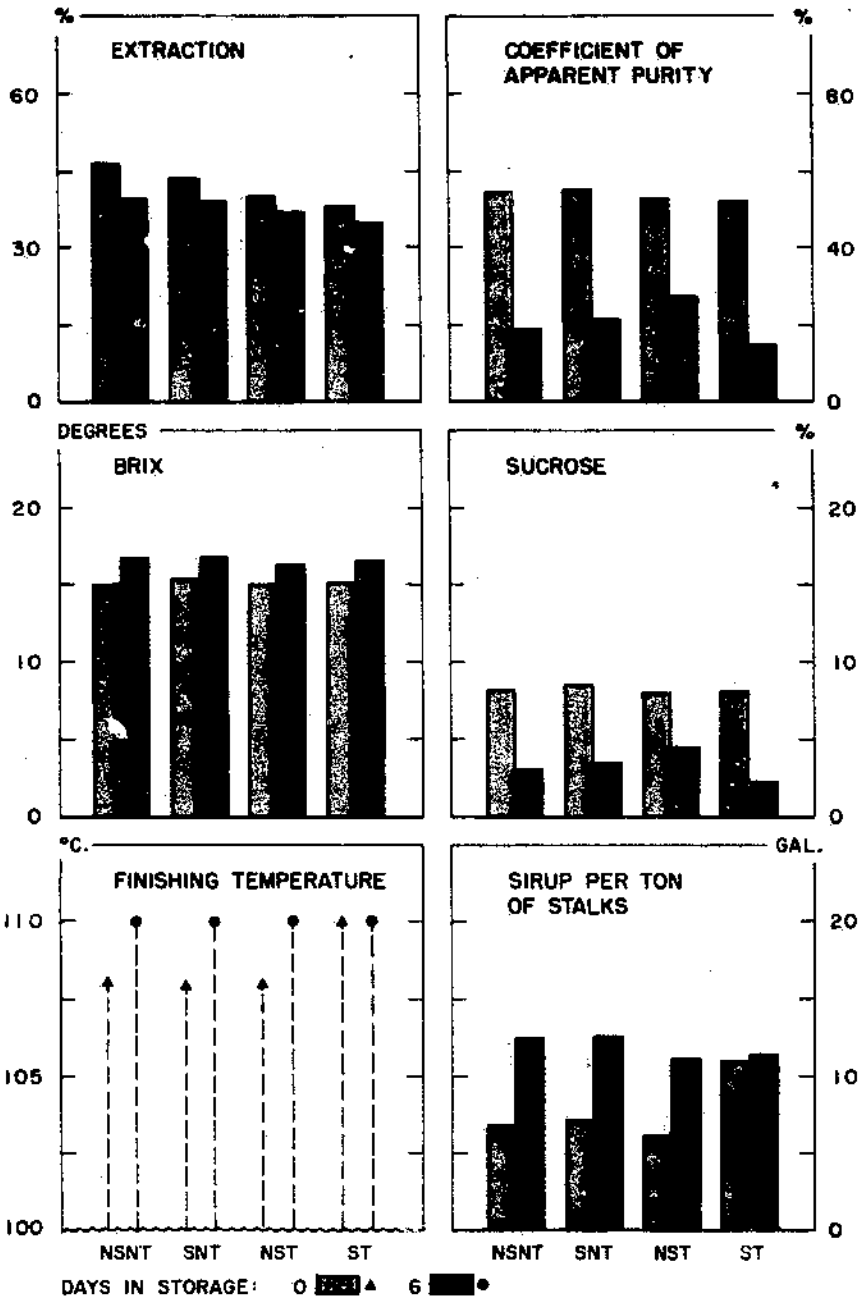

FIGURE 17.—Effect of various treatments on yield and quality of juice and of sirup obtained from Sart and Wiley sorgo harvested in the milk stage of maturity and stored for 0 and 6 days, 1956–58. (For explanation of letter symbols, see legend for figure 14.)

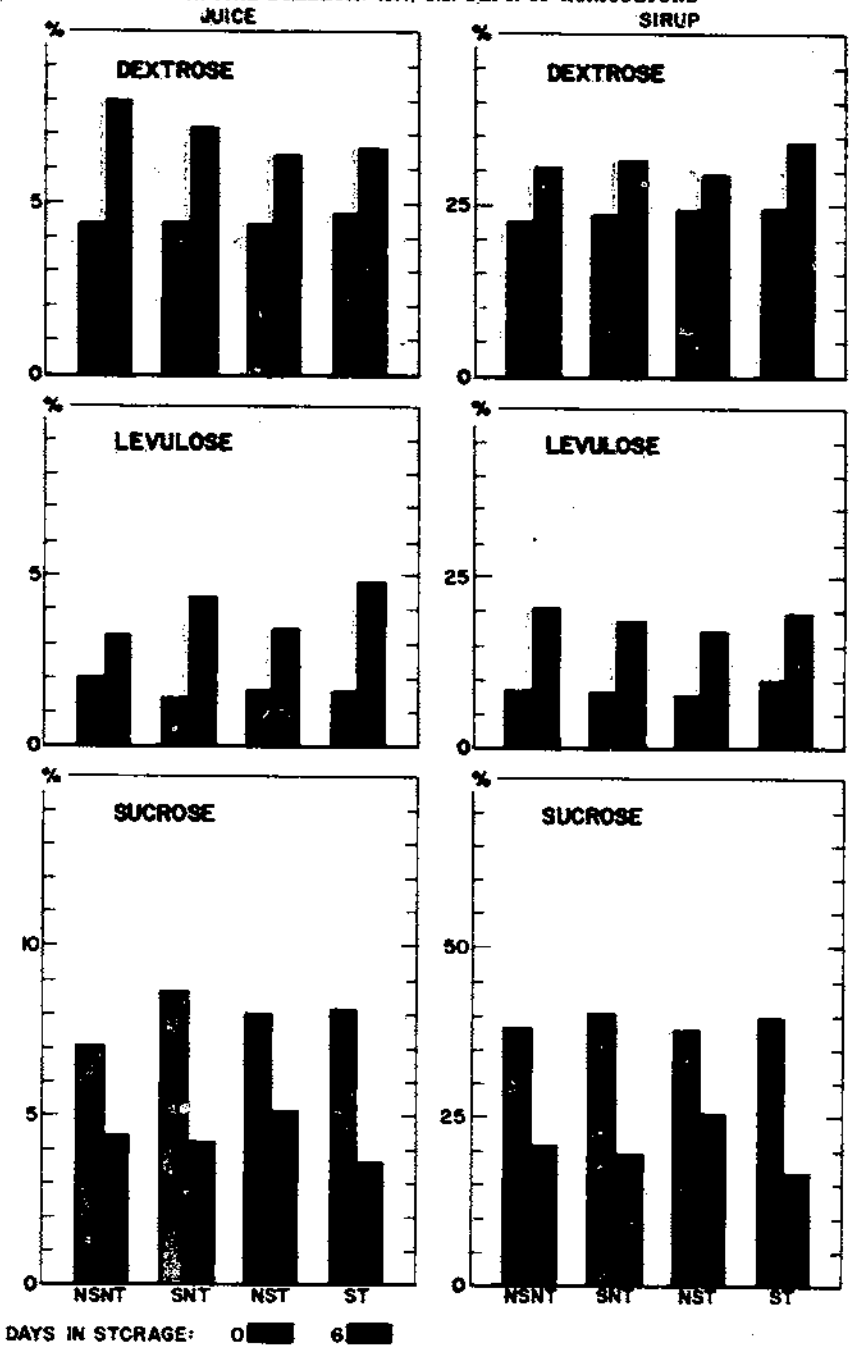

FIGURE 18.—Effect of various treatments, based on frozen-juice and sirup analyses, on Sart and Wiley sorgo harvested in the milk stage of maturity and stored for 0 and 6 days, 1956–58. (For explanation of letter symbols, see legend for figure 14.)

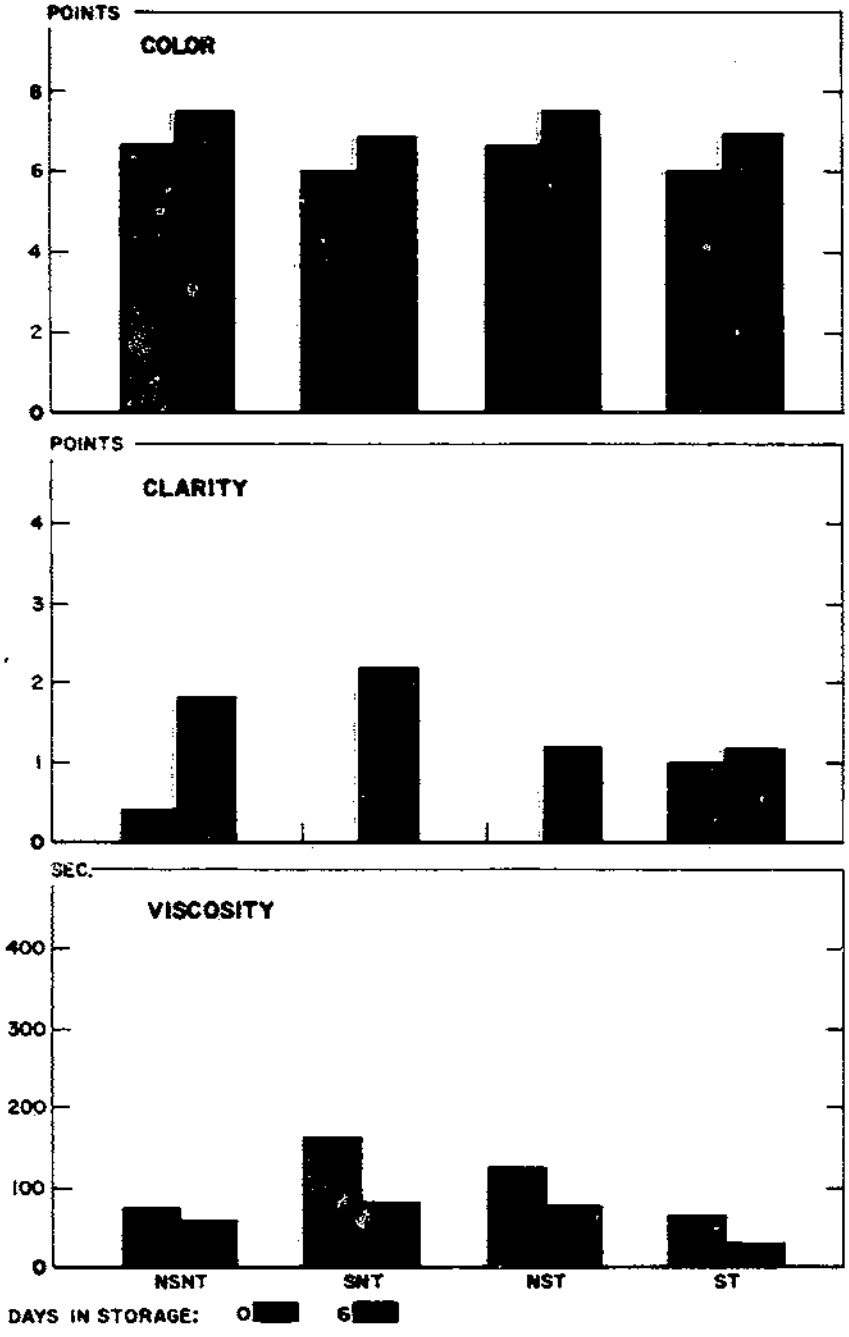

FIGURE 19.—Effect of various treatments on quality of sirup made from Sart and Wiley sorgo harvested in the milk stage of maturity and stored for 0 and 6 days, 1956–58. (For explanation of letter symbols, see legend for figure 14.)

