THE SACCHARINE CONTENT OF SORGHUMS

THE SACCHARINE CONTENT OF SORGHUMS

By

THOMAS EDISON MCAFEE

Bachelor of Science

Oklahoma Agricultural and Mechanical College

Stillwater, Oklahoma

1938

Submitted to the Department of Agronomy

Oklahoma Agricultural and Mechanical College

In Partial Fulfillment of the Requirements

For the degree of

MASTER OF SCIENCE

1940

APPROVED BY:

C W Gernert
In Charge of Thesis

H. F. Murphy
Head of the Department

D. G. M. Entosh
Dean of the Graduate School

PREFACE

In 1750 German chemists started investigations with sugar beets. At that time this plant contained only five per cent sugar content. Today this plant has a sugar content of fifteen to twenty per cent, as a result of continuous selection and improvement. The same thing may be pointed out in the case of sugar cane. It is not unusual to see in a Sugar Journal or sugar cane bulletin some variety that is outstanding in sugar content. The largest per cent of these varieties have been developed by selection.

It is a well established fact that this improvement is possible because of variations within a population.

It was with these facts in mind that the writer became interested in the saccharine content of sorghums. While this work was conducted at the Oklahoma A. and M. Experiment Station with sorghums, such variations as in height, diameter, color of leaves, and numerous other characteristics were observed. It was only logical to assume that there would be found a variation in chemical composition which would cause variation in saccharine content. The value or importance of such a variation is easy to realize if one keeps in mind that sorghums became one of the leading forage plants in areas of insufficient rainfall for corn.

Before any crop can be noted as an important forage for livestock, it must contain sufficient food material and be palatable, and both of these factors are particularly dependent upon the sugars in that plant.

In the problem, variation in the saccharine content of some fifty varieties of sorghums was investigated along with tests for saccharine content at various stages of development of the plant, differences, if

any, in the saccharine content at the base, middle, and top of the plant; and variations within a variety and whether a strain with a higher saccharine content than its parent could be obtained. The fifty varieties studied were composed of thirty varieties of the grain sorghum types, ten varieties of the saccharine sorgo types, and ten varieties of the broom corn types of sorghums.

To obtain the per cent saccharine to total weight of a plant by chemical analysis would have required a chemical laboratory, chemicals, and an experienced organic chemist. Having none of these available, a Carl Zeiss Jena Refractometer which gives the per cent saccharine to juice was used. This hand refractometer is easy to operate, efficient, and offers a very rapid method of comparison.

It is a pleasure to acknowledge Dr. W. B. Gernert, Associate Professor of Agronomy, Oklahoma A. and M. College, for his suggestions, criticisms, and guidance on how to conduct the work as reported in this thesis. The writer would like also to acknowledge Professor C. B. Godbey, Professor of Genetics, Texas A. and M. College, for his suggestions in analyzing the data which have been collected.

TABLE OF CONTENTS

INTRODUCTION

The equipment necessary to conduct this problem consisted of a refractometer; heavy wire pliers to squeeze juice; clean, soft cloth to keep the refractometer clean; sharp knife; clipboard; paper; and pencil. The study was confined to the sorghums on the Oklahoma State Experiment Station at Perkins, Oklahoma.

It was found to be less confusing to keep the data on the three types of sorghum; namely, grain sorghum, sorgo, and broom corn, separately and also to analyze each year separately. For the stages of development, blooming, soft dough, and hard dough stages were used. To study the different locations on a plant, the second internode above ground level was used as the base, the center internode of the plant was used to represent the middle, and the internode below the inflorescence was used to represent the top of the plant.

The investigation was started July 27, 1937, when the sorghums were in the blooming stage of development. Three stalks were selected at random within a variety that were in as near the same stage of blooming as possible. The plants were cut down at the surface of the ground and the blades stripped off. The next internode from the base was cut into, and with the pliers, two or three drops of juice were squeezed on the refractometer. Figure 1 shows this process. The refractometer was then closed and the per cent saccharine in the juice was read directly from the scale in the refractometer as illustrated in figure 2. The reading was recorded as the base reading on plant number one of that variety. The juice on the refractometer was wiped off with a soft cloth and the same process was carried out at the middle and top of the plant and so

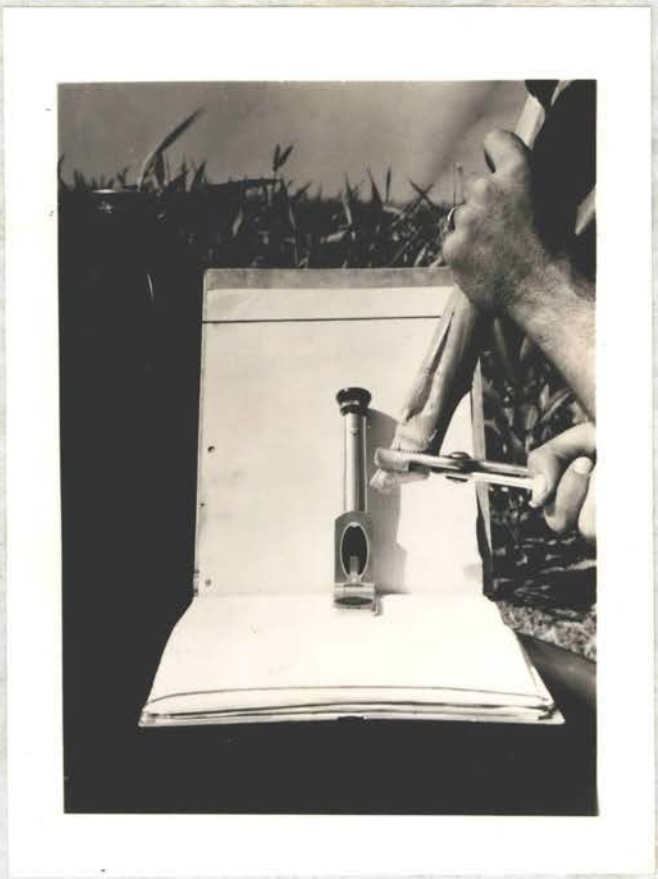


Figure 1. The process of making a reading with the refractometer

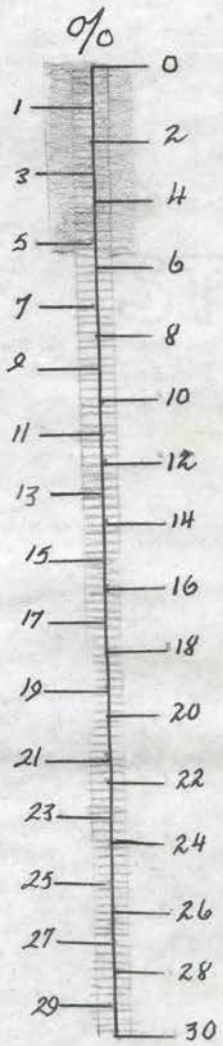


Figure 2. Scale as seen when looking in the refractometer. The illustrated reading is 5.3%

on for each plant.

On August 6, 1937, the entire process was repeated when the sorghums were in the soft dough stage of development. Then on August 31, 1937, when the plants had reached the hard dough stage of development, a third set of readings was taken on each variety.

In 1938 the work was confined to studies of atlas sorghum selections. Due to a heavy chinch bug infestation and a drought in 1939, it was impossible to get any reliable readings after the blooming stage of development; therefore, it was not permissible to make a complete comparison with any two years' results.

REVIEW OF LITERATURE

In a review of literature, no reports were available on the saccharine content of sorghums by the refractometer method; however, it was interesting to find that the hand refractometer has been used in saccharine analysis of many different plants for a number of years.

H. C. Lythgoe, in an article which he wrote in 1912, stated "A refractometer can be used advantageously to run saccharine analysis on foods, condiments, drugs, beverages, and pure chemicals."[1]

Also in 1912, R. E. Remington of North Dakota used a refractometer on a number of samples of commercial vinegar and stated that his results were satisfactory.[2]

W. E. Cross of Louisiana State, in his investigation on methods of analysis of cane products, found the refractometer useful in sugar house work determining juices, syrups, molasses, massecutes, and sugar. He concluded, "the refractometer insures higher accuracy and greater simplicity."[3]

Sidney F. Sherwood, Associate Biochemist, Bureau of Plant Industry, used a refractometer in an extensive study of sugar beets.[4]

---

[1] Lythgoe, H. C., Uses of the Refractometer, Journal of Agriculture Research, Vol. 28-612. Washington, D. C.

[2] Remington, R. E., Use of Refractometer on Commercial Vinegar, Journal of Agriculture Research, Vol. 27-112

[3] Cross, W. E., Investigation on Methods of Analysis of Cane Products, Journal of Agriculture Research, Vol. 28-614

[4] Sherwood, Sidney F., A Study of the Saccharine of Sugar Beets, Journal of Agriculture Research, Vol. 50

RESULTS

Grain Sorghum

All data were recorded in tabular form as shown in figure 3 and in the appendix. From the data in these tables, bar graphs were made so that the variations may be easily compared.

Figure 4 is a bar graph based on the three stages of development studied in 1937. The per cent saccharine at each stage of development is taken from an average of three plants within a variety. The average per cent saccharine when blooming was 10.5 per cent. The lowest was 7.5 per cent, found in Shallu and the highest was 14.5 per cent, found in Feterita.

When the grain sorghums had reached the soft dough stage, the average per cent saccharine increased to 11.8 per cent. The lowest reading was 8.5 per cent, found in Shallu and Wheatland Milo, and the highest reading was 14.5 per cent, found in White Darso and Farr's Atlas X Atlas.

