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# Study of Total Solids - Sucrose Content Relationship in Sugarcane Juice with Reference to Varieties *

## *Determination of Earliness or Lateness of Varieties Using Total Solids - Sucrose Regression.*

*by*

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**Introduction :** The importance of determining the ripening point of growing sugarcane is recognised by all who are connected with the production of sugar or jaggery. The sugarcane grower requires an easy method of determining when a particular variety cultivated by him could be expected to ripen, so that it might be harvested at a period at which, the sucrose content will be at a peak value, and at which utilisation of the sugar produced will be maximum and losses due to deterioration will be at a minimum.

The jaggery manufacturer is interested in ensuring that the sugarcane crop is harvested when it is just satisfactorily ripe, as the setting of jaggery is seriously hampered, by the use of unripe or over-ripe cane, with consequent impairing of jaggery quality. The sugar factory is particular that the cane supplied by the grower attain peak maturity. As payment for sugarcane is mostly made on the basis of cane weight, the payment for unripe or over-ripe canes at the same rate as for optimum ripe canes will affect the economy of the sugar-factory.

In tracts where the climatic conditions requisite for all year planting are lacking, crushing is usually limited to about six months in the year. Among the six months devoted to crushing, the planting and harvesting schedules of varieties have to be so adjusted as to ensure an even and satisfactory supply of canes to the Factory all through the crushing period. An accurate knowledge of the earliness or lateness of varieties, is therefore imperative for the correct preparation of harvest schedules.

The present paper describes an attempt at determining even during the early stages of cane growth, the earliness or lateness of different cane varieties, from a consideration of the total solids-sucrose relationship in sugarcane juice.

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**Literature:** *Earliness or lateness of varieties:* Several methods are available for the determination of the ripening points of different cane varieties. The most obvious one is to grow the cane itself and conduct maturity observations on the crop over a period of about 6 months round about its ripening point, by analysing the sugarcane juice for Total Solids (Brix) and Sucrose. Although fool-proof and accurate, this method is time-consuming and may take up to 15 months for carrying out. Moreover, it is not possible, according to this method, to predict the ripening point during the early phases of growth of an unknown sugarcane variety.

A method (1) (1948) based on the moisture content of leaf sheaths attached to elongating stem was developed in Hawaii. According to this method the progressive variation in moisture-content of standard sugarcane leaf-sheaths is followed by determining sheath-moisture at frequent regular intervals towards the ripening period, and harvesting the canes when a constant minimum of sheath moisture is reached. At any point during the growth of a number of varieties planted on the same day the sheath moisture is dependent on the earliness or lateness of the variety, that is, late varieties have higher values for sheath moisture and vice-versa. Fibre content of cane also serves to a certain degree to fix the earliness or lateness of varieties, early canes usually having a higher fibre content than late varieties.

*Juice Composition:* The general relationship between the Total Solids and sucrose content of sugarcane juice is a matter of common observation. It is well known that as the total solids (Brix) increase, the sucrose also can be expected to increase. Craig (2) (1931) demonstrated a strong positive correlation between the refractometer Brix and Sucrose content of Sugarcane juice and showed that the curve representing the correlation takes the form of one section of a wide second degree curve.

Khanna and Sen suggested the use of the Hand Refractometer as an alternative to the usual polarisation method in the evaluation of sugarcane varieties from the sugar point of view. These authors have also prepared tables for the conversion of Middle internodal Brix of standing canes to True Brix and Sucrose % of cane.

*Part of stem to represent whole plant regarding juice quality:* Khanna & Sen (4) (1953) have worked out the correlation between the middle internodal Brix of Sugarcane and the Brix of juice from the whole stalk, when crushed, and found out that the correlation co-efficient was positive and very high. They worked out regression equation for conversion of middle internodal Brix into Brix of juice from crushed stalks.

*Nature of Brix-Sucrose Correlation in Sugarcane Juice:* Durairaj, Ranganathan and Subramanian, from a detailed study of sugarcane juice analytical results of Central Sugarcane Research Stations, Palur and Cuddalore (3) (1957), Madras State, concluded that the Brix-Sucrose relationship of juice of a sugarcane variety, as quantitatively expressed by the relevant regression coefficient, was a varietal characteristic, that the correlation is practically absolutely linear if individual varieties are considered separately and that forms and doses of nitrogenous manures, time of planting, levels of irrigation and age of crop have no perceptible influence in altering the regression coefficient of a particular veriety.