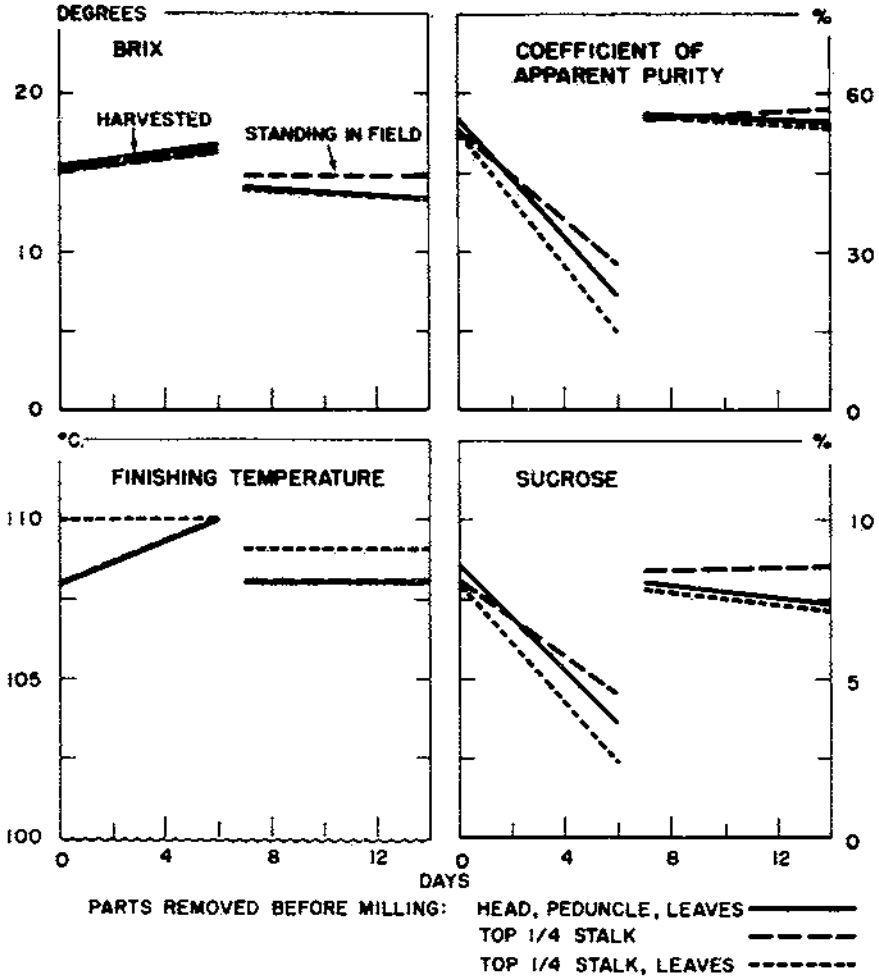

FIGURE 20.—Effect of various treatments on quality of juice and of sirup obtained from Sart and Wiley sorgo in the milk stage of maturity when (1) harvested and stored for 0 and 6 days and (2) left standing in the field for 1 and 2 weeks, 1956–58.

not-topped treatment. After 6 days of storage the lowest percentage of sucrose was obtained from the stalks that were stripped and topped.

Color, clarity, and viscosity ratings for Sart and Wiley in the milk stage are included in figure 19. The unstripped stalks produced darker sirups than the stripped stalks. Here again, storage for 6 days darkened the sirups by about 1 point. Clarity increased greatly with 6 days of storage, except for the stripped and topped stalks. The best clarity rating was for whole stalks stripped and stored for 6 days. Storage reduced viscosity for all treatments. The highest viscosity was for

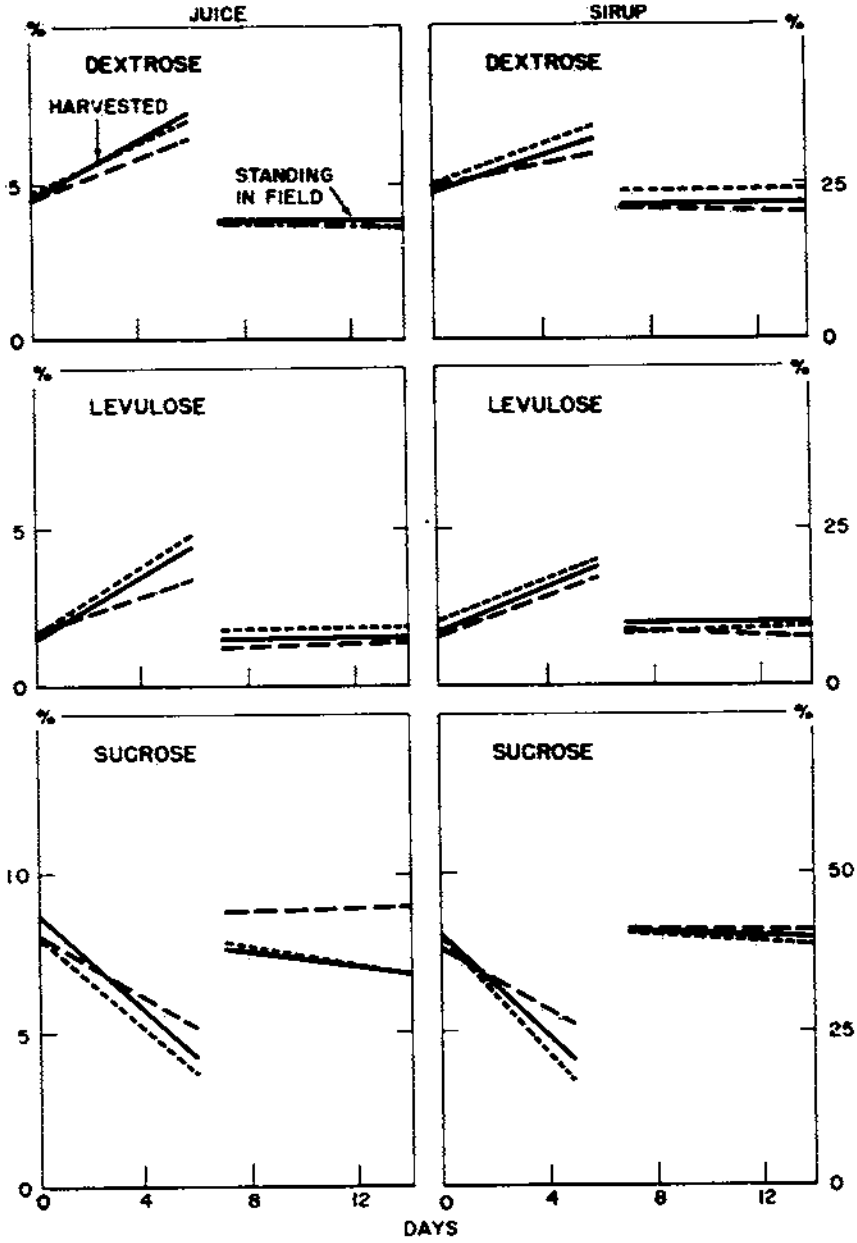

FIGURE 21.—Effect of various treatments, based on frozen-juice and sirup analyses, on Sart and Wiley sorgo in the milk stage of maturity when (1) harvested and stored for 0 and 6 days and (2) left standing in the field for 1 and 2 weeks, 1956–58.

whole stalks stripped and milled on the day of harvest. The lowest viscosity was for stripped and topped stalks stored for 6 days.

Data for Sart and Wiley in the milk stage of maturity left standing in the field for 1 and 2 weeks after stripping or topping, or both, as compared with samples cut and left in storage for 6 days are included in figure 20. There was a gradual decrease in Brix for the stalks left standing in the field, except the topped stalks with the leaves remaining. Sucrose values also tended to drop slightly, except for this same treatment. Purity remained rather constant for 2 weeks after the treatment. The quality of sirup as measured by the finishing temperature indicated that there was actually a loss in quality when the stalks were left standing for 1 or 2 weeks after treatment. This was true whether or not the stalks were stripped. Finishing temperatures of the sirups made from standing stalks were lower than from comparative samples stored for 6 days for every treatment. Consequently, these data indicate that the practice of stripping or treating the stalks a week or two in advance of harvest is not conducive to the production of good yields of high-quality sirup.

Figure 21 includes frozen-juice and sirup data for treated stalks left standing in the field as compared with harvested stalks in storage for 6 days. Dextrose in the juice and sirup increased for all treatments if the stalks were cut and held in storage but remained constant if the stalks were left standing in the field for 2 weeks. The same results applied to levulose. Sucrose decreased rapidly for all treatments when stalks were cut and stored for 6 days, but it decreased slightly when they were left standing in the field for 2 weeks after treatment except when the top one-fourth of the stalk was removed.

Color, clarity, and viscosity ratings for the cut and the standing stalks are included in figure 22. The sirup darkened with storage for cut stalks but only very slightly, if any, for standing stalks. The sirup made from the latter, however, was darker than that made from fresh stalks. Clarity increased greatly for stripped stalks cut and stored for 6 days but decreased when the stalks were left standing in the field for 2 weeks. Clarity for the other field treatments remained constant. Viscosity decreased rapidly for cut stalks stored for 6 days and remained about constant for standing stalks.

Dough Stage of Maturity

Tracy and Wiley were available in the dough stage of maturity during 1957–58. Data for these varieties are included in figure 23. Extraction figures are similar to those previously described. Similar results were also obtained for Brix, sucrose, and purity, except that these values were slightly higher than in the milk stage. However, the lowest sucrose and the lowest purity were obtained from stalks that were stripped and topped and held in storage for 6 days. There was a slight improvement in the finishing temperature of the sirup after 6 days of

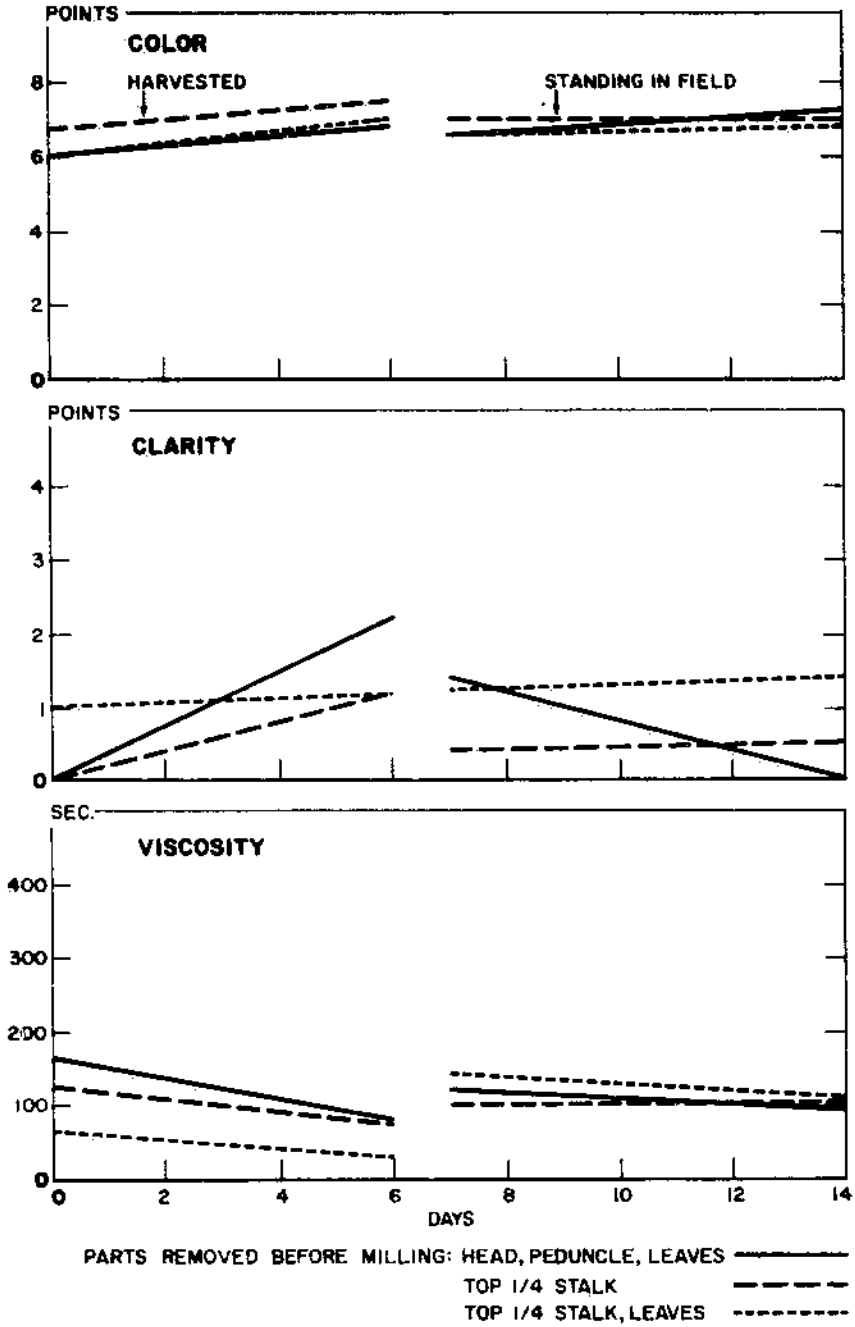

FIGURE 22.—Effect of various treatments on quality of sirup made from Sart and Wiley sorgo in the milk stage of maturity when (1) harvested and stored for 0 and 6 days and (2) left standing in the field for 1 and 2 weeks, 1956–58.