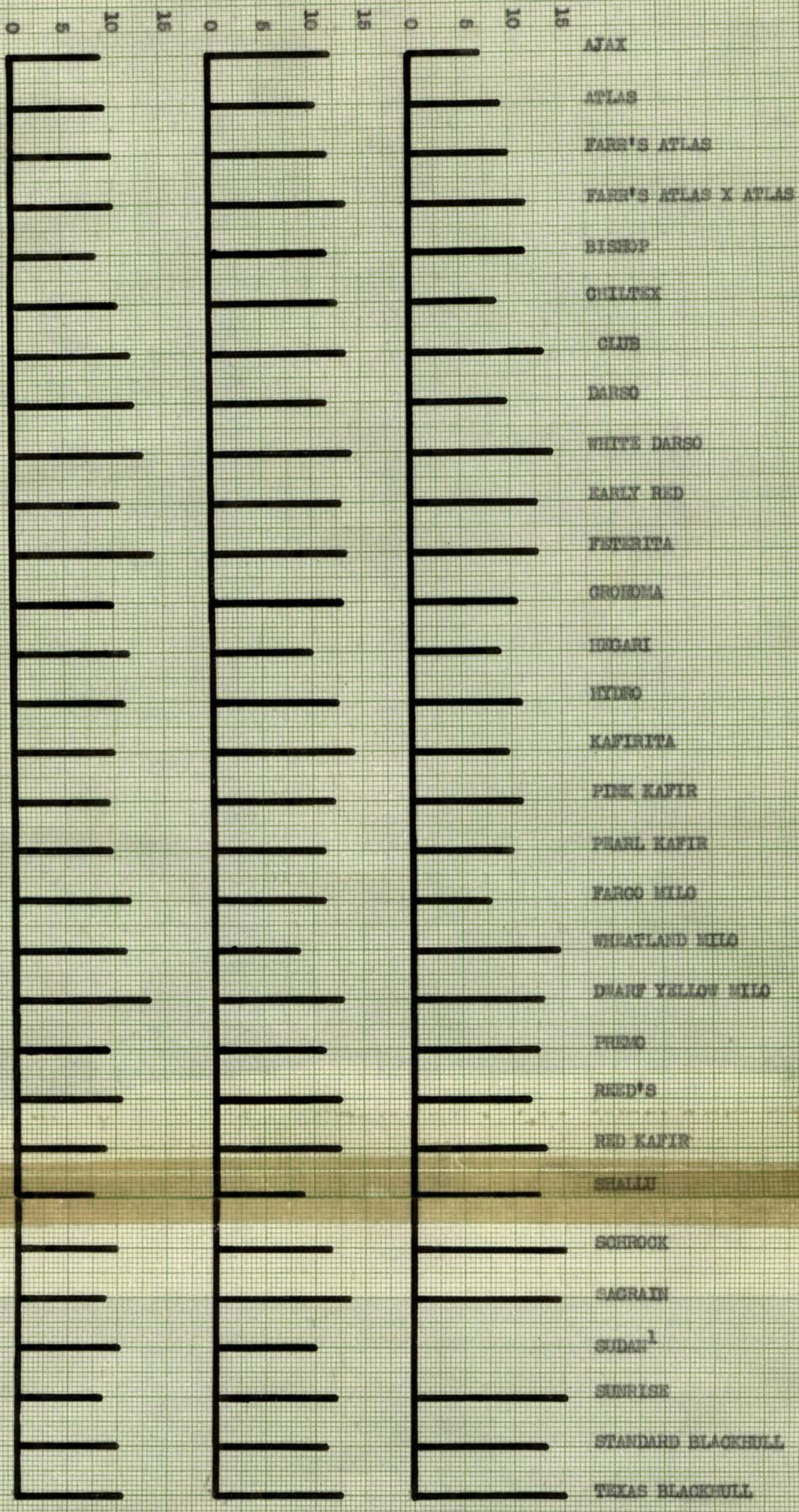
At the hard dough stage of development, the average per cent saccharine had dropped one tenth of one per cent to 11.7 per cent. The lowest reading was 7 per cent, found in Fargo Milo, and the highest was 15 per cent, found in White Darso, Schrock, and Texas Blackhull.

An interesting observation was that by the time Sudan Grass reached the hard dough stage, enough juice to take a reading could not be extracted. This might indicate that it had passed its most desirable stage as a forage crop.

Figure 5 is a bar graph pointing out the relationship of the three places on the plant being considered in this problem.

Type Plant	Plant Development	First plant B	First plant M	First plant T	Second plant B	Second plant M	Second plant T	Third plant B	Third plant M	Third plant T	Average
Ajax	Blooming	9.8	10.4	9.8	10.2	10.2	9.2	7.4	8.6	9.0	9.4
Ajax	Soft Dough	10.0	11.8	14.9	11.4	12.6	15.8	9.9	13.2	14.7	12.7
Ajax	Hard Dough	9.4	12.2	8.2	4.6	6.7	4.7	4.1	7.5	6.8	7.1
Average		9.7	11.4	10.9	8.7	9.8	9.9	7.1	9.8	10.2	9.7

Figure 3. Tabular form in which all data were recorded.



[1]Not enough juice in hard dough stage to take a reading

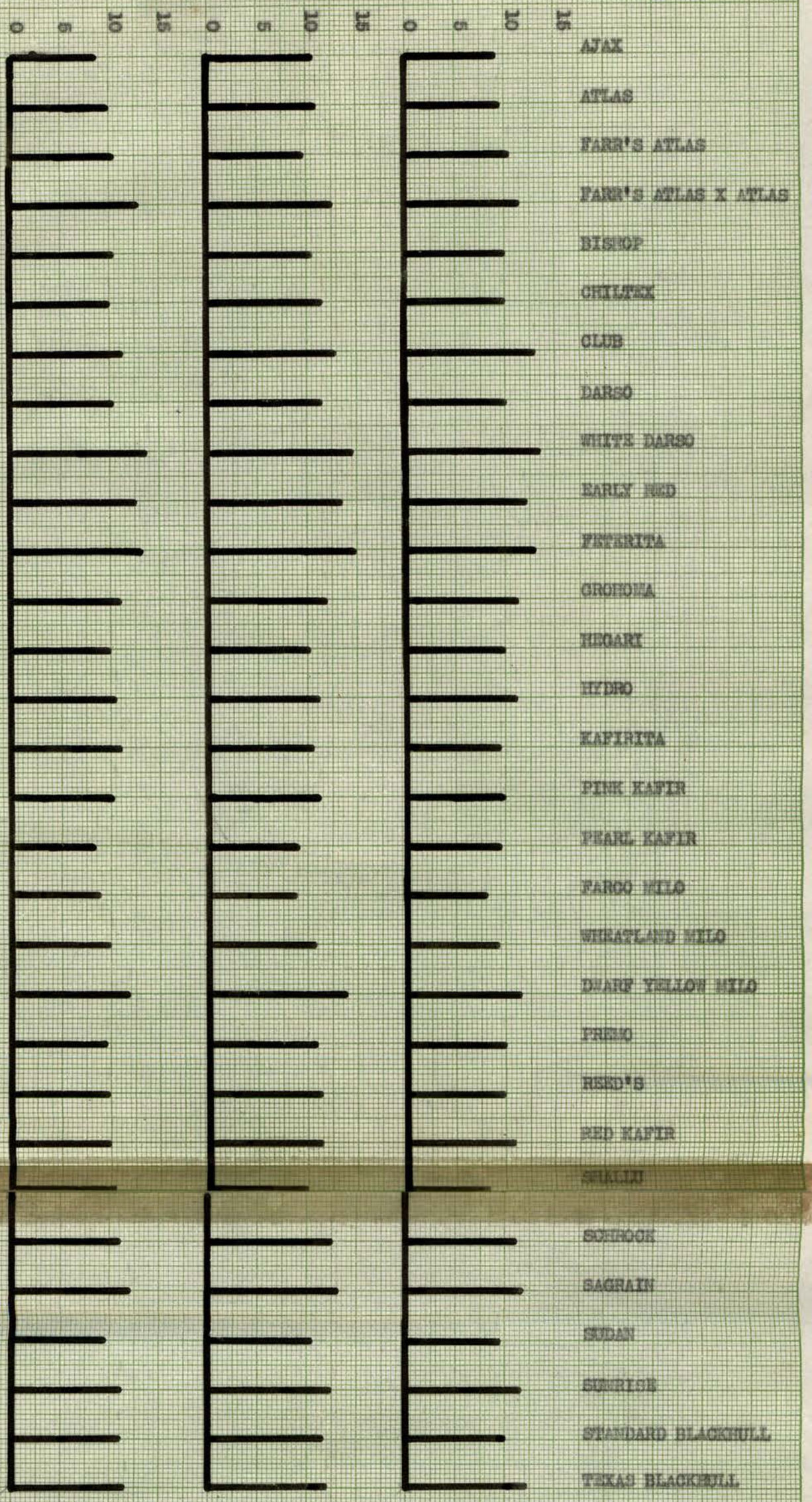


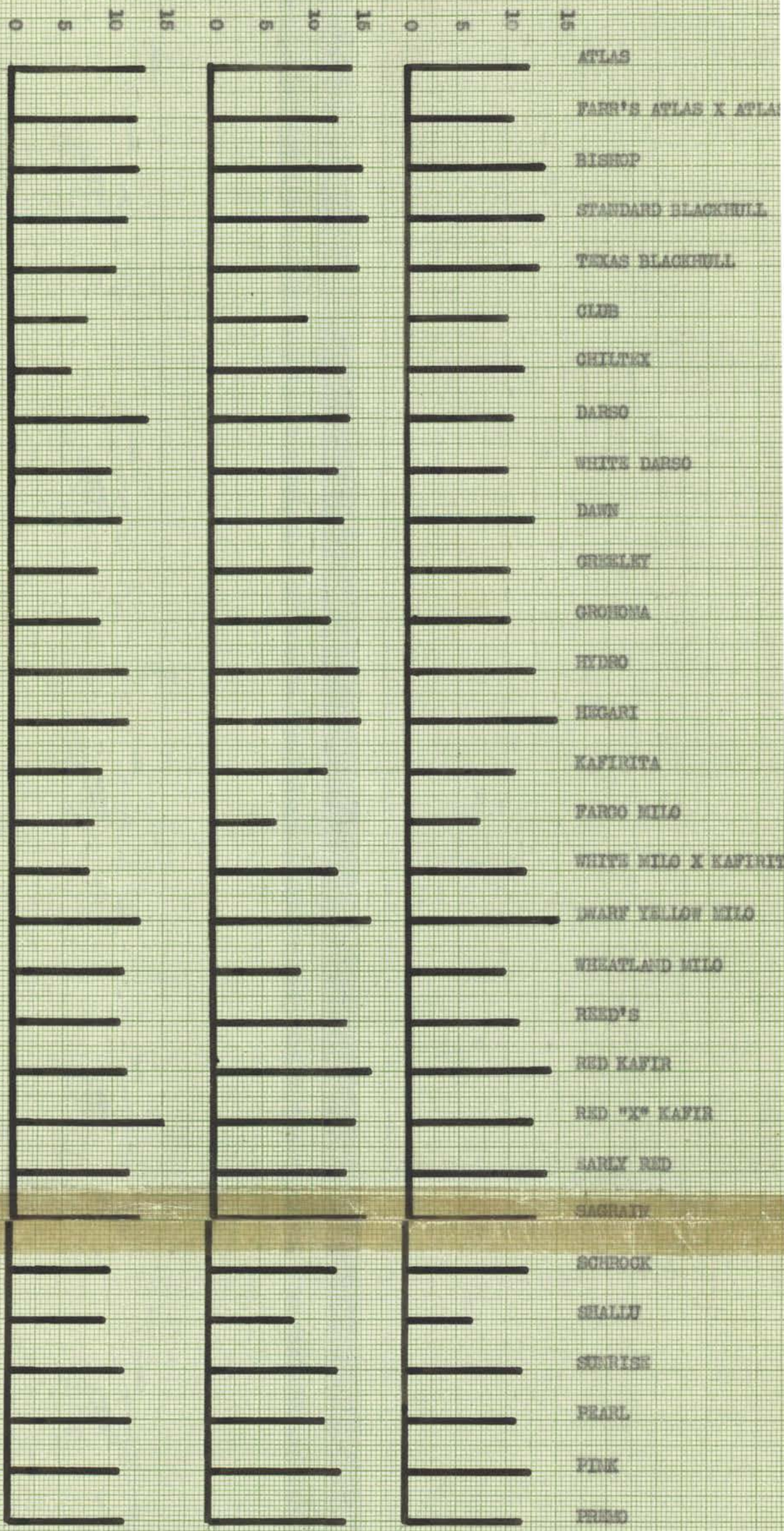
Figure 5. Relationship of place on plant to variety in grain sorghums, 1937

The average reading for all varieties at the base of the plant was 9.7 per cent. The lowest reading was 8.5 per cent on Ajax, and the highest reading at the base was 14 per cent on White Darso.