**Experimental Details:** *Variation of Brix-Sucrose Regression Coefficient within the field:* To determine the variations, if any, of the Brix-Sucrose regression coefficient among different spots in the same field, 37 whole clumps of Co. 527 from 2 rows of 50 cents in a plot, with identical manurial and cultural schedule, were crushed separately, and the Brix and Sucrose of the juice determined using the Brix hydrometer, and the Polariscope, respectively, for the two determinations (Table 1.)

Correlation and regression coefficients were worked out for Brix-Sucrose for each of the 2 rows and for two half portions of the 2 rows considered together, so as to have 2 patches of the field with different orientations, (Table 4, serial Nos. 1 & 2.)

*Comparative study of Brix-sucrose Regression of a number of varieties:* Out of 60 sugarcane varieties, (Co. 1172 to Co. 1231) released during 1957 from the Sugarcane Breeding Institute, Coimbatore, 24 varieties which exhibited favourable agronomic characteristics and juice quality were studied in detail. At harvest at the age of 11 months, each of the 24 varieties was separated mostly into 5 sub-groups according to quality of juice as obtained from the determination of refractometer Brix of the middle internode of each individual cane. Canes having similar middle internodal Brix were grouped together and the total number of sub-groups adjusted to be about five. The sub-groups were crushed separately, and the Brix and Sucrose of the juice obtained were determined as usual in the case of 116 samples (Table 2).