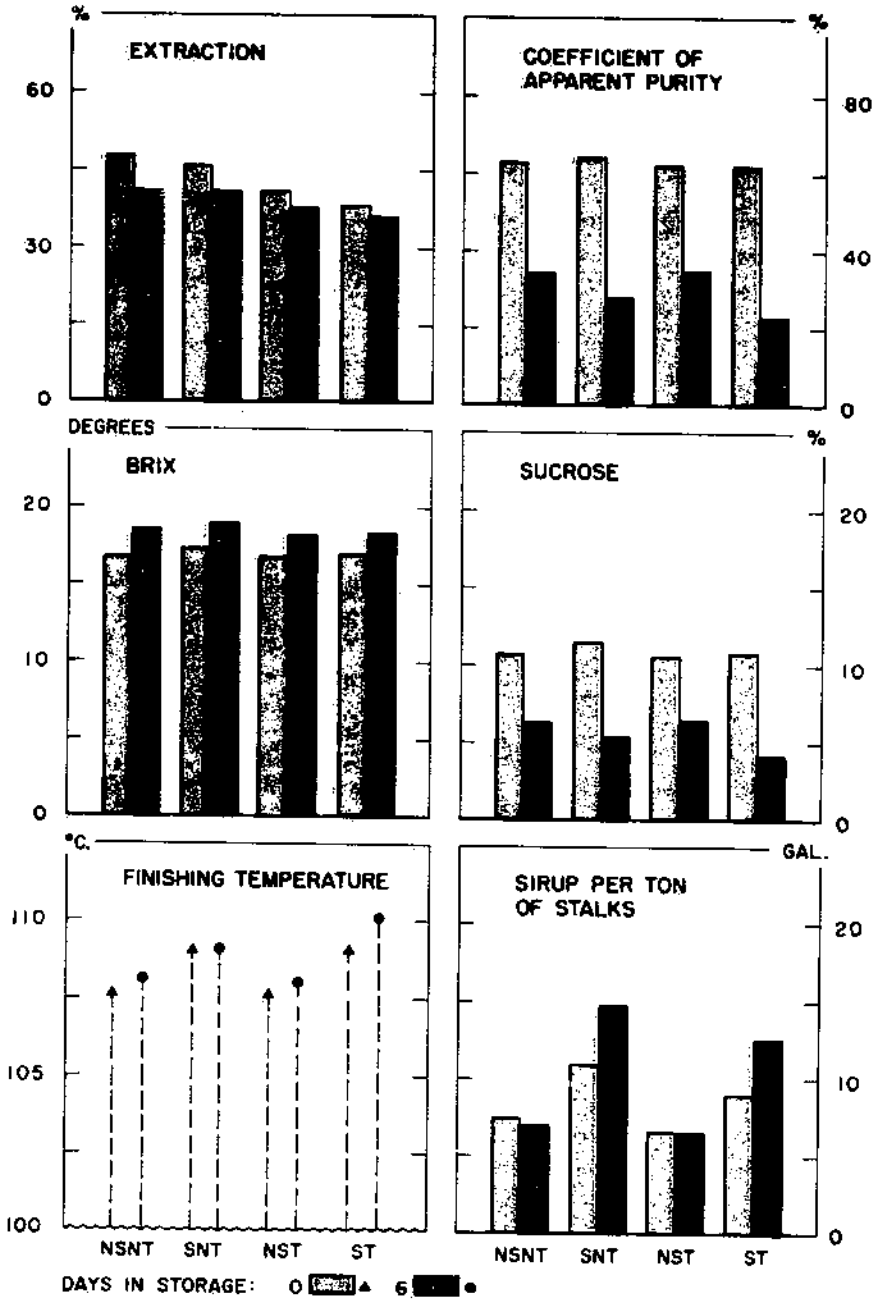

FIGURE 23.—Effect of various treatments on yield and quality of juice and of sirup obtained from Tracy and Wiley sorgo harvested in the dough stage of maturity and stored for 0 and 6 days, 1957–58. (For explanation of letter symbols, see legend for figure 14.)

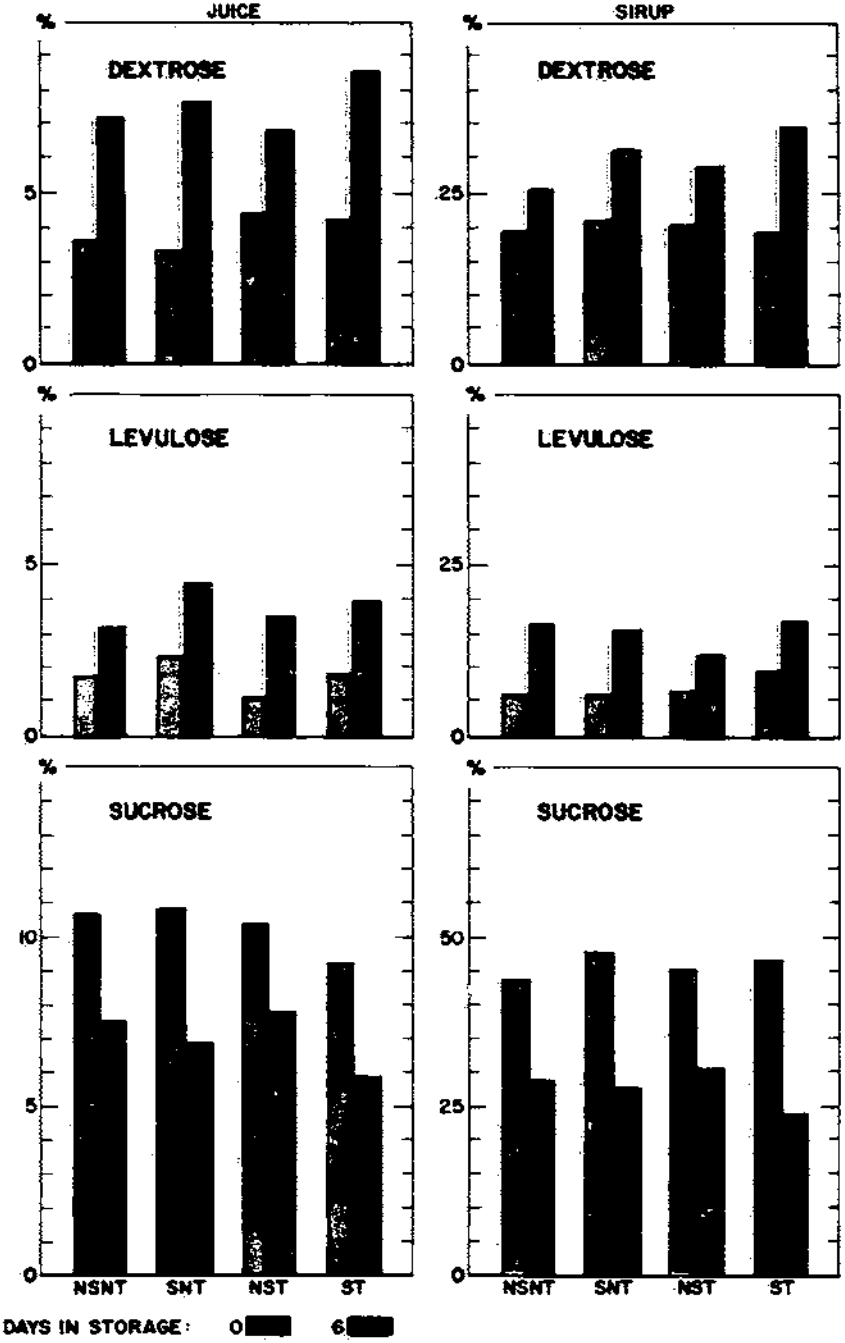

FIGURE 24.—Effect of various treatments, based on frozen-juice and sirup analyses, on Tracy and Wiley sorgo harvested in the dough stage of maturity and stored for 0 and 6 days, 1957–58. (For explanation of letter symbols, see legend for figure 14.)

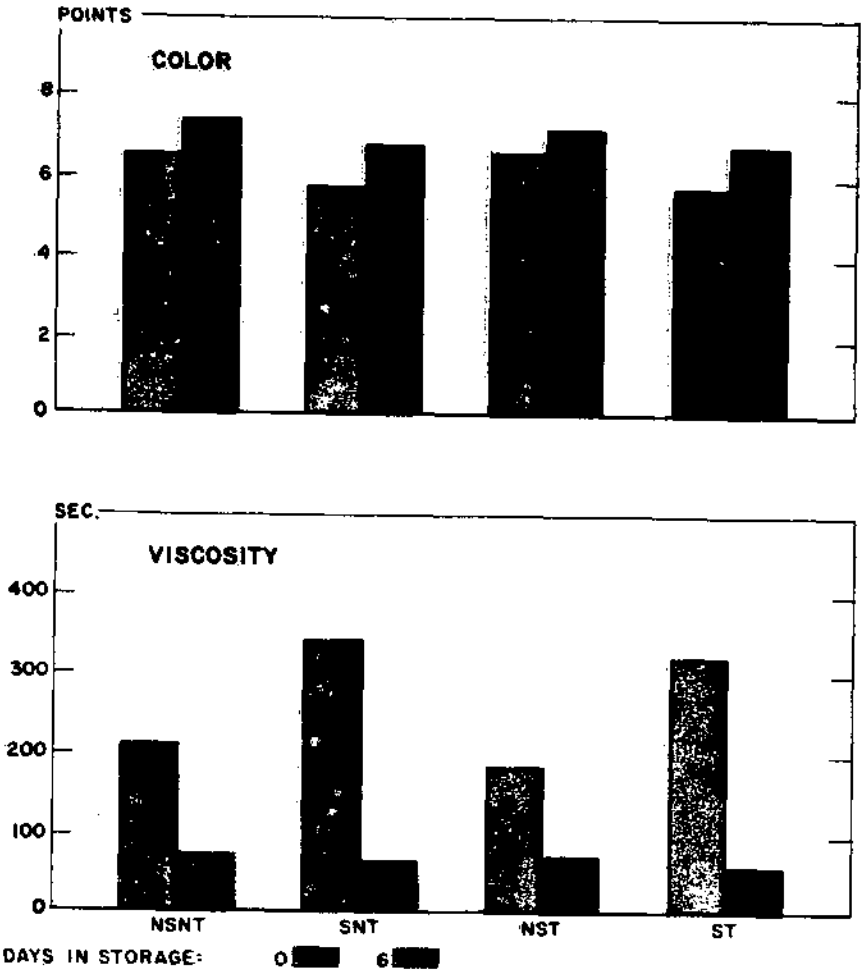

FIGURE 25.—Effect of various treatments on quality of sirup made from Tracy and Wiley sorgo harvested in the dough stage of maturity and stored for 0 and 6 days, 1957–58. (For explanation of letter symbols, see legend for figure 14.)

storage in all treatments except stripped and not topped. The improvement appeared to be greater for the stalks that were topped. The only samples that reached 110° C. were those that were stripped and topped and stored for 6 days. Acceptable sirup, however, was produced from the stalks stored for 6 days that were neither stripped nor topped. In the dough stage of maturity the highest yield of sirup per ton of stalks was from the stripped samples that were not topped and held in storage for 6 days.