The average per cent saccharine at the middle of the plant was 11.4 per cent. The lowest reading was 9.5 per cent, found on Pearl Kafir and Fargo Milo. The highest reading was 15.5 per cent, found on Feterita and White Darso. At the top of the plants in grain sorghum, the average per cent saccharine was 10.8 per cent. The lowest reading was 8.0 per cent, found on Shallu, and the highest reading was 14.0 per cent, found on White Darso. The graph indicates clearly that if a variety is low in saccharine content at one place on the plant, it may be expected to be low at the other two places; and the same rule applies for those that are high in saccharine content. This does not mean that there is no variation from one place to another, but the variation is small compared to the variation of one variety to another.

In 1939 the average per cent was higher for place on plant than in 1937. However, the figures for 1939 were based on only the blooming stage of development.

Figure 6 shows the relationship of place on plant to variety for 1939. The average for all varieties at the base of the plant was 10.9. The lowest reading was 6.5 per cent on Chiltex, and the highest reading was 15.5 per cent on Red X. At the middle of the plant, the average per cent saccharine was 13.1. The lowest reading was 6.0 per cent on White Milo X Kafirita, and the highest reading was 16.5 on Red Kafir. At the top of the plants an average of 11.8 per cent was found for all varieties. The lowest reading was 6.5 per cent, found on Shallu, and the highest reading was 15.5 per cent, found on Dwarf Yellow Milo.



Saccharine content at base of plant

Saccharine content at middle of plant

Saccharine content at Top of plant

Figure 6. Relationship of place on plant to variety in grain sorghums, 1932

When the plants were in the blooming stage the distribution of saccharine was not as uniform as in later stages of development. In some varieties, such as Chiltex, the saccharine content was low at the base and high at the top of the plant, while the opposite was found in Shallu.

It is also interesting to note the wide variation in the Milo varieties. For instance, Fargo Milo had the lowest average per cent saccharine of all the grain sorghum varieties; and at the same stage of development, Dwarf Yellow Milo was one of the highest in saccharine content.

The bar graphs on grain sorghums for the years 1937 and 1939 show that there was a certain amount of variation between varieties, stages of plant development, and places on the same plant.

In any experiment or field test there is always variability that is uncontrollable. This variability has been assigned the name of "experimental error." It includes such factors as weather, diseases, insects, sampling variability, and any other variation that cannot be accounted for by the experimenter. Because of these factors, one cannot call his variation significant until there is a larger difference between the factors in consideration than the difference that can be expected to occur due to chance. By use of "analysis of variance" found in Snedecor's book on statistical methods[1] it is possible to isolate the essential features of a body of data and test to see if the variability is significant or is only variability that one would expect to occur by chance. Figure 7 is a summary of the calculations in testing the significance of variability between varieties, stages of maturity, and place on the plant. The "F" value in Figure 7 is a ratio of variance and by use of

---

[1] Snedecor, George W., Statistical Methods, Pp. 179-208.

Source of Variability	Degrees of Freedom	Sums of Squares	Mean Squares	F Value
Total	269	4,417.57		
Variety	29	1,298.64	44.78	7.86*
Stage Maturity	2	258.15	129.07	22.60*
Place on Plant	2	185.46	92.73	16.24*
Place X Stage	4	470.32	117.58	
Variety X Stage	58	1,321.71	22.78	
Variety X Place	58	221.25	3.82	
Variety X Place X Stage (error)	116	662.04	5.71	

*Highly significant variability

Figure 7. Analysis of variance of variety, stage of maturity, and place on plant in grain sorghum, 1937.

an F table, it is possible to look up the variance that is due to chance using the same degrees of freedom. In the case of the variability between varieties, an F value of only 1.85 would be required to be highly significant. That is, if the variance ratio exceeds 1.85, the variability between varieties is real and not due to chance. To be a significant difference between stages of maturity would require an F value of 4.78, therefore, the F value of 22.60 shows that there is a highly significant variation between stages of maturity. To be significant, variations between places on the plant would also require an F value of 4.78. Therefore, since the F value was 16.24, a highly significant variability is indicated.

Figure 8 gives a summary of the calculations of analysis of variance for variability between varieties and place on plants in grain sorghums for the year 1939. In order that the variability between varieties be significant, an F value of 2.03 is required; therefore, the F value of 8.11 indicates that the variability between varieties is highly significant. For the variability between places on plants to be significant, an F value of 4.98 is required; so again the value of 19.0 indicates that the variability between places on the same plant is highly significant.

Source of Variability	Degrees of Freedom	Sums of Squares	Mean Squares	F Value
Total	89	2,974.09	33.41	
Variety	29	2,100.57	72.43	8.11*
Place on Plant	2	355.71	177.85	19.0*
Variety X Place (error)	58	517.81	8.93	

*Highly significant variability

Figure 8. Analysis of variance of variety and place on plant in grain sorghum, 1939.

Sorgos

The field data on each variety of sorgos were taken and recorded in tabular form the same as the grain sorghums were recorded, and from these tables, bar graphs have been made to display the essential features in a more readily understandable form.

Figure 9 is a bar graph pointing out variability in the three stages of development within varieties. The average per cent saccharine for all ten varieties when blooming was 10.5 per cent. The lowest reading was 9.0 per cent, found in Leoti Red and Red X. The highest reading at the blooming stage of development was 14.0 per cent, found in Gooseneck.

When the varieties reached the soft dough stage, the average per cent saccharine increased to 12.2 per cent. The lowest reading was 10.0 per cent, found in Orange Selection No. 2.

At the hard dough stage of development, the average per cent saccharine had again increased to 13.1 per cent. The lowest reading was 9.0 per cent, found in Sugar Drip, and the highest per cent was 16.5 per cent, found in Red X.

The graphs point out clearly that there is a variation at different stages of development. The variety Red X is the best example of this. At the blooming and soft dough stages, it had the least per cent saccharine of any of the varieties, and when it reached the hard dough stage, it had the highest per cent saccharine of any of the varieties.

In summing up the data for place on plant in sorgos for 1937, as shown in Figure 10, it was found that the average per cent saccharine at the base of the plants was 12.1 per cent. The lowest reading was 10.0 per cent, found in Leoti Red, and the highest per cent was 14.5 per cent, found in Gooseneck.