Frozen-juice and sirup data for Tracy and Wiley in the dough stage are included in figure 24. These data are similar to those

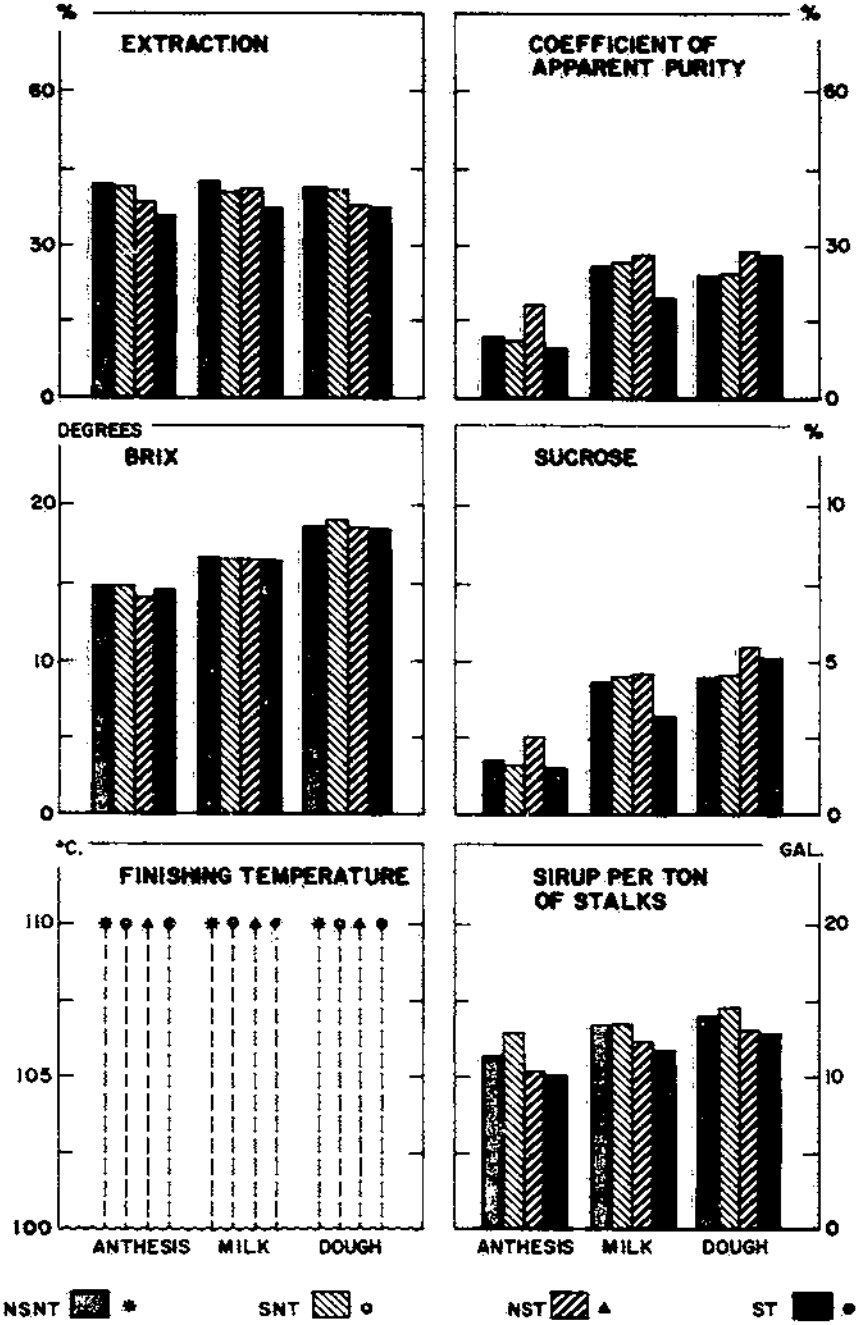

FIGURE 26.--Effect of various treatments on yield and quality of juice and of sirup obtained from Wiley sorgo harvested in three stages of maturity and stored for 6 days, 1956–58. (For explanation of letter symbols, see legend for figure 14.)

obtained in the milk stage. Dextrose and levulose increased during the storage period, whereas sucrose decreased.

The color of the sirup was darker after 6 days of storage when Tracy and Wiley were in the dough stage of maturity, as shown in figure 25. The clarity of the sirups was zero for all treatments. The viscosity decreased rapidly with 6 days of storage.

Wiley—Stages of Maturity

Figure 26 includes the data for Wiley for three stages of maturity and four treatments in 1956–58. Extraction figures remained about constant during the three stages of maturity. The Brix values increased consistently for the three stages as did sucrose and purity. The juice of Wiley produced sirup that reached a finishing temperature of 110° C., irrespective of the stage of development or the treatment. The increase of sirup per ton of stalks with maturity agrees with the increase in Brix. There was a loss of sirup when the top fourth of the stalk was removed.

Comparisons for Wiley between stripped and unstripped stalks for three stages of maturity and for 0 and 6 days of storage are included in figure 27. Extraction for these samples was based on the original weight of the unstripped stalks. For each stage of maturity the unstripped stalks had a higher extraction than the stripped stalks on the day of harvest. There was a reduction in extraction associated with 6 days of storage. On the other hand, there was a strong tendency for the Brix to increase with storage and maturity. Storage decreased the sucrose whether the stalks were stripped or not. Purity values also dropped with storage and the stripped and unstripped stalks averaged about the same. The sirup reached 110° C. for all treatments and stages of maturity, except for the unstripped stalks milled the day of cutting in the dough stage of maturity. This result indicates that there may be some problem of manufacturing sirup from Wiley in the dough stage of maturity if the stalks are unstripped and milled the same day cut. Stripping had very little effect, if any, on the yield of sirup per ton of stalks, irrespective of the stage of maturity.

Figure 28 includes the sirup-quality data for Wiley during 1956–58. The color of the sirup improved as the plant matured but darkened slightly during the 6 days of storage. Generally the sirup made from stalks that were not stripped was slightly darker than that from the stripped stalks; however, the sirup was of acceptable color in both treatments.

The best clarity was obtained from the plants in the anthesis stage of maturity and the poorest clarity from the plants in the dough stage. The sirup lowest in dispersed colloids was obtained from stalks that were stored 6 days and were not stripped. Actually, stripping did not improve the clarity of sirup, but storage tended to reduce the amount of colloidal material in suspension.

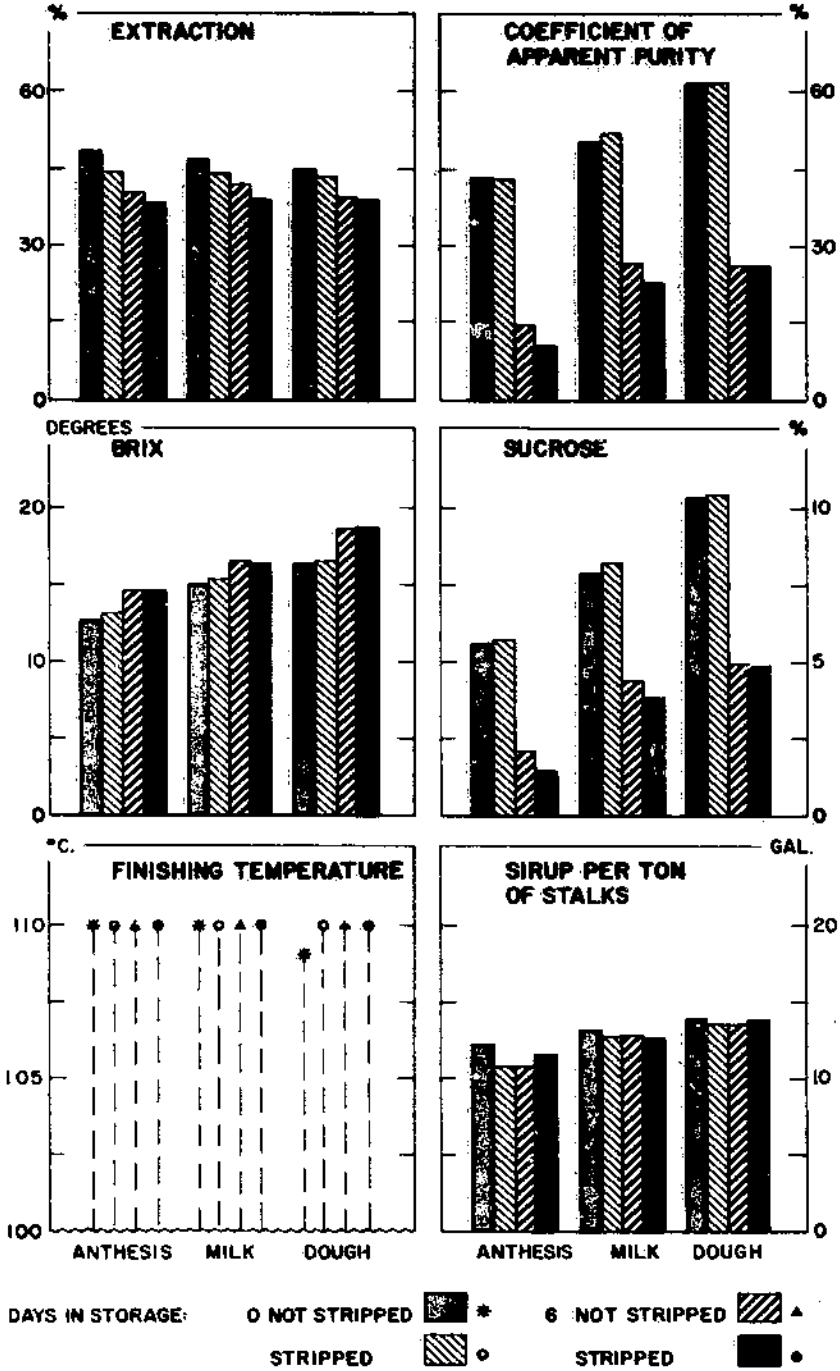

FIGURE 27.—Effect of stripped and unstripped treatments on yield and quality of juice and of sirup obtained from Wiley sorgo harvested in three stages of maturity and stored for 0 and 6 days, 1956–58.

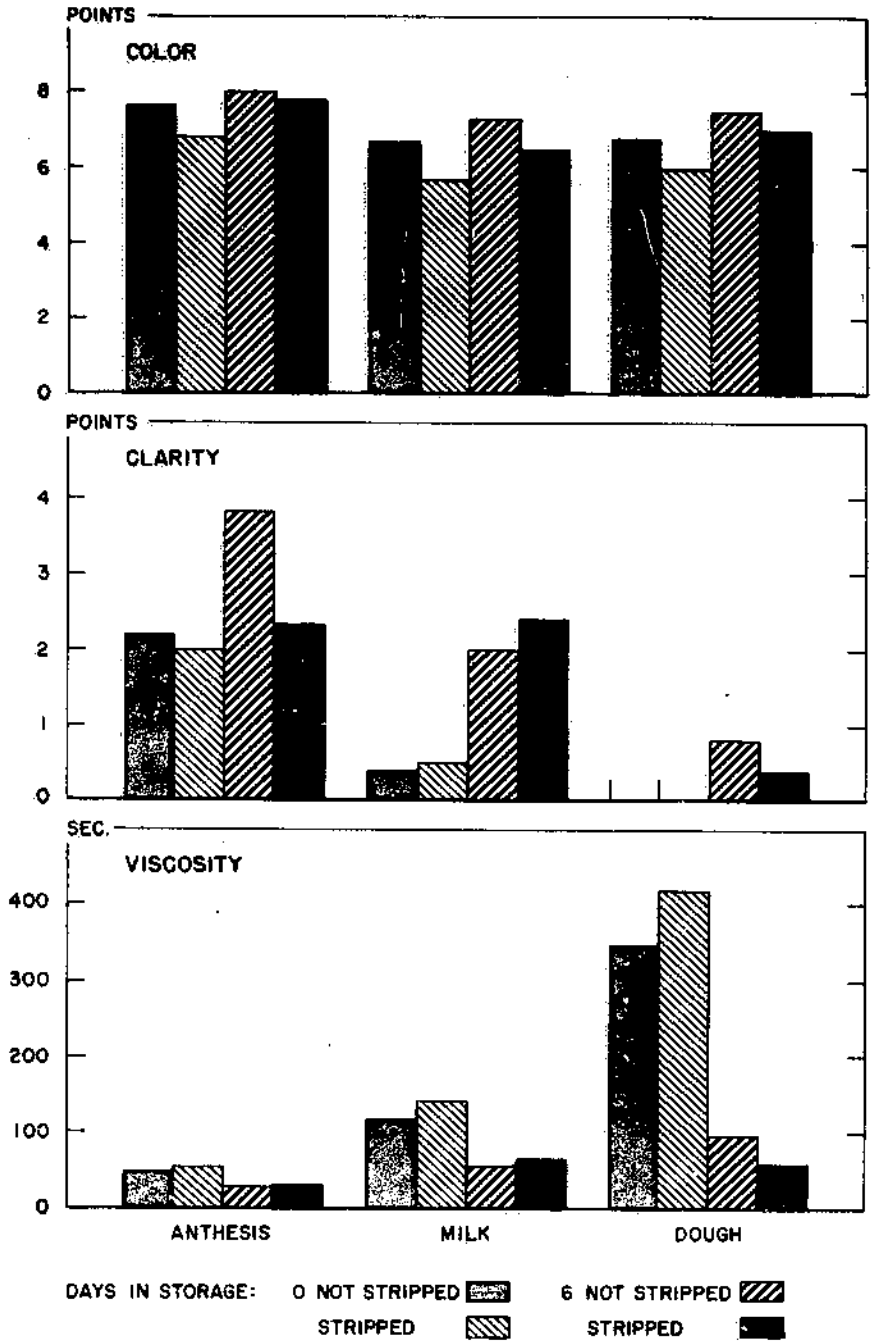

FIGURE 28.—Effect of stripped and unstripped treatments on quality of sirup made from Wiley sorgo harvested in three stages of maturity and stored for 0 and 6 days, 1956–58.