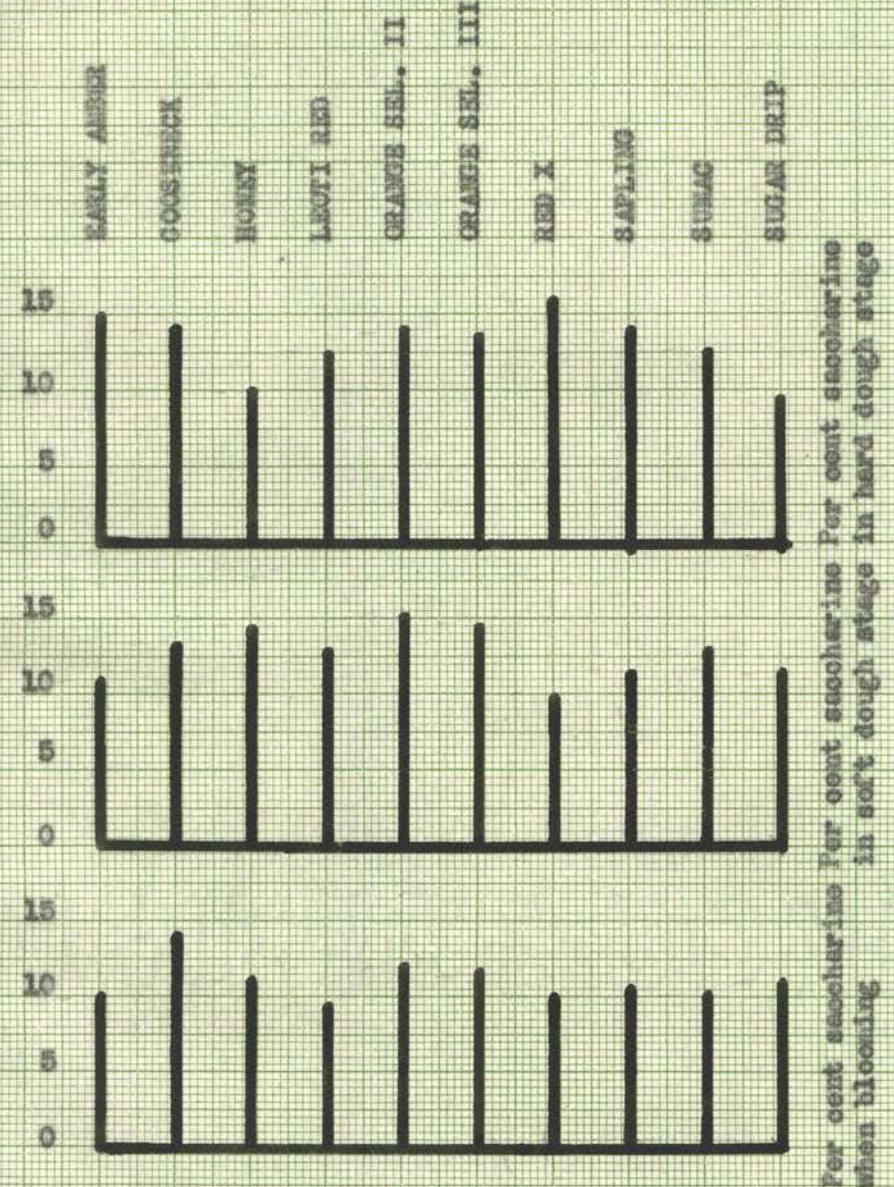


Figure 9. Relationship of stage of development to variety in sorgos, 1937

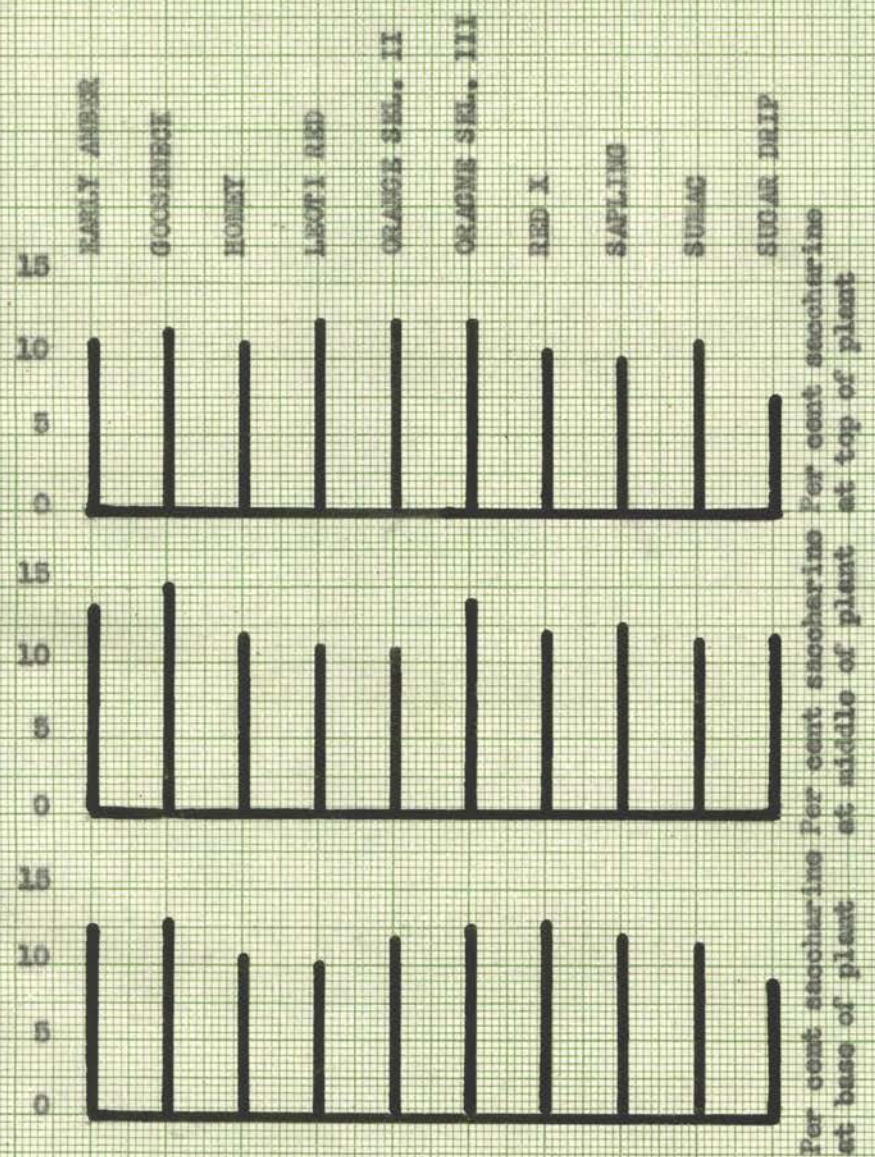


Figure 10. Relationship of place on plant to variety in sorgos, 1957

At the top of the plants, the average for all varieties was 10.9 per cent. The lowest reading was 10.0 per cent, found in Red X, and the highest reading was 12.5 per cent, found in Leoti Red.

The variety Red X contained a high per cent saccharine at the base and was the lowest at the top of the plant, which shows that in some varieties there is a very large variation at different places on the plant.

In the data for 1939 on sorgos, Atlas, Farr's Atlas, and Farr's Atlas X Atlas are included. These varieties are often used as both grain and sweet sorgos, so they were included in both comparisons.

The bar graph in Figure 11 shows the per cent saccharine at the three places on the plants. The average per cent saccharine at the base of the plant was 10.8. The lowest reading was 6.5 per cent, found in Early Amber, and the highest per cent was 16.5, found in Farr's Atlas.

At the middle of the plants, the average per cent saccharine was 12.5. The lowest reading was 4.5 per cent, found in Early Amber, and the highest per cent was 17.0, found in White African.

The average per cent saccharine at the top of the varieties was 10.8. The lowest reading was 5.0 per cent, found in Early Amber, and the highest reading was 16.5 per cent, found in Farr's Atlas.

The most outstanding thing in Figure 11 is the low readings found in Early Amber. The average per cent saccharine at all three places in 1939 was only 5.0 per cent, while in 1937, this same variety had an average for the three places of 11.0 per cent.

Figure 12 gives the results of the calculations to determine whether or not there is a significant amount of variability between varieties, between stages of maturity, and between the three places on the plants.

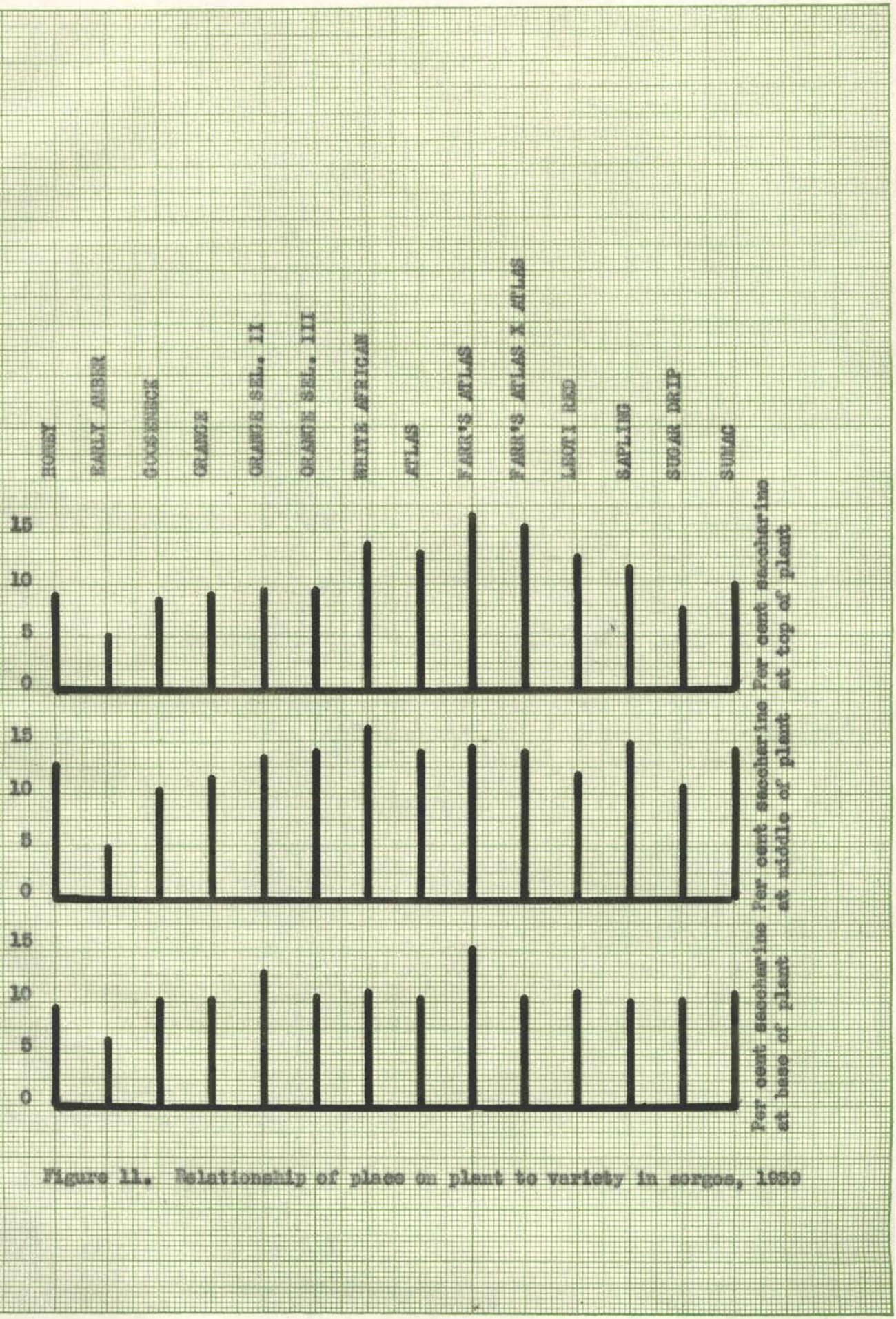


Figure 11. Relationship of place on plant to variety in sorgos, 1939

Source of Variability	Degrees of Freedom	Sums of Squares	Mean Square	F Value
Total	89	1,602.22		
Variety	9	308.8	34.3	13.4*
Stage Maturity	2	304.69	152.34	59.5*
Place on Plant	2	179.54	89.77	35.0*
Place X Stage	4	54.85		
Variety X Stage	18	577.00		
Variety X Place	18	84.96		
Variety X Place X Stage (error)	36	92.38	2.56	

*Highly significant variability

Figure 12. Analysis of variance of variety, stage of maturity and place on Plant in Sorgos, 1937.

For the variability between varieties to be significant, an F value of 2.15 is required. Therefore, the F value of 13.4 for varieties indicates that there is a highly significant variation between varieties. For the variability between the three stages of maturity to be significant, an F value of 5.25 is required; so the value of 59.5 shows that the variability between stages of maturity is highly significant. In order that there be a significant amount of variability between places on a plant, an F value of 5.25 is also required. So again, the F value of 35.0 indicates a highly significant variability between places on the plant.

Broom Corn

The field data for broom corn were collected and placed in tabular form in the same way that grain sorghums and sorgos were recorded. Again bar graphs were made to display the facts in the tables made.

Figure 13 gives the relationship of stage of maturity to variety. When all varieties of broom corn were in the blooming stage, the average per cent saccharine was 3.8. The lowest reading was 3.0 per cent, found in Austrian, and the highest per cent was 5.0 found in Whisp. At the soft dough stage of maturity, the average per cent saccharine was 5.5. The lowest reading was 3.5 per cent, found in Austrian, and the highest reading was 8.5, found in Black Spanish.