The viscosity was lowest for sirup made from plants in the anthesis stage of maturity and highest when the plants were in the dough stage. In general, the viscosity was greater when the stalks were processed on the day of harvest than when they were held in storage for 6 days. This difference became greater as the plants matured.

Sart, Tracy, and Wiley—Storage Treatments and Stages of Maturity, 1958

Many farmers have been cutting sorgo with a corn binder and milling the entire plant. Some of them have not completely removed the heads, and, to a large extent, the entire plant was milled. Consequently, the additional treatment of milling the entire plant was included in the studies in 1958.

Anthesis Stage of Maturity

Figure 29 includes the data for Sart and Wiley in the anthesis stage of maturity in 1958. Since extraction was highest for the whole plant, apparently some juice was obtained from the peduncle. Actual extraction based on the original weight decreased as the plant material was removed. This was true whether it was peduncle, leaves, or the top fourth of the stalk. Extraction was lower after 6 days of storage. The poorest extraction, based on the whole plant weight, was from the stalks that were stripped and topped and left in storage for 6 days.

On the other hand, on the day of harvest the lowest Brix was produced from the whole plant. The Brix gradually increased as plant material was removed from the stalk. The highest Brix was from the stalks that were topped. After 6 days of storage the Brix values for most of the treatments were about the same.

Sucrose values fluctuated between treatments but dropped off very rapidly during the 6 days of storage. The lowest sucrose value on the day of harvest was obtained from the whole plant; the highest was from the stripped and topped stalks.

Purity values followed the same pattern as for sucrose.

All the juice boiled down to 110° C., except that on the 0 day of storage from the unstripped stalks from which the head and peduncle were removed before milling. Even in these treatments acceptable sirup was produced.

Sirup per ton of stalks was greatest from whole plants and lowest from stalks that were stripped and topped. Six days in storage did not affect the yield of sirup.

Dextrose and levulose increased with storage and sucrose decreased in the frozen juice and in the sirup. No significant treatment effects were evident except from storage, as shown in figure 30.

The sirup-quality data for Sart and Wiley in 1958 at the anthesis stage of maturity are given in figure 31. The various

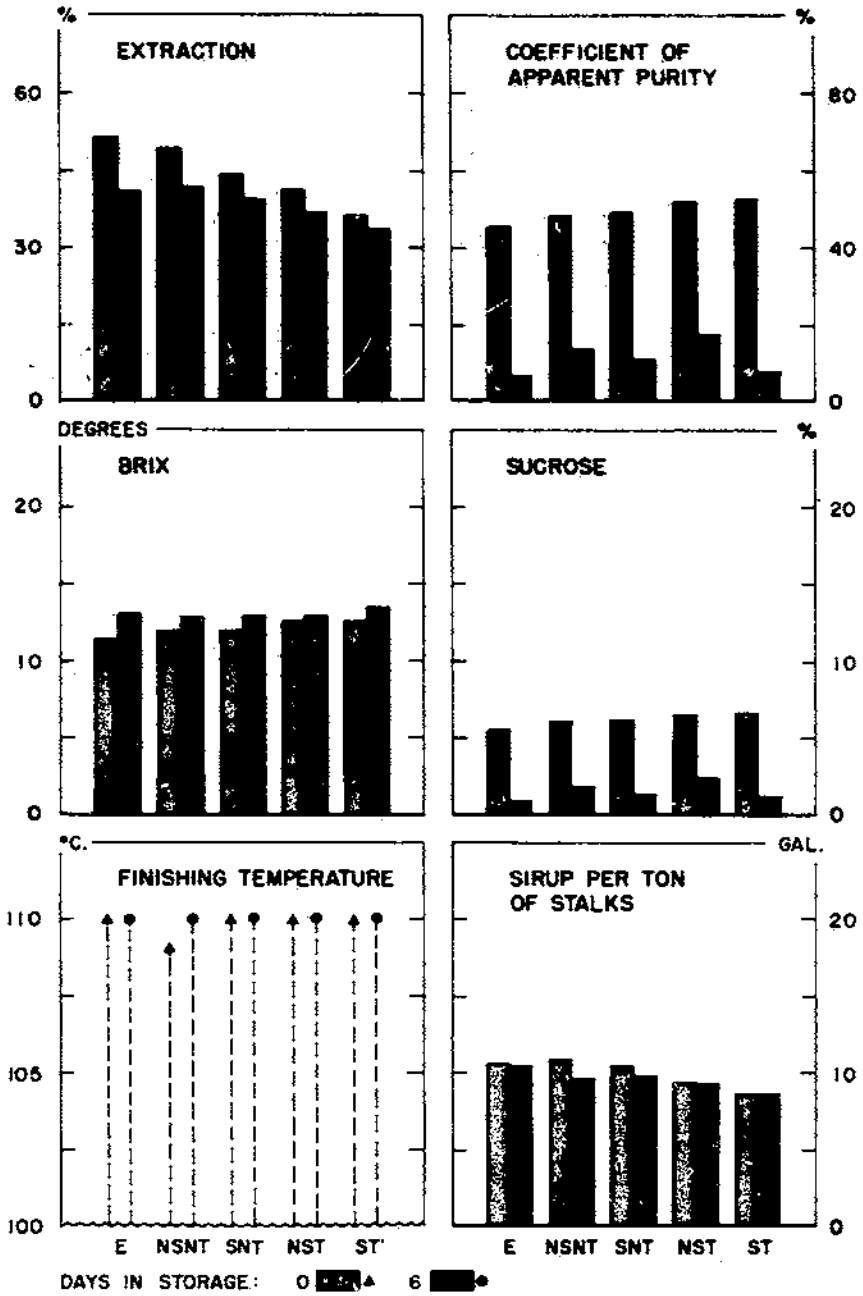

FIGURE 29.—Effect of various treatments on yield and quality of juice and of sirup obtained from Sart and Wiley sorgo harvested in the anthesis stage of maturity and stored for 0 and 6 days, 1958. (E—entire plant milled. Parts removed before milling: NSNT—head, peduncle; SNT—head, peduncle, leaves; NST—top one-fourth of stalk; ST—top one-fourth of stalk, leaves.)

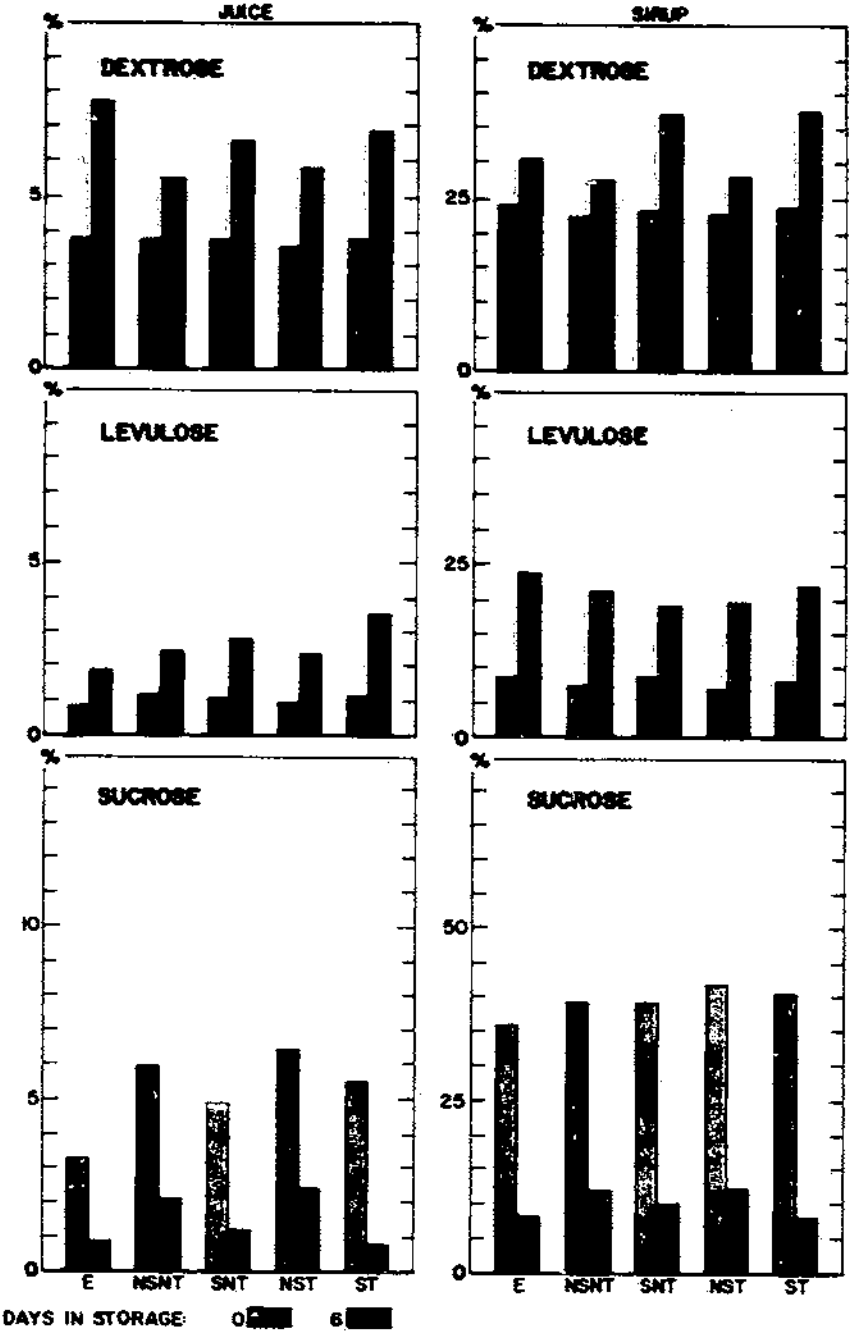

FIGURE 30.—Effect of various treatments, based on frozen-juice and sirup analyses, on Sart and Wiley sorgo harvested in the anthesis stage of maturity and stored for 0 and 6 days, 1958. (For explanation of letter symbols, see legend for figure 29.)

treatments had no appreciable effect on color, except that 6 days of storage increased the darkness by slightly over 1 point.

Clarity of these sirups was not exceptionally high in any treatment. When the stalks were not stripped, the clarity fluctuated. The clarity of sirup made from the stripped stalks was improved when the stalks were stored for 6 days.

The viscosity of the sirup increased gradually as the amount of material was removed from the stalk on the 0 day of storage; sirup made from stripped and topped stalks had the highest viscosity. Six days of storage decreased the viscosity of sirup for all treatments, and the viscosity was similar for all treatments.

Milk Stage of Maturity

Enough plants were available to include Sart, Tracy, and Wiley at the milk stage of maturity. The trends in extraction were the same as in the anthesis stage of maturity, as shown in figure 32. There appeared to be no difference among the treatments for Brix, except that the stored stalks had higher Brix values than those milled on the day of harvest. Sucrose values were about the same for all treatments on the day of harvest, but they were considerably lower after 6 days of storage and were rather erratic. Purity values followed the same pattern as the sucrose values.