The average per cent saccharine in the hard dough stage of maturity was 4.9. The lowest reading was 4.0 per cent, found in Whisp, Evergreen Dwarf, and Miller Evergreen, and the highest reading was 9.0 per cent, found in White Italian.

Figure 13 shows that all broom corn varieties are much lower in saccharine content than the other two types of sorghums studied.

The relationship of place on plant to variety is shown in Figure 14. The average per cent saccharine at the base of the plant was 5.7 per cent. The lowest reading was 3.5, found in Whisp and Miller Evergreen, and the highest reading was 6.0 per cent, found in White Italian. At the middle of the plants, the average per cent saccharine was 6.7 per cent. The lowest reading was 4.0 per cent, found in Whisp, and the highest was 7.5 per cent, found in Black Spanish. The average per cent saccharine at the top of the plants was 7.6. The lowest reading was 4.5 per cent, found in Evergreen Dwarf, and the highest was 8.0 per cent, found in Black Spanish.

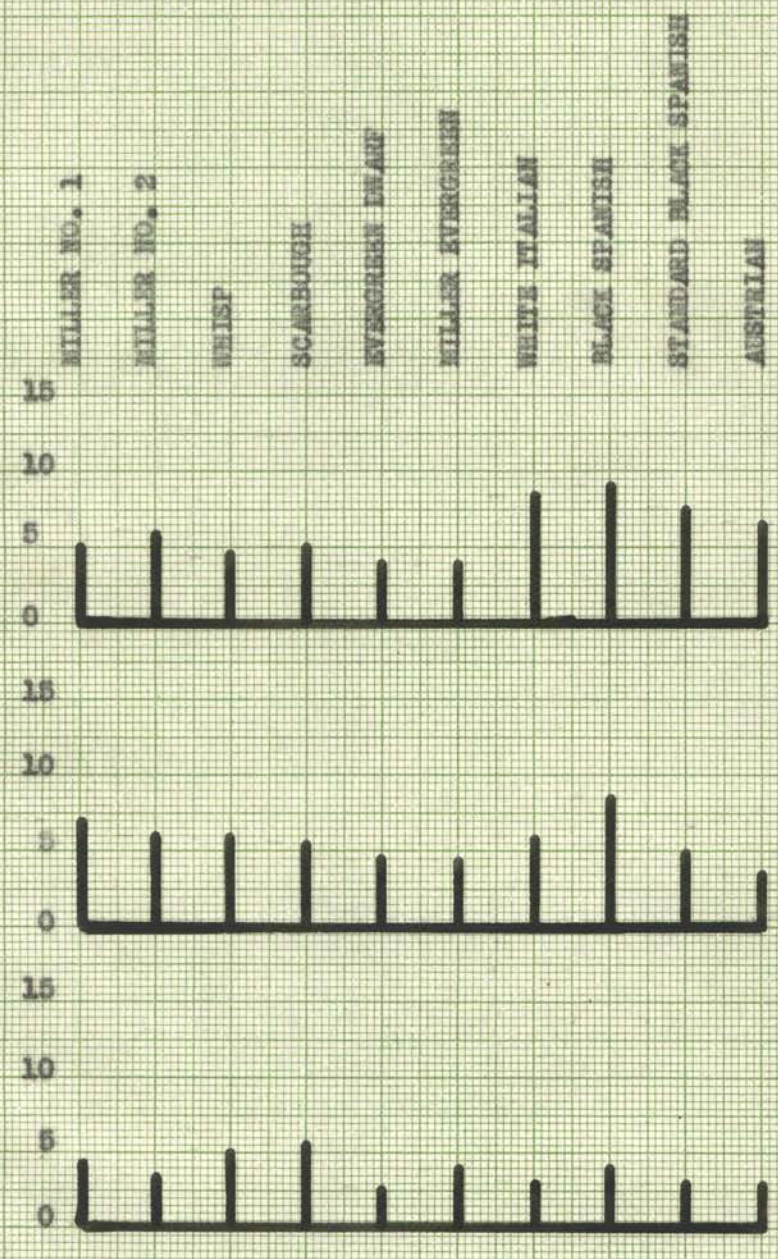


Figure 13. Relationship of stage of maturity to variety in broom corn, 1957

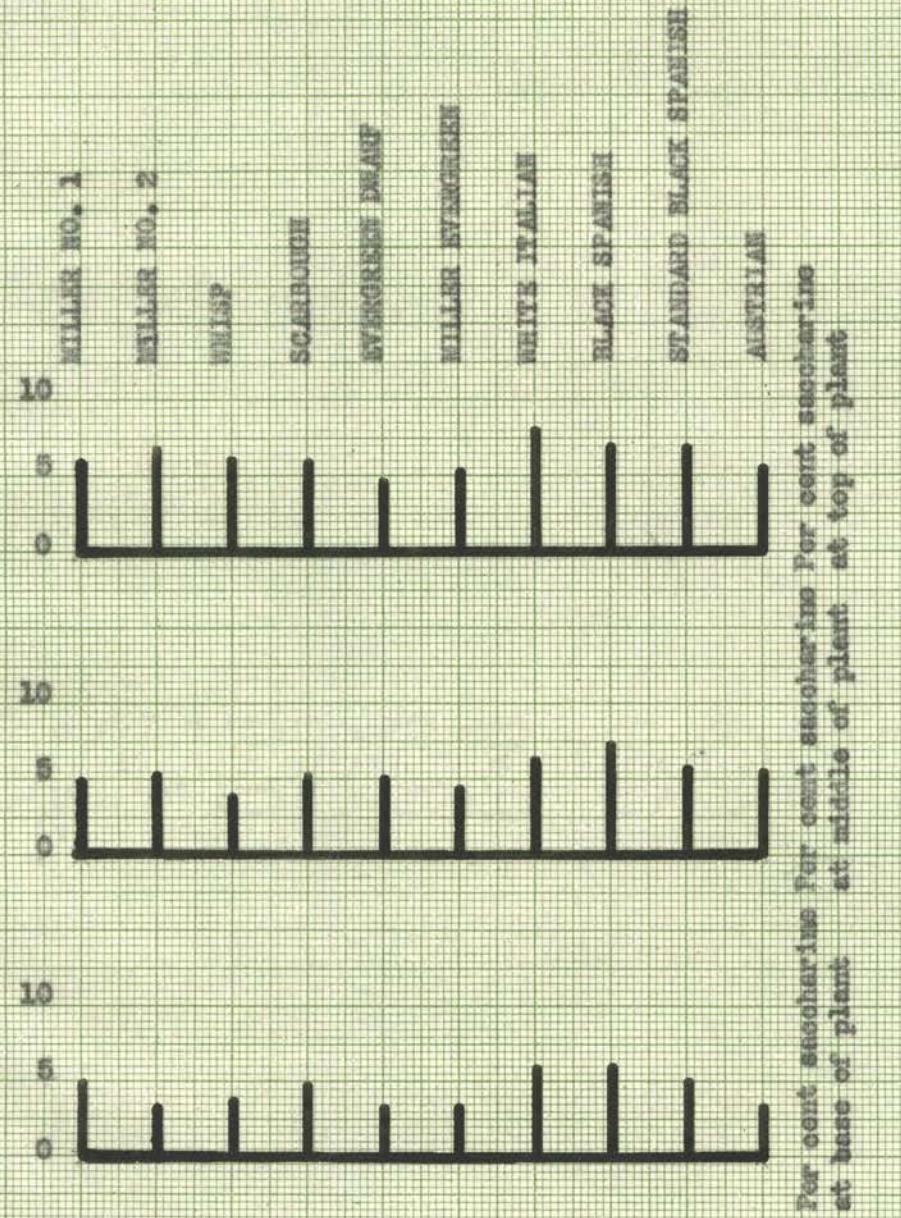


Figure 14. Relationship of place on plant to variety in broom corn, 1937

The summary of the calculations to determine whether or not the variability between varieties, between stages of maturity, and between places on the plant is shown in Figure 15. In each comparision the F value is larger than the required F value for the variability to be significant. Therefore, it is permissible to state that there is a highly significant variability between varieties, stages of maturity, and places on the plant in broom corn.

In summing the results in broom corn, it appears that the two outstanding factors are; first, the saccharine content is very low, and, second, all readings were difficult to make due to a very small amount of juice.

From Figure 16 it is noted that the highest per cent saccharine was found in grain sorghum and broom corn while the plants were in the soft dough stage of maturity, and that the highest per cent saccharine in sorgos was in the hard dough stage.

C. F. Walton, Jr., Chemist, Carbohydrate Research Division, found in his chemical analysis of sorghum sirup made from various parts of the plant that the sugar content was highest from sirup coming from the middle of the plant when in the milk to dough stages.[1] He also discovered that the sugar content in sorghum sirup was higher in the later stages of development than in the earlier stages. A glance at Figures 16 and 17 will show that the highest per cent saccharine in sorgos agrees with his highest figures made from the sirup at the same places on the plant and during the same stages of maturity.

---

[1]Walton, C. F., Jr., Ventre, E. K., And Biall, S., Farm Production of Sorgo Sirup, Farmers Bulletin No. 1791, Pp. 2 - 6.

Source of Variability	Degrees of Freedom	Sums of Squares	Mean Squares	V Values	F Value Required to be Significant
Total	89	971.45			
Variety	9	219.48	24.38	7.17	2.94
Stage of Maturity	2	100.57	50.28	14.63	5.25
Place on Plant	2	108.24	54.12	15.91	5.25
Place X Stage	4	91.55	22.88		
Variety X Place	18	68.02	3.77		
Variety X Stage	18	261.13	14.50		
Variety X Place X Stage	36	122.45	3.40		

Figure 15. Analysis of variance of variety, stage of maturity, and place on plant in broom corn, 1937.

	Per Cent Saccharine Content		
Stages of Maturity	Grain Sorghums	Sorgos	Broom Corn
Blooming	10.5	10.5	3.8
Soft Dough	11.8	12.2	5.5
Hard Dough	11.7	13.1	4.9

Figure 16. Summary of per cent saccharine at three stages of maturity in the three types of sorghums.

Place on Plant	Per Cent Saccharine Content		
	Grain Sorghums	Sorgos	Broom Corn
Base	9.7	12.1	5.7
Middle	11.4	12.9	6.7
Top	10.8	10.9	7.6

Figure 17. Summary of saccharine content at the three places on the plant in the three types being studied.

ATLAS SORGO SELECTIONS

In 1938 thirty-four Atlas Sorgo selections were made. These selections could not be made until the plants were mature so that seed could be saved. The average saccharine content in these plants had a range of 7.0 per cent to 16.6 per cent. The heads from each plant were saved in order to plant them in 1939 by the head to row method and thus determine if the offspring would have as high or as low saccharine content as its parent.

In 1939 a heavy chinch bug infestation killed out several of the selections, and no results could be obtained on twenty-two of the original selections made in 1938.

Figure 18 shows the per cent saccharine of the selections made in 1938 and beside each one is the per cent saccharine obtained in 1939 from the offspring. From these data it is apparent that in some of the selections the offspring was either much higher or much lower than the parent. It is hoped that by further selections and isolations, or by hybridization, a strain with a much higher saccharine content can be obtained.

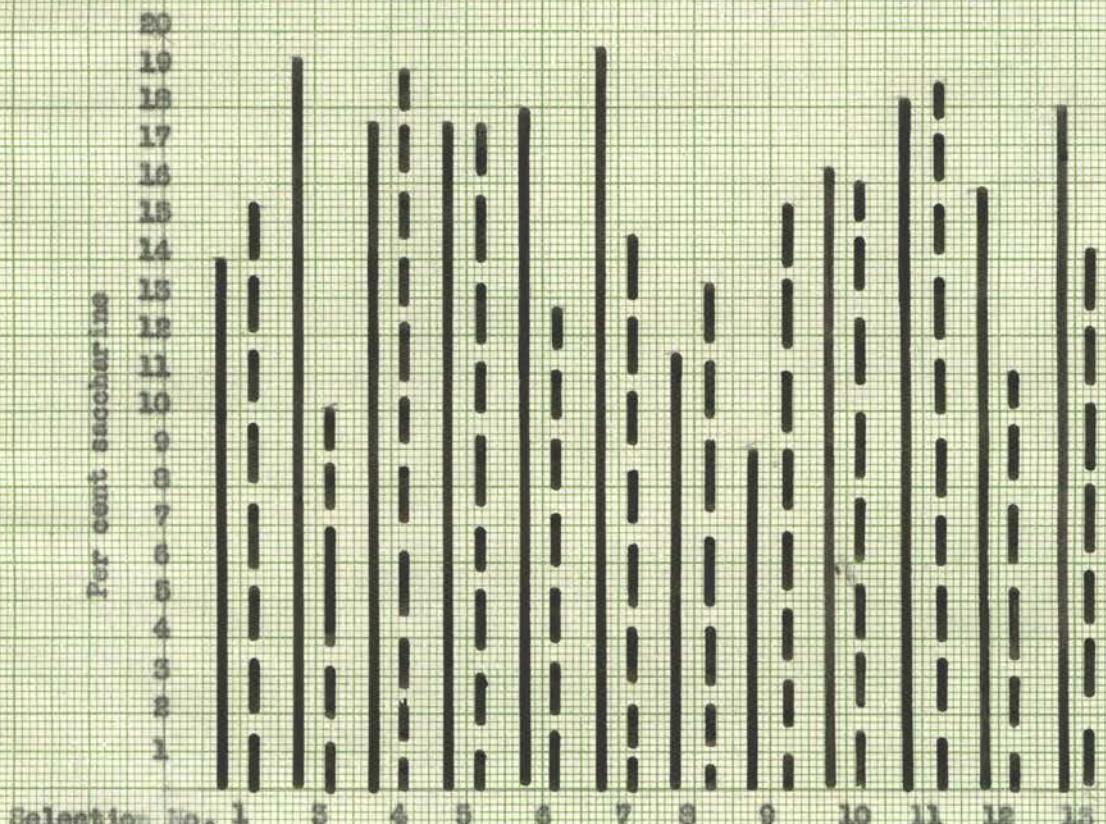


Figure 10. Relationship of parent to offspring

_____ Selection made in 1938

- - - - Offspring from parent in 1939

CONCLUSIONS

1. There is a significant variability in saccharine content between varieties of sorghums in the grain, sorgo, and broom corn types.
2. There is a significant variability in saccharine content between blooming, soft dough, and hard dough stages of maturity in the three types of sorghums mentioned above.
3. There is a significant variability in saccharine content between the base, middle, and top of the plant in the three types of sorghums studied.
4. Sorgos have a higher average saccharine content than grain sorghums, and broom corn is the lowest of the three types studied in saccharine content.
5. Grain sorghums are highest in saccharine when in the soft dough stage of maturity, and the middle of the plant is highest in saccharine content.
6. Sorgos are highest in saccharine content in the hard dough stage of maturity and the middle of the plant contains the most saccharine.
7. Broom corn is highest in saccharine content in the soft dough stage of maturity, and the top of the plant contains the highest per cent saccharine.

No attempt was made to draw any conclusions on Atlas Sorgo selections as the data were not complete. The results were as observed, and this study is yet being carried on by Dr. W. B. Gernert at the Oklahoma A. and M. Experiment Station.

BIBLIOGRAPHY

Bourne, B. A., "Effects of Freezing Temperatures on Sugar Cane in the Florida Everglades," Florida Agricultural Experiment Station Bulletin 278.

Brandes, E. W. and Sartoris, G. B., "Sugar Cane: Its Origin and Improvement," U.S.D.A. Yearbook. Washington, D. C.: U. S. Government Printing Office, 1936.

Craig, N., "Use of Refractometer in Sugar Cane Seedlings," International Sugar Journal No. 385, p. 14f., 1931.

Cross, W. E., "Investigation on Methods of Analysis of Cane Products," Journal of Agriculture Research, Vol. 28-614.

Lythgoe, H. C., "Uses of the Refractometer," Journal of Agriculture Research, Vol. 28-612.

Remington, R. E., "Use of Refractometer on Commercial Vinegar," Journal of Agriculture Research, Vol. 27-112.

Sherwood, Sidney F., "A Study of the Saccharine of Sugar Beets," Journal of Agriculture Research, Vol. 50.

Snedecor, George W., Statistical Methods. Ames, Iowa: Collegiate Press Inc. 1938. p. 179f.

Walton, C. F., Jr., Ventre, E. K., and Byall, S., "Farm Production of Sorgo Sirup," Farmers' Bulletin No. 1791, p. 2f.

APPENDIX

Field Data

Grain Sorghums

Plant	Plant Development	First Plant B	First Plant M	First Plant T	Second Plant B	Second Plant M	Second Plant T	Third Plant B	Third Plant M	Third Plant T	Average
Ajax	Blooming	9.8	10.4	9.8	10.2	10.2	9.2	7.4	8.6	9.0	9.4
Ajax	Soft dough	10.0	11.8	14.9	11.4	12.6	15.8	9.9	13.2	14.7	12.7
Ajax	Hard Dough	9.4	12.2	8.2	4.6	6.7	4.7	4.1	7.5	6.8	7.1
Average		9.7	11.4	10.9	8.7	9.8	9.9	7.1	9.8	10.2	9.7
Atlas	Blooming	10.8	11.0	9.3	7.0	9.6	9.2	9.0	9.8	10.6	9.6
Atlas	Soft Dough	10.4	12.0	11.3	9.2	10.6	10.4	12.3	14.3	12.2	11.4
Atlas	Hard Dough	11.0	11.8	7.0	11.3	12.7	11.3	8.2	10.0	4.6	9.6
Average		10.7	11.6	9.2	9.2	10.9	10.3	9.8	11.4	9.1	10.2
Farr's Atlas	Blooming	11.0	11.8	11.6	8.6	8.2	9.4	6.6	11.2	10.2	9.8
Farr's Atlas	Soft Dough	12.5	11.6	14.7	9.2	6.6	12.4	10.2	9.7	11.6	10.9
Farr's Atlas	Hard Dough	10.8	12.0	10.5	10.0	9.8	6.0	16.4	15.7	10.4	10.1
Average		11.4	11.8	12.3	9.3	8.2	9.3	11.1	12.2	10.7	10.3
Farr's Atlas X Atlas	Blooming	8.4	12.0	10.4	10.4	12.6	12.0	11.0	10.0	9.8	10.7
Farr's Atlas X Atlas	Soft Dough	12.4	12.3	13.5	14.6	12.9	15.4	14.2	14.7	16.2	14.1
Farr's Atlas X Atlas	Hard Dough	15.4	14.5	7.0	15.0	12.3	12.2	13.5	13.7	8.6	12.4
Average		12.1	12.9	10.3	13.3	12.6	12.5	12.9	12.8	11.5	12.4
Bishop	Blooming	10.2	9.6	8.8	10.2	9.2	9.2	10.0	8.4	8.6	9.4
Bishop	Soft Dough	7.9	8.2	8.6	9.6	12.0	13.2	12.0	13.7	13.3	10.9
Bishop	Hard Dough	9.0	9.4	8.5	9.8	12.2	12.3	14.4	13.4	12.7	11.3
Average		9.0	9.1	8.6	9.9	11.1	11.6	12.1	11.8	11.5	10.5
Chiltex	Blooming	7.4	11.2	9.4	12.2	14.6	10.8	10.8	11.4	9.6	10.8
Chiltex	Soft Dough	14.6	14.0	12.2	11.0	14.6	11.2	11.1	11.4	12.4	12.5
Chiltex	Hard Dough	7.8	6.5	7.0	4.3	14.3	12.4	11.2	9.0	8.3	9.0
Average		9.9	10.6	9.5	9.2	14.5	11.5	11.0	10.6	10.1	10.8
Club	Blooming	9.2	11.5	11.4	10.0	13.2	13.8	12.0	11.7	11.4	11.7
Club	Soft Dough	13.2	12.0	12.6	14.4	15.3	14.0	12.9	14.2	14.8	13.7
Club	Hard Dough	7.5	10.8	7.4	11.6	14.2	9.7	11.9	13.0	9.1	10.6
Average		10.2	13.1	10.7	10.0	12.9	10.9	10.7	12.2	10.3	11.2
Darso	Blooming	9.9	14.4	12.0	9.8	11.3	9.2	10.2	11.3	11.0	11.0
Darso	Soft Dough	13.3	14.4	12.8	8.6	13.4	14.0	9.9	12.2	10.8	12.1
Darso	Hard Dough	7.5	10.8	7.4	11.6	14.2	9.7	11.9	13.0	9.1	10.6
Average		10.2	13.1	10.7	10.0	12.9	10.9	10.7	12.2	10.3	11.2
White Darso	Blooming	14.0	16.0	15.9	11.1	11.3	11.8	12.0	13.1	14.4	13.3
White Darso	Soft Dough	12.3	15.0	15.0	13.0	11.4	10.7	14.6	18.8	17.4	14.3
White Darso	Hard Dough	19.3	18.5	12.4	15.3	16.8	9.7	14.5	18.3	9.6	15.0
Average		15.2	16.5	14.6	13.1	13.2	10.7	13.7	16.7	13.8	14.2