The finishing temperature of the sirup increased as the plant material was removed from the stalk when the plants were milled on the day of harvest. The lowest temperature, 106° C., was when the whole plant was processed, and the highest temperature, a little more than 109°, was when the stalk was stripped and topped. After 6 days of storage, however, all the treatments gave acceptable sirup.

Sirup yield per ton of stalks was profoundly affected by the finishing temperature. Consequently, the plants that were stripped and topped gave the highest yield of sirup when processing was done on the day of harvest. After 6 days of storage, however, the highest yield was from the stalks that were not topped.

Frozen-juice and sirup data for Sart, Tracy, and Wiley in the milk stage of maturity are included in figure 33. Dextrose and levulose increased during the 6 days of storage for all treatments. Sucrose decreased for all treatments during 6 days' storage and was highest in the topped stalks with the leaves intact.

Figure 34 includes the sirup-quality data for Sart, Tracy, and Wiley in the milk stage of maturity in 1958. The color of the sirup made from stalks that were stripped and topped was slightly better than the other samples milled on the day of harvest. The difference was about 0.7 point on the color scale. The 6 days of storage darkened this sirup about 2 points, and the stripped stalks produced the lightest sirup.

None of the sirup made from the stalks in the milk stage was

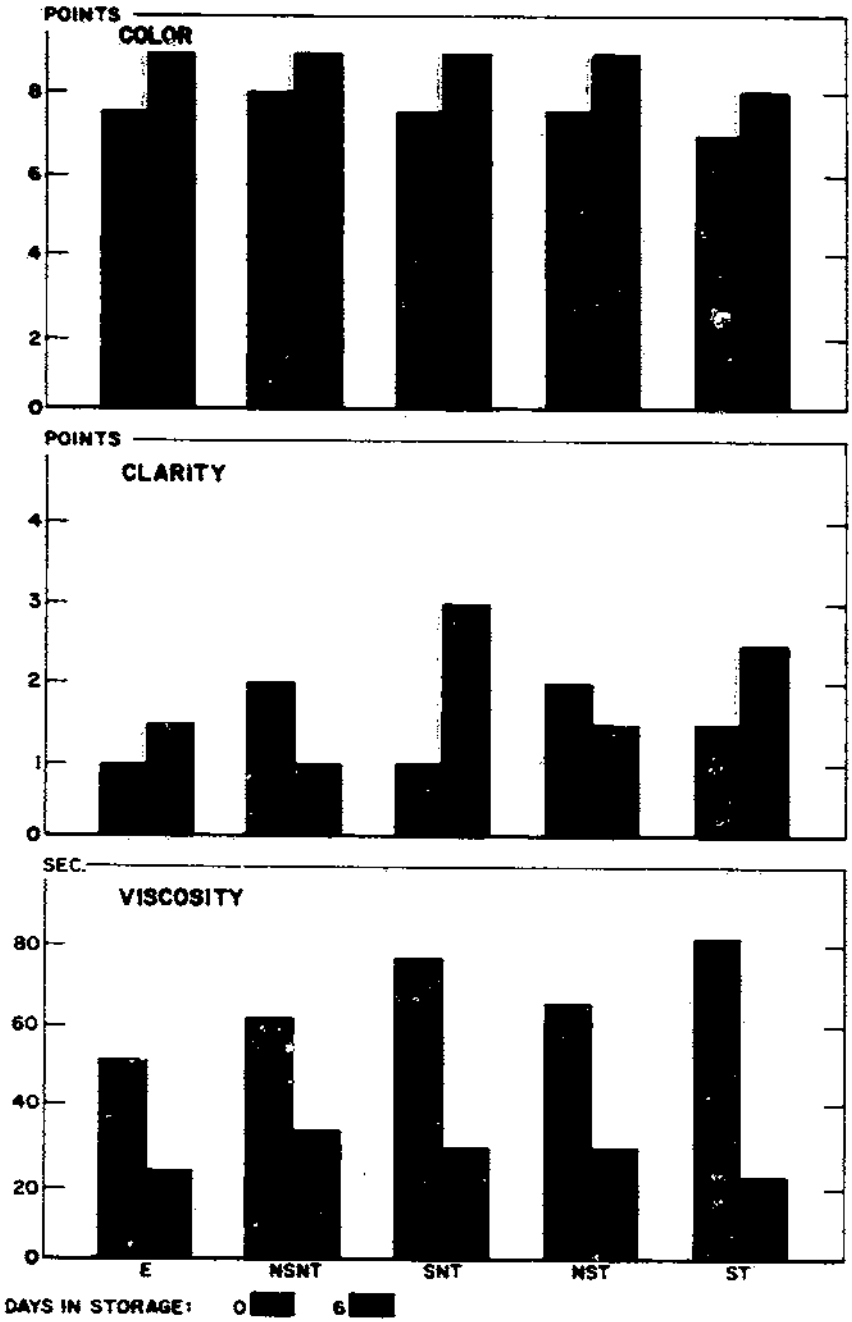

FIGURE 31.—Effect of various treatments on quality of sirup made from Sart and Wiley sorgo harvested in the anthesis stage of maturity and stored for 0 and 6 days, 1958. (For explanation of letter symbols, see legend for figure 29.)

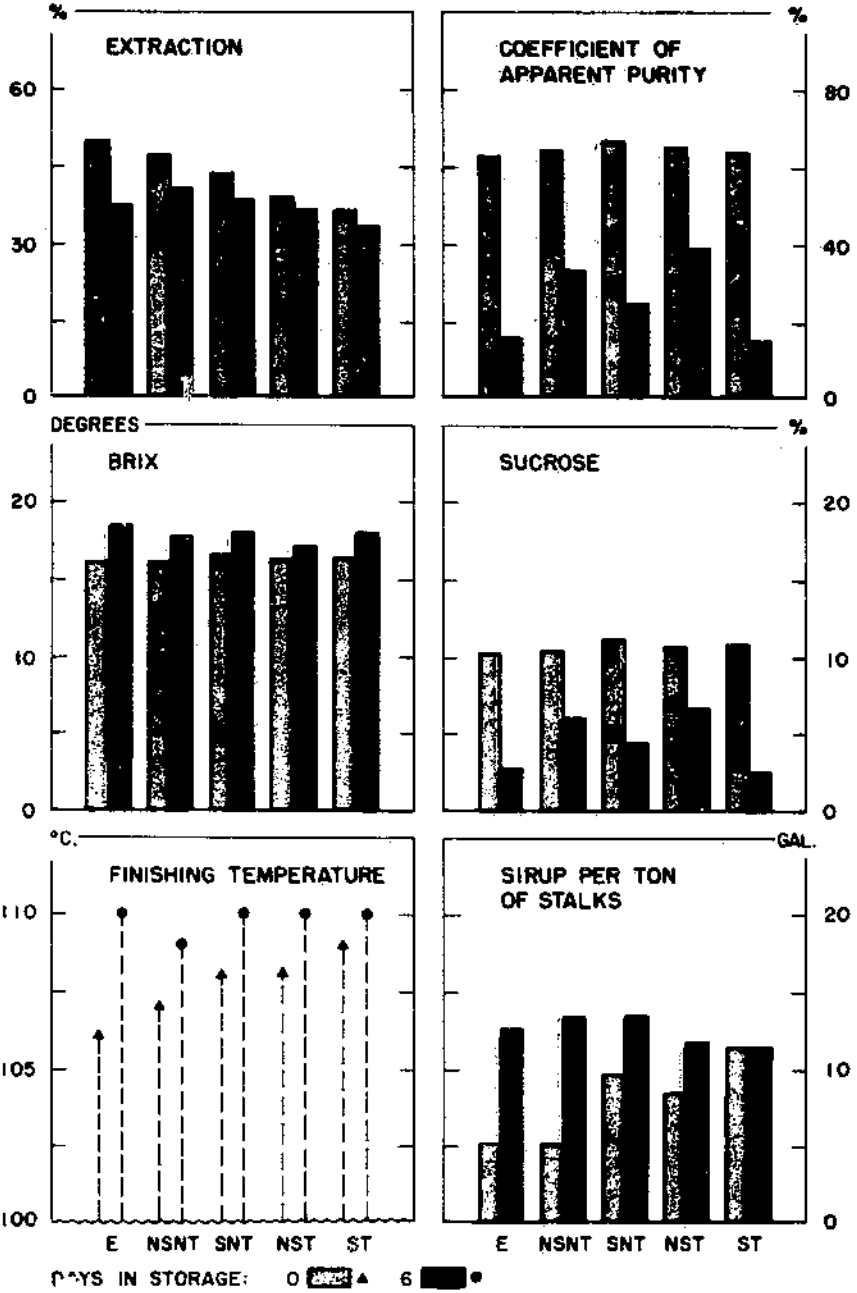

FIGURE 32.—Effect of various treatments on yield and quality of juice and of sirup obtained from Sart, Tracy, and Wiley sorgo harvested in the milk stage of maturity and stored for 0 and 6 days, 1958. (For explanation of letter symbols, see legend for figure 29.)

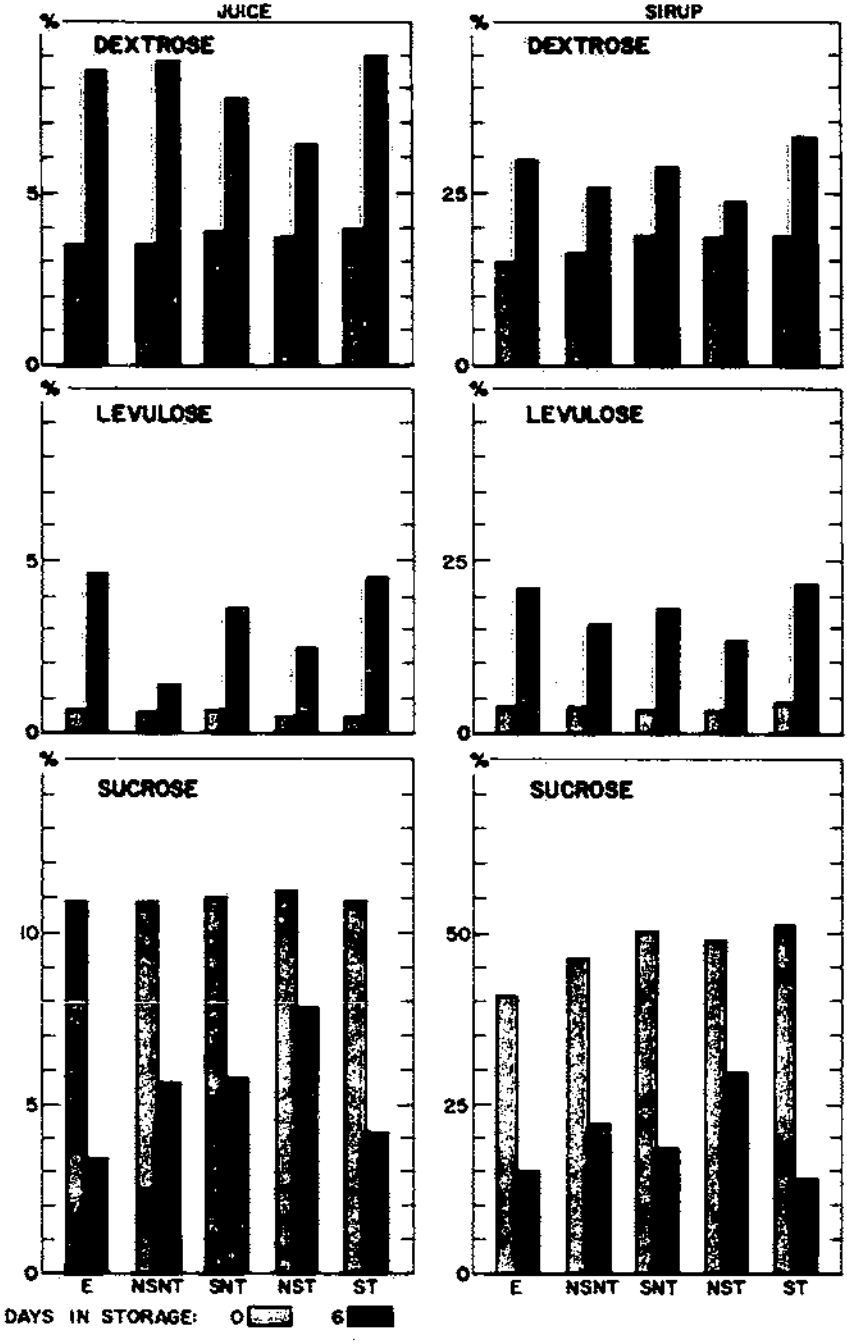

FIGURE 33.—Effect of various treatments, based on frozen-juice and sirup analyses, on Sart, Tracy, and Wiley sorgo harvested in the milk stage of maturity and stored for 0 and 6 days, 1958. (For explanation of letter symbols, see legend for figure 29.)