Plant	Plant Development	First Plant B	First Plant M	First Plant T	Second Plant B	Second Plant M	Second Plant T	Third Plant B	Third Plant M	Third Plant T	Average
Early Red	Blooming	10.7	11.5	12.6	13.4	16.4	16.3	12.8	14.2	14.3	13.8
Early Red	Soft Dough	11.0	11.0	10.6	14.0	14.0	13.3	13.2	15.3	13.7	13.0
Early Red	Hard Dough	12.2	14.7	11.5	12.2	14.9	6.4	14.3	16.0	11.2	12.6
Average		11.3	12.4	11.6	13.2	15.1	12.0	13.4	15.2	13.1	13.1
Feterita	Blooming	13.3	17.2	13.1	13.3	20.4	16.0	10.4	13.3	11.6	14.3
Feterita	Soft Dough	12.6	12.3	13.2	15.4	16.3	14.4	10.8	13.3	12.8	13.4
Feterita	Hard Dough	20.2	21.4	22.8	13.4	16.0	10.8	10.6	7.2	9.6	14.7
Average		15.4	16.9	16.4	14.1	17.6	13.7	10.6	11.3	11.3	14.1
Grohoma	Blooming	9.4	11.7	10.4	12.4	10.8	10.7	11.2	12.4	11.8	11.2
Grohoma	Soft Dough	13.4	10.9	10.9	11.5	12.0	12.6	15.6	13.1	13.2	12.6
Grohoma	Hard Dough	15.0	15.8	10.4	5.0	6.9	7.0	13.0	11.8	11.2	10.7
Average		12.6	15.4	10.6	9.6	9.9	10.1	13.3	12.4	12.1	11.5
Hegari	Blooming	10.7	12.3	13.0	8.9	11.4	12.5	10.0	11.8	12.2	11.4
Hegari	Soft Dough	14.6	10.0	10.8	10.3	9.9	11.0	8.2	7.8	7.2	10.0
Hegari	Hard Dough	9.1	6.0	4.3	10.4	14.4	10.1	11.6	6.8	4.0	8.5
Average		11.5	9.5	9.4	9.9	11.9	11.2	9.9	8.8	7.8	9.9
Hydro	Blooming	10.6	12.9	12.0	9.5	9.2	10.4	11.1	11.0	11.2	10.8
Hydro	Soft Dough	11.2	13.3	15.8	10.2	11.3	12.0	14.4	11.8	13.9	12.6
Hydro	Hard Dough	17.5	18.0	13.5	10.8	11.9	9.9	5.2	6.8	4.8	10.9
Average		13.1	14.7	13.8	10.2	10.8	10.8	10.2	9.9	9.9	11.4
Kafirita	Blooming	9.2	10.3	10.2	8.3	8.6	8.0	10.2	11.6	10.2	9.6
Kafirita	Soft Dough	11.7	14.5	12.8	13.9	14.0	13.7	13.1	13.1	13.3	13.3
Kafirita	Hard Dough	12.6	9.2	6.9	10.2	8.2	3.8	12.0	14.9	9.9	9.7
Average		11.2	11.3	9.9	10.8	10.3	8.5	11.8	13.3	11.1	10.9
Pink Kafir	Blooming	11.2	10.2	9.6	10.1	11.4	8.8	10.0	9.7	8.8	10.0
Pink Kafir	Soft Dough	13.2	13.0	15.1	8.2	11.0	13.3	10.2	10.5	12.0	11.8
Pink Kafir	Hard Dough	8.1	10.0	6.2	12.9	12.9	8.9	15.8	16.0	10.4	11.2
Average		10.8	11.1	10.3	10.4	11.8	10.3	12.0	12.1	10.4	11.0
Pearl Kafir	Blooming	8.6	10.0	10.8	8.1	9.7	9.2	9.1	10.7	9.0	99.6
Pearl Kafir	Soft Dough	11.9	10.4	12.5	8.4	10.0	11.5	11.2	9.7	12.0	10.8
Pearl Kafir	Hard Dough	10.4	13.0	9.8	8.4	8.5	9.3	5.0	5.8	5.4	8.6
Average		10.3	11.1	11.0	8.3	9.4	10.0	8.4	8.7	8.8	9.6
Fargo Milo	Blooming	10.6	10.1	11.8	11.2	10.3	10.2	10.6	8.9	12.0	10.6
Fargo Milo	Soft Dough	8.7	9.2	11.1	12.0	11.3	*	9.7	12.1	*	10.6
Fargo Milo	Hard Dough	9.5	8.7	4.3	7.0	7.6	5.3	9.4	10.0	5.0	7.4
Average		9.6	9.3	9.1	10.1	9.7	7.7	9.7	10.3	8.5	9.5
Wheatland Milo	Blooming	10.8	11.0	8.6	10.0	10.4	9.8	12.0	13.3	14.2	11.1
Wheatland Milo	Soft Dough	4.3	8.2	10.5	11.0	12.4	9.8	5.5	9.0	9.2	8.9
Wheatland Milo	Hard Dough	16.0	9.6	9.2	12.4	13.3	8.2	17.0	17.0	10.1	14.4
Average		10.4	9.6	9.4	11.1	12.0	9.3	11.5	13.1	11.2	11.5

Plant	Plant Development	First Plant B	M	T	Second Plant B	M	T	Third Plant B	M	T	Average
Dwarf Yellow Milo	Blooming	13.0	12.4	10.3	11.0	12.2	10.3	14.1	19.8	17.6	13.4
Dwarf Yellow Milo	Soft Dough	9.8	13.9	11.8	9.5	13.9	12.0	12.9	14.0	15.8	12.6
Dwarf Yellow Milo	Hard Dough	18.0	17.9	11.7	12.0	12.4	11.2	9.0	9.6	11.5	12.6
Average		13.6	14.8	11.3	10.8	13.2	11.2	12.0	14.5	14.9	12.9
Premo	Blooming	7.3	9.8	8.0	8.9	9.3	10.8	11.3	10.8	10.8	9.5
Premo	Soft Dough	9.9	11.8	12.0	8.8	10.5	9.8	8.4	10.0	12.4	10.4
Premo	Hard Dough	15.2	15.9	10.6	9.9	12.0	8.9	13.7	16.4	9.4	12.4
Average		10.8	12.5	10.8	8.9	10.4	9.3	10.9	12.5	10.9	10.8
Reeds	Blooming	9.4	12.2	9.8	12.0	14.0	11.4	10.3	11.6	9.8	11.2
Reeds	Soft Dough	10.3	14.4	14.6	8.0	10.3	14.4	8.5	11.8	13.8	11.9
Reeds	Hard Dough	8.9	10.8	6.9	9.2	13.9	8.8	12.9	16.0	8.2	10.6
Average		9.5	12.4	10.4	9.7	12.7	11.5	10.6	13.1	10.6	11.2
Red	Blooming	6.6	9.4	8.8	7.3	9.0	10.8	7.0	10.2	7.6	8.5
Red	Soft Dough	9.2	9.0	13.4	10.7	14.1	14.2	9.8	13.7	14.6	12.1
Red	Hard Dough	14.2	14.2	9.6	14.0	13.1	14.2	14.2	13.3	9.0	12.9
Average		10.0	10.9	10.6	10.8	12.1	13.1	10.3	12.4	10.4	11.2
Shallu	Blooming	8.0	8.1	9.6	7.0	6.8	7.0	8.3	7.1	6.4	7.6
Shallu	Soft Dough	10.0	11.0	*	9.8	6.3	7.2	8.5	6.5	7.2	8.3
Shallu	Hard Dough	12.7	13.8	8.4	15.3	14.0	6.5	15.2	16.6	10.1	12.5
Average		10.2	10.9	9.0	10.7	9.0	5.9	10.7	10.1	7.9	9.4
Schrock	Blooming	5.2	7.6	8.2	11.0	12.4	9.0	10.0	11.2	10.0	9.4
Schrock	Soft Dough	10.9	11.0	14.5	6.0	10.0	13.1	9.9	11.2	14.1	11.2
Schrock	Hard Dough	14.7	16.5	12.5	15.8	16.0	12.8	18.0	16.0	10.7	14.8
Average		10.3	11.7	11.7	11.1	12.8	11.6	12.6	12.8	11.6	11.8
Sagrain	Blooming	8.4	10.4	9.8	9.1	11.6	10.7	9.7	10.9	8.1	9.8
Sagrain	Soft Dough	10.8	11.4	14.4	13.7	11.6	14.9	12.7	17.3	17.5	13.8
Sagrain	Hard Dough	16.3	16.2	11.8	14.8	16.3	10.6	14.0	14.4	11.3	14.0
Average		11.8	12.5	12.0	12.5	13.2	12.1	12.1	14.2	12.3	12.5
Sudan	Blooming	12.0	14.0	*	8.4	7.8	9.4	9.8	11.0	10.0	10.3
Sudan	Soft Dough	10.7	*	*	9.2	10.5	*	8.0	9.1	*	9.5
Sudan	Hard Dough	*	*	*	*	*	*	*	*	*	*
Average		11.3	14.0	*	8.8	9.1	9.4	8.9	10.1	10.0	9.9
Sunrise	Blooming	6.7	9.0	9.4	6.8	8.2	8.1	6.0	9.0	8.8	8.0
Sunrise	Soft Dough	6.3	9.5	15.0	7.9	11.0	14.1	11.9	14.8	15.2	11.7
Sunrise	Hard Dough	16.3	18.3	14.2	15.1	18.2	12.1	12.0	16.6	9.5	14.7
Average		9.8	12.3	12.9	9.9	12.5	11.4	9.9	13.4	11.9	11.5
Standard Blackhull	Blooming	9.9	10.0	8.0	11.6	10.0	8.0	8.8	9.0	8.4	9.3
Standard Blackhull	Soft Dough	8.9	10.4	10.7	8.3	9.6	10.0	10.9	12.5	12.0	10.4
Standard Blackhull	Hard Dough	12.1	15.6	14.3	11.3	11.7	11.8	12.9	13.6	13.0	13.0
Average		10.3	12.0	11.0	10.4	10.4	9.9	10.9	11.7	11.1	10.9

Plant	Plant Development	First Plant B	M	T	Second Plant B	M	T	Third Plant B	M	T	Average
Texas Blackhull	Blooming	11.2	10.4	11.2	10.0	11.0	10.0	8.8	9.2	12.0	10.4
Texas Blackhull	Soft Dough	13.2	13.4	12.4	11.5	12.0	12.8	11.8	10.9	12.0	12.2
Texas Blackhull	Hard Dough	17.8	21.0	*	14.3	14.4	17.7	11.6	13.4	10.9	15.0
Average		14.1	14.9	11.8	11.9	12.5	13.5	10.7	11.2	11.6	12.5

*Not enough juice for a reading.

Sorgo

Plant	Plant Development	First Plant B	M	T	Second Plant B	M	T	Third Plant B	M	T	Average
Early Amber	Blooming	7.6	9.8	9.2	13.8	14.0	10.2	7.8	8.2	8.0	9.8
Early Amber	Soft Dough	6.2	9.8	11.0	11.4	11.6	9.0	13.0	13.0	9.8	10.5
Early Amber	Hard Dough	18.5	17.2	12.4	18.8	19.2	15.0	10.5	9.8	9.3	14.6
Average		10.8	12.3	10.9	14.7	14.9	11.4	10.4	10.3	9.0	111.9
Gooseneck	Blooming	14.4	13.6	10.8	12.0	14.2	11.8	15.0	18.5	13.0	14.0
Gooseneck	Soft Dough	17.2	15.0	14.4	7.2	11.6	11.0	14.6	13.0	11.0	12.8
Gooseneck	Hard Dough	13.0	17.5	15.5	5.0	9.7	8.8	17.7	17.4	11.5	13.0
Average		14.9	15.7	13.6	8.1	11.8	10.5	15.8	16.3	11.5	13.3
Honey	Blooming	5.9	9.1	9.0	10.5	15.6	13.2	9.0	10.9	8.0	10.1
Honey	Soft Dough	10.0	13.2	11.6	11.4	11.8	12.8	21.0	17.8	17.0	14.1
Honey	Hard Dough	10.5	12.9	6.4	8.0	10.8	10.4	10.3	11.2	10.6	10.1
Average		8.8	11.7	9.0	10.0	12.7	12.1	13.4	13.3	11.9	11.4
Leoti Red	Blooming	11.3	10.2	9.4	9.9	9.2	8.4	9.0	10.3	7.0	9.4
Leoti Red	Soft Dough	10.0	13.0	14.2	11.6	9.8	11.2	12.6	11.0	13.1	11.8
Leoti Red	Hard Dough	11.0	12.0	11.1	13.3	13.5	11.3	11.3	15.0	11.2	12.2
Average		10.8	11.7	11.6	11.6	10.8	10.3	10.9	12.1	10.4	11.1
Orange Selection II	Blooming	11.0	11.4	10.0	11.3	11.0	11.1	14.4	13.2	11.3	11.6
Orange Selection II	Soft Dough	13.2	15.6	13.8	16.0	17.6	12.8	15.4	16.2	14.0	15.0
Orange Selection II	Hard Dough	12.2	14.5	10.2	13.2	17.1	10.3	14.3	18.2	15.0	14.0
Average		12.1	13.8	12.3	13.5	15.2	11.4	14.4	15.9	13.4	13.5
Orange Selection III	Blooming	11.7	13.4	10.5	9.4	10.3	9.2	10.0	13.0	10.8	10.9
Orange Selection III	Soft Dough	15.0	15.0	13.6	13.3	13.1	12.0	14.6	15.0	13.0	13.8
Orange Selection III	Hard Dough	17.8	19.3	14.0	12.3	12.8	10.7	11.8	17.0	12.2	14.2
Average		14.8	15.9	12.7	11.7	12.7	10.6	12.1	15.0	12.0	12.9
Red X	Blooming	10.3	9.2	6.5	11.2	10.1	7.0	10.4	9.5	9.1	9.2
Red X	Soft Dough	13.0	9.8	8.0	15.0	7.5	7.0	11.6	9.0	9.2	10.0
Red X	Hard Dough	17.5	19.3	16.4	16.3	16.1	12.9	17.0	19.1	14.2	16.5
Average		13.6	12.8	10.3	14.2	11.2	8.9	13.0	12.5	10.8	11.9

Plant	Plant Development	First Plant B	M	T	Second Plant B	M	T	Third Plant B	M	T	Average
Sapling	Blooming	10.6	9.6	8.4	11.3	12.2	8.4	10.5	9.4	9.8	10.1
Sapling	Soft Dough	13.2	13.8	11.9	10.6	7.8	8.6	9.8	12.2	11.6	11.1
Sapling	Hard Dough	16.4	18.2	11.0	16.3	20.0	12.5	13.0	14.4	10.0	14.6
Average		13.4	13.9	10.4	12.7	13.3	9.8	11.1	12.0	10.5	11.9
Sumac	Blooming	10.4	10.0	8.5	10.4	9.8	8.7	8.8	9.9	9.0	9.5
Sumac	Soft Dough	14.9	14.3	12.8	12.2	13.2	11.6	10.9	10.0	11.8	12.4
Sumac	Hard Dough	12.5	12.2	14.0	13.8	13.2	12.3	14.2	14.1	15.4	13.5
Average		12.6	12.2	11.8	12.1	12.1	10.9	11.3	11.3	12.1	11.8
Sugar Drip	Blooming	10.9	10.9	9.2	10.8	11.3	8.5	11.0	10.0	9.0	10.2
Sugar Drip	Soft Dough	10.2	11.6	11.2	13.2	11.0	12.2	9.6	8.9	10.0	10.9
Sugar Drip	Hard Dough	8.8	11.6	6.0	8.2	8.4	4.6	9.8	8.2	5.5	8.0
Average		9.9	11.4	8.8	10.7	13.6	8.4	10.1	9.0	8.2	9.7

Broom Corn

Plant	Plant Development	First Plant B	M	T	Second Plant B	M	T	Third Plant B	M	T	Average
Miller No. 1	Blooming	4.0	5.1	*	4.0	4.0	*	4.1	6.2	*	4.6
Miller No. 1	Soft Dough	4.4	6.5	*	4.1	5.2	4.9	11.0	4.9	8.0	6.2
Miller No. 1	Hard Dough	3.2	4.6	5.0	6.1	4.1	4.6	4.6	4.8	5.9	4.8
Average		3.9	5.4	5.0	4.7	4.4	4.7	6.6	5.3	6.9	5.2
Miller No. 2	Blooming	3.7	4.2	*	0.3	2.5	*	5.0	3.4	*	3.2
Miller No. 2	Soft Dough	4.9	4.4	8.0	5.0	5.8	4.8	4.4	5.1	12.0	6.0
Miller No. 2	Hard Dough	3.0	6.0	4.3	1.2	8.0	7.0	4.4	9.0	6.9	5.5
Average		3.9	4.9	6.1	2.2	5.4	5.9	4.6	5.8	9.4	4.9
Whisp	Blooming	3.7	4.0	*	3.9	4.4	*	5.0	4.4	*	4.9
Whisp	Soft Dough	4.0	5.4	11.1	2.2	3.0	8.0	3.0	4.0	6.2	5.2
Whisp	Hard Dough	4.0	4.1	3.2	7.0	4.8	0.6	4.1	5.0	4.2	4.1
Average		3.9	4.5	7.2	4.4	4.1	4.3	4.0	4.5	5.2	4.7
Scarbough	Blooming	2.3	*	*	*	*	*	*	*	*	*
Scarbough	Soft Dough	5.5	4.0	*	5.0	5.0	7.2	6.0	4.2	7.0	5.5
Scarbough	Hard Dough	3.9	5.9	6.0	4.0	4.0	4.0	4.8	4.6	6.0	4.8
Average		3.9	4.9	6.0	4.5	4.5	5.6	5.4	4.4	6.5	5.1
Evergreen Dwarf	Blooming	3.0	3.1	*	4.8	5.0	*	2.2	4.1	*	3.7
Evergreen Dwarf	Soft Dough	2.4	3.9	*	6.0	5.6	*	4.0	6.1	*	4.7
Evergreen Dwarf	Hard Dough	5.8	4.7	6.0	6.9	5.3	3.2	2.6	2.0	2.0	4.3
Average		3.7	3.9	6.0	5.9	5.3	3.2	2.9	4.1	2.0	4.2
Miller Evergreen	Blooming	3.0	2.5	*	3.8	5.8	*	4.2	4.3	*	4.0
Miller Evergreen	Soft Dough	3.2	5.1	*	4.2	5.9	*	3.8	5.3	*	4.6
Miller Evergreen	Hard Dough	1.5	3.0	6.2	2.4	3.3	4.0	5.4	4.9	5.6	4.0
Average		2.6	3.5	6.2	3.5	5.0	4.0	4.5	4.8	5.6	4.2

Plant	Plant Development	First Plant B	First Plant M	First Plant T	Second Plant B	Second Plant M	Second Plant T	Third Plant B	Third Plant M	Third Plant T	Average
White Italian	Blooming	3.5	4.8	*	3.9	3.3	*	3.7	1.5	*	3.5
White Italian	Soft Dough	3.5	4.9	6.8	5.2	7.1	7.2	5.0	5.3	7.0	5.8
White Italian	Hard Dough	10.1	11.1	9.4	7.1	10.2	5.0	9.9	12.4	8.1	9.2
Average		5.7	6.9	8.1	5.4	6.9	6.1	6.2	6.4	7.5	6.2
Black Spanish	Blooming	3.1	4.0	4.8	4.2	4.0	4.9	2.6	2.6	3.7	3.7
Black Spanish	Soft Dough	4.8	8.0	10.6	6.0	7.6	10.0	9.1	9.8	12.0	8.7
Black Spanish	Hard Dough	8.2	9.0	5.4	8.0	12.9	9.6	8.1	9.1	7.2	8.7
Average		5.4	7.0	7.3	6.1	8.2	8.2	6.6	7.2	7.6	7.0
Stan. Black Spanish	Blooming	4.0	3.5	*	3.3	2.0	*	4.2	3.8	*	3.5
Stan. Black Spanish	Soft Dough	*	4.9	*	5.4	6.0	*	3.8	*	*	5.0
Stan. Black Spanish	Hard Dough	7.6	8.4	7.8	8.4	11.9	8.0	5.9	6.8	5.0	7.7
Average		5.3	5.6	7.8	5.7	6.6	8.0	4.6	5.3	5.0	5.4
Austrian	Blooming	2.9	5.3	*	2.5	3.4	*	2.4	1.5	*	3.0
Austrian	Soft Dough	1.6	5.4	*	3.6	6.0	*	1.5	2.0	*	3.7
Austrian	Hard Dough	5.0	6.6	4.2	7.2	12.6	8.4	4.4	3.1	3.0	6.1
Average		3.2	5.8	4.2	4.4	7.3	8.9	2.8	2.2	3.0	4.3

*Not enough juice for a reading

Typist - Mildred Thompson, Secretary, Department of Agricultural Education, A. and M. College of Texas, College Station, Texas