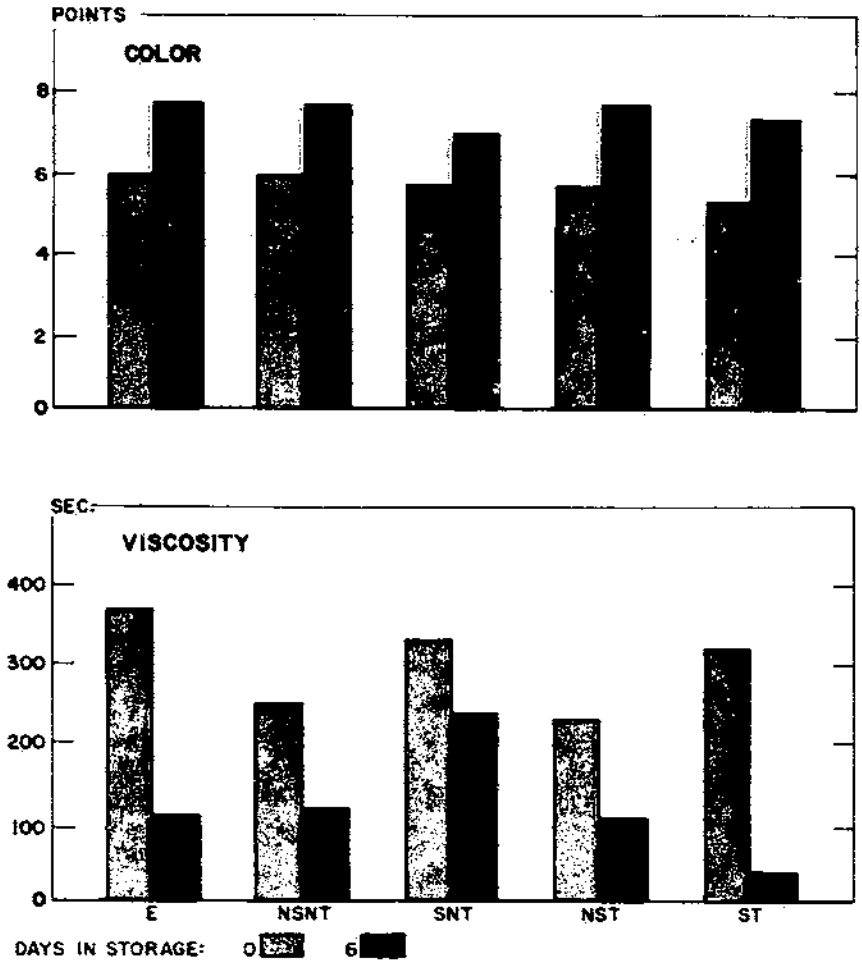

FIGURE 34.—Effect of various treatments on quality of sirup made from Sart, Tracy, and Wiley sorgo harvested in the milk stage of maturity and stored for 0 and 6 days, 1958. (For explanation of letter symbols, see legend for figure 29.)

of high quality so far as clarity was concerned. All the readings were zero.

The viscosity decreased considerably during the 6-day storage period, but it was very high when the stalks were milled on the day of harvest. Actually, several of the samples of Sart and Tracy jelled. There appeared to be no significant beneficial effect of stripping and topping the stalks so far as viscosity was concerned.

Dough Stage of Maturity

Tracy and Wiley were also harvested in the dough stage of maturity in 1958. The extraction data, as shown in figure

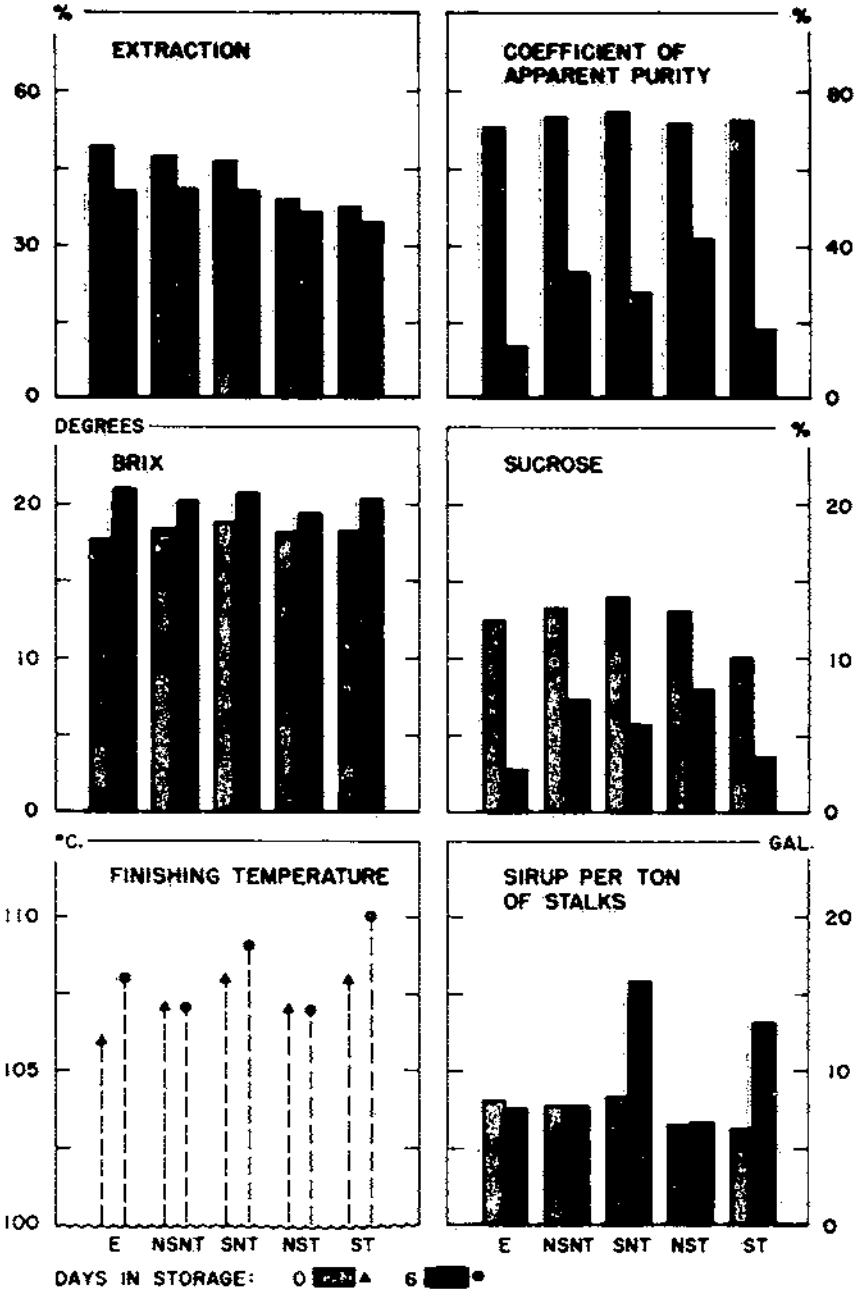

FIGURE 35.—Effect of various treatments on quality and yield of juice and of sirup obtained from Tracy and Wiley sorgo harvested in the dough stage of maturity and stored for 0 and 6 days, 1958. (For explanation of letter symbols, see legend for figure 29.)

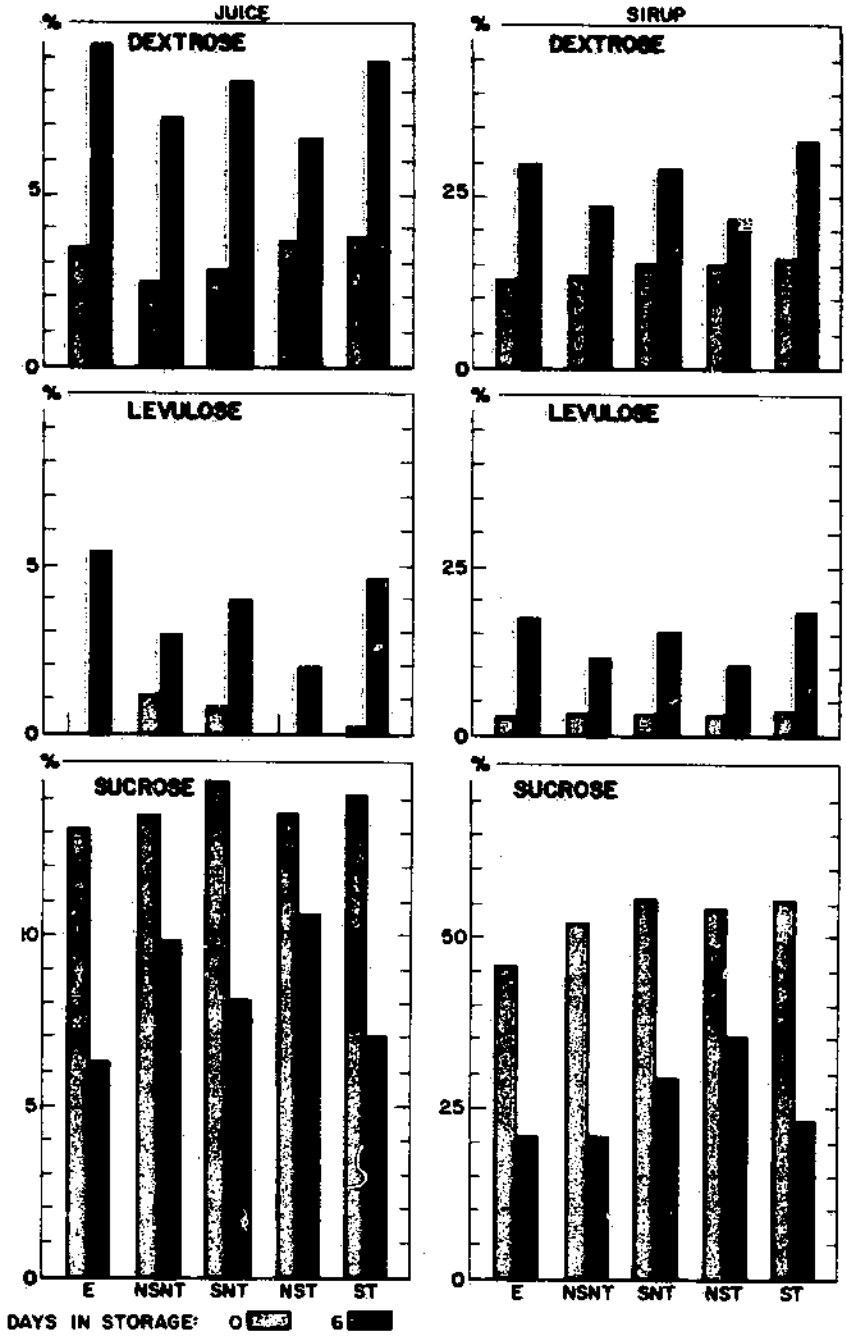

FIGURE 36.—Effect of various treatments, based on frozen-juice and sirup analyses, on Tracy and Wiley sorgo harvested in the dough stage of maturity and stored for 0 and 6 days, 1958. (For explanation of letter symbols, see legend for figure 29.)

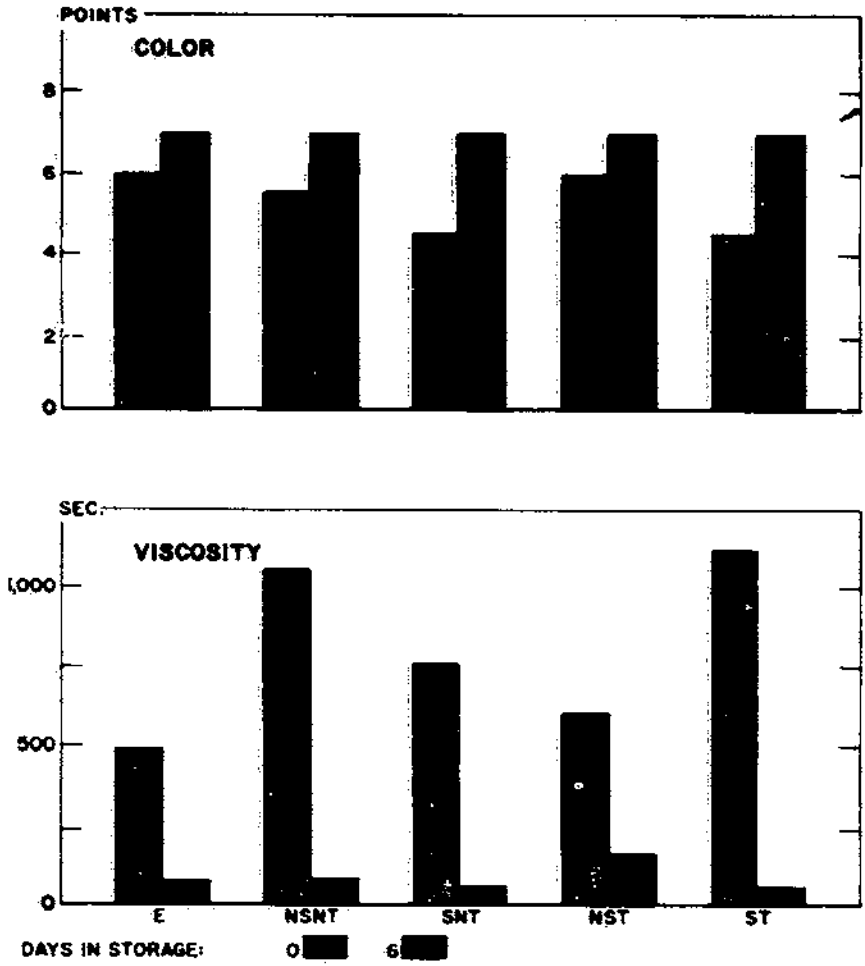

FIGURE 37.—Effect of various treatments on quality of sirup made from Tracy and Wiley sorgo harvested in the dough stage of maturity and stored for 0 and 6 days, 1958. (For explanation of letter symbols, see legend for figure 29.)

35, were similar to those obtained in the anthesis and milk stages of maturity.

All Brix values increased with time in storage, but there were no appreciable differences in Brix among treatments either before or after 6 days of storage.

Sucrose values for the various treatments were about equal on the day of harvest, but were very much lower and rather irregular after 6 days of storage. The same was true for the purity values.

The finishing temperature of the sirup made from the whole plant was slightly lower on the 0 storage day than for the other treatments. Even after 6 days of storage several sam-

ples of Tracy failed to make sirup. The only treatments that gave high-quality sirup when milled on the day of harvest in the dough stage of maturity were those in which the stalks were stripped.

Storage for 6 days did not affect the production of sirup, except from the stalks that were stripped. In this treatment there was a very significant increase in sirup from the 0 to the sixth day of storage, because this was the only treatment of Tracy that produced sirup of commercial quality. The sirup yields for the other treatments of this variety in this test were zero.

Frozen-juice and sirup data for Tracy and Wiley in the dough stage of maturity are included in figure 36. The patterns of dextrose, levulose, and sucrose were similar to those obtained when the plants were harvested in the anthesis and milk stages of maturity.

Sirup-quality data for the dough stage of maturity are included in figure 37. The best color was obtained from the two stripped samples on the 0 day of storage, but after 6 days of storage all the samples were darker and had the same color rating.

Again in the dough stage of maturity the clarity was very poor in all treatments and these readings were zero.

The Tracy samples all jelled and are not included in the viscosity data. The viscosity ratings were very high on the 0 day of storage irrespective of the treatment. After 6 days of storage the viscosity dropped to an acceptable level and was similar for all treatments.

SUMMARY

1. Juice extraction remained constant for sorgo stalks kept wet, but it decreased gradually for dry stalks during 2 weeks' storage.

2. Extraction losses were mainly due to evaporation. Brix values increased as extraction values decreased during storage.

3. Sucrose losses were negligible for stalks kept wet and were only slight when stalks were dry during storage of sugar varieties like Rex.

4. Coefficient of apparent purity decreased slightly when stalks were kept wet and decreased significantly for dry stalks of sugar varieties.

5. Acidity was not affected by length of storage or wet and dry treatments.

6. Inversion took place more rapidly in sirup varieties, such as Iceberg, Sart, and Wiley, during storage than in sugar varieties.

7. Storing dry for 6 days reduced crystallization and improved sirup quality without reducing yields of sirup per ton of stalks.

8. Storing wet counteracted the normal benefits of storage on sirup quality.

9. Protecting (storing in a shed) stalks had no beneficial effect on sirup quality and yield unless processing was done during a period of simulated rainfall.

10. Stripped stalks of Sart, Tracy, and Wiley made good sirup 1 day of storage sooner than did unstripped shocked stalks. Unstripped shocked stalks of Wiley kept wet made inferior but acceptable sirup, but Tracy and Sart did not make commercial-grade sirup.

11. In general, dextrose and levulose increased during the first 10 days of storage, whereas sucrose decreased. All three sugars tended to level off during the last 4 days of the 2 weeks' storage.

12. No inversion took place in the sirup. The relative amounts of dextrose, levulose, and sucrose in percent of total sugars were the same in the juice as in the sirup made from that juice.

13. When juice extraction was based on the weight of treated stalks at the mill, extraction of stripped stalks was always higher than that of unstripped stalks.

14. When extraction was based on the weight of the entire harvested plant in the field, extraction of stripped stalks was consistently lower than that of unstripped stalks.

15. Removal of the top fourth of the stalk reduced the yield of sirup per ton of stalks but slightly improved sirup quality.

16. Storage for 6 days improved quality as measured by finishing temperature, clarity, and viscosity but caused slightly darker sirup. Sirup yields were increased for varieties like Sart and Tracy.

17. In general, sirup made from unstripped stalks was slightly darker than that made from stripped stalks.

18. Sirup varieties such as Sart, Tracy, and Wiley could be harvested for sirup at any time from the anthesis to the dough stage of maturity. Extraction remained about constant with maturity, but Brix and consequently yield of sirup per ton of stalks increased. The color of the sirup improved, but clarity decreased and viscosity increased with maturity. The sirup was slightly more difficult to process when the plant was in the dough stage, but this was compensated for by storing for 6 days.

19. Extraction, when based on field weight, was reduced by removing any part of the plant, but Brix increased slightly.

20. Good sirup was produced by processing the entire plant if stalks were stored relatively dry for about 6 days. This sirup was slightly darker and was somewhat more difficult to process than that made from stripped and deheaded stalks.

APPENDIX

TABLE 1.—*Variance analyses of gross weight of Sart and Wiley stalks at different stages of maturity in sorgo storage studies, 1956–58*

Category	Degrees of freedom	Mean square [1]				
		Sart		Wiley		
		Anthesis	Milk	Anthesis	Milk	Dough
Years	2	2,267.22**	1,228.98**	2,052.24**	431.18**	455.98**
Treatments	3	10.08	17.39*	3.86	3.57	3.80
T × Y	6	10.91	24.04**	6.86	5.32	6.06
Days	1	7.60	4.65	21.42	15.70	.00
D × Y	2	4.92	15.66*	13.16	13.64	4.67
D × T	3	9.56	7.58	5.81	1.38	12.99
D × T × Y	6	1.24	9.59	8.05	10.28	2.85
Error	96	5.03	4.96	6.50	8.08	5.35

[1] * = 5-percent level of significance; ** = 1-percent level of significance.

TABLE 2.—*Variance analyses of net weight of Sart and Wiley stalks at different stages of maturity in sorgo storage studies, 1956–58*

Category	Degrees of freedom	Mean square [1]				
		Sart		Wiley		
		Anthesis	Milk	Anthesis	Milk	Dough
Years	2	1,891.85**	1,232.92**	1,800.70**	434.96**	569.75**
Treatments	3	314.41**	268.13**	162.80**	165.07**	104.76**
T × Y	6	5.04	16.87**	2.82	3.50	12.98
Days	1	6.35	1.18	17.86	12.22	2.10
D × Y	2	3.14	14.34*	7.98	12.50	7.30
D × T	3	6.11	6.73	5.15	1.73	13.01*
D × T × Y	6	.84	9.77*	4.70	9.56	2.51
Error	96	4.56	3.74	5.57	6.48	4.68

[1] * = 5-percent level of significance; ** = 1-percent level of significance.

TABLE 3.—*Variance analyses of juice extraction of Sart and Wiley stalks at different stages of maturity in sorgo storage studies, 1956–58*

Category	Degrees of freedom	Mean square[1]				
		Sart		Wiley		
		Anthesis	Milk	Anthesis	Milk	Dough
Years	2	23.90**	313.24**	14.94**	15.65**	245.73**
Treatments	3	387.38**	264.49**	438.41**	275.13**	252.59**
T × Y	6	7.43*	15.00**	8.74**	13.29**	8.62**
Days	1	408.48**	545.28**	1,379.06**	802.90**	768.10**
D × Y	2	37.80**	82.22**	20.20**	47.04**	4.00
D × T	3	14.31**	19.97**	34.13**	32.08**	16.64**
D × T × Y	6	2.50	11.31**	.80	7.83*	9.06**
Error	96	2.58	2.42	2.08	3.16	2.39

[1] * = 5-percent level of significance; ** = 1-percent level of significance.

TABLE 4.—*Variance analyses of Brix of juice from Sart and Wiley stalks at different stages of maturity in sorgo storage studies, 1956–58*

Category	Degrees of freedom	Mean square[1]				
		Sart		Wiley		
		Anthesis	Milk	Anthesis	Milk	Dough
Years	2	175.58**	85.01**	17.18**	53.20**	170.82**
Treatments	3	.54*	.77**	1.28**	.93**	1.31**
T × Y	6	1.41**	.77**	.25	.78**	.51*
Days	1	56.72**	91.71**	80.21**	51.62**	143.88**
D × Y	2	2.24**	8.84**	4.36*	1.73**	.46
D × T	3	1.06**	1.19**	.29	.92**	.36
D × T × Y	6	.58**	.49**	.22	1.29**	.59*
Error	96	.14	.18	.12	.13	.24

[1] * = 5-percent level of significance; ** = 1-percent level of significance.

TABLE 5.—*Variance analyses of sucrose in juice from Sart and Wiley stalks at different stages of maturity in sorgo storage studies, 1956–58*

Category	Degrees of freedom	Mean square[1]				
		Sart		Wiley		
		Anthesis	Milk	Anthesis	Milk	Dough
Years	2	19.58**	99.13**	53.20**	280.93**	140.62**
Treatments	3	1.52**	13.75**	1.61**	5.26**	.90
T×Y	6	.29	3.55**	.77*	2.02**	3.12**
Days	1	468.47**	1,017.92**	445.06**	436.24**	895.99**
D×Y	2	8.51**	98.01**	21.24**	7.76**	65.11**
D×T	3	.64*	8.68**	6.26**	3.91**	3.45**
D×T×Y	6	.50*	5.03**	.52	3.02**	2.95**
Error	96	.20	1.16	.30	.56	.69

[1] * = 5-percent level of significance; ** = 1-percent level of significance.

TABLE 6.—*Variance analyses of coefficient of apparent purity of juice from Sart and Wiley stalks at different stages of maturity in sorgo storage studies, 1956–58*

Category	Degrees of freedom	Mean square[1]				
		Sart		Wiley		
		Anthesis	Milk	Anthesis	Milk	Dough
Years	2	1,060.72**	2,623.91**	1,927.54**	7,620.20**	1,612.04**
Treatments	3	62.68**	503.60**	116.32**	148.98**	18.22
T×Y	6	10.66	118.41**	43.32**	93.52**	119.96**
Days	1	31,376.27**	45,637.80**	28,060.21**	21,571.33**	37,509.89**
D×Y	2	311.11**	2,881.42**	760.54**	188.27**	1,544.03**
D×T	3	28.84	373.14**	89.42**	113.74**	106.36**
D×T×Y	6	34.62**	177.76**	20.40	103.04**	84.03**
Error	96	11.45	41.65	13.95	18.04	23.86

[1] * = 5-percent level of significance; ** = 1-percent level of significance.

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