# FIGURES

## STUDY OF TOTAL SOLIDS-SUCROSE CONTENT RELATIONSHIP IN SUGARCANE JUICE WITH REFERENCE TO VARIETIES

FIG. 1.a BRIX-SUCROSE REGRESSION — VARIETIES WITH REGR. COEFFICIENT <1·32

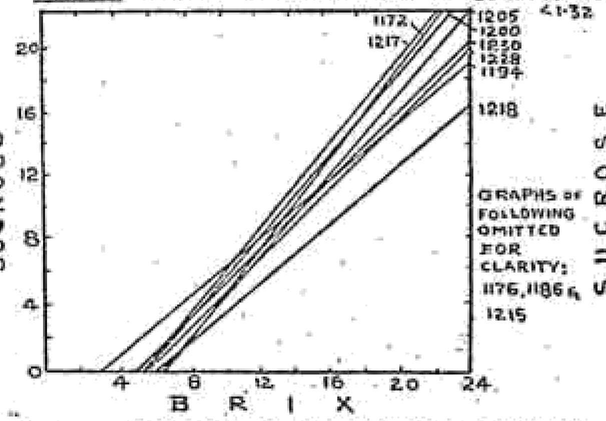



FIG. 1.b BRIX-SUCROSE REGRESSION — VARIETIES WITH REGR. COEFFICIENT >1·32

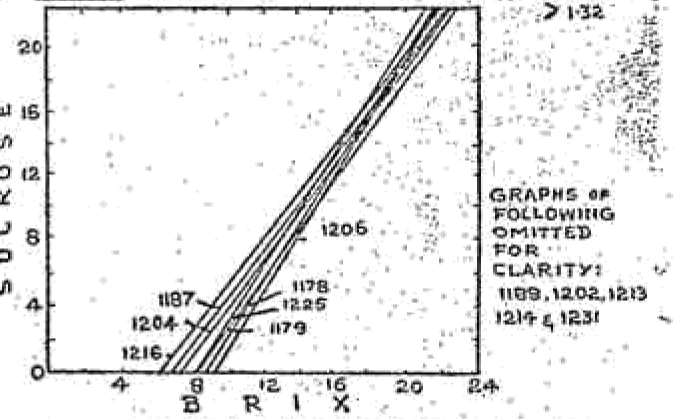



FIG. 2. REGRESSION COEFFICIENT-SUBTRACTION FACTOR REGRESSION

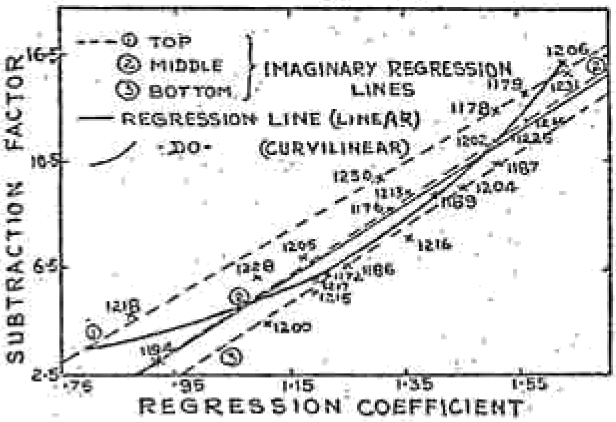



FIG. 3. TO PROVE REGR. COEFFICIENT = TAN ANGLE OF SLOPE

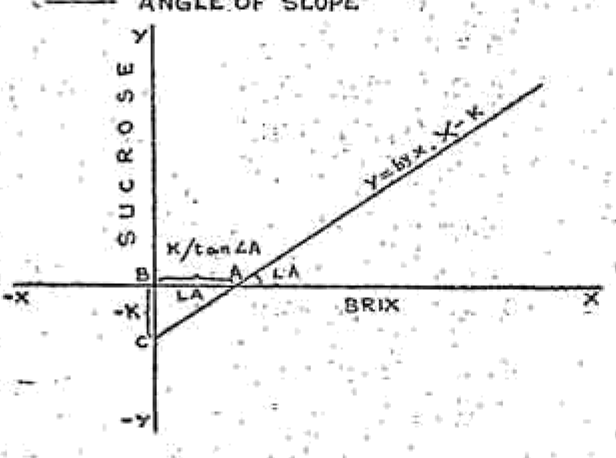
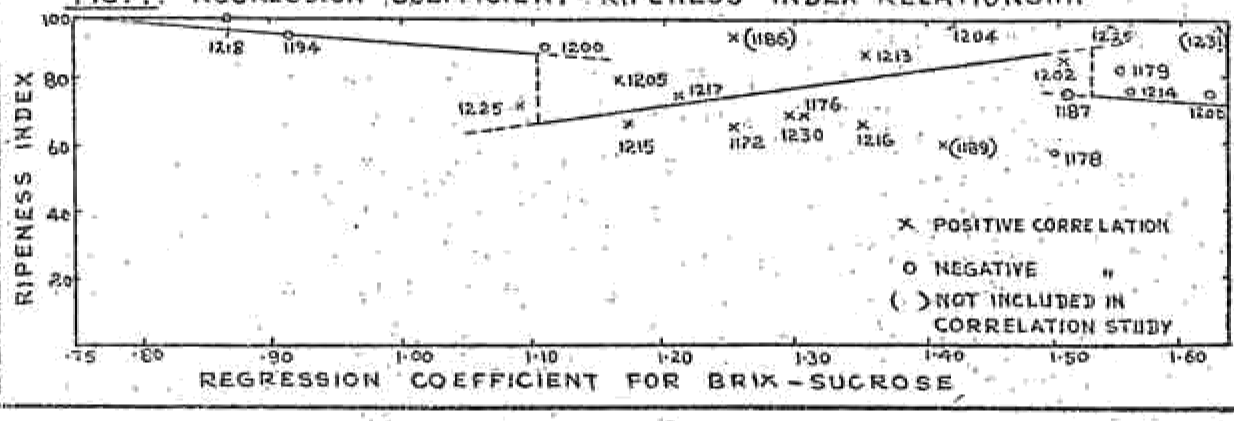



FIG. 4. REGRESSION COEFFICIENT-RIPENESS INDEX RELATIONSHIP



The Brix-Sucrose data for each of 23 varieties were analysed statistically for correlation. The correlation and regression coefficients, standard error and regression equation for varieties were arrived at (Table 5). The regression lines for the varieties were drawn [ Figures 1 (a) and (b) ].

*Discussion of results and further Statistical and Mathematical Studies Variation of Brix-Sucrose Regression Coefficient within the Field :* The correlation coefficients for the relationship calculated in either position in the field was positive and very high (about ·99). The regression coefficients ranged from 1·18 to 1·21, and there was practically no difference between the coefficients, thus indicating that the regression coefficient is not perceptibly affected by changes of position within a field.

*Comparative study of Brix-Sucrose regression of a number of varieties :* The correlation coefficients for Brix-Sucrose were more than ·99 in the majority of cases, indicating a very high degree of correlation, which is practically absolute in its linearity. The regression coefficients varied from ·87 to 1·63. The very high figures obtained for the correlation coefficients, inspite of the fact that only 5 pairs of data were utilized for each calculation are a good indication of the absoluteness of the Brix-Sucrose relationship in Sugarcane juice and of the specific nature of this relationship with reference to the varieties.

Although there was a fairly wide range of Brix-Sucrose values, with low as well as high values, all the points followed the same course determined from the regression line, thus enabling the course to be determined even when the canes were young. As the course is the same during the early as well as late stages, as seen from the behaviour of the points representing low as well as high values, the behaviour at later stages is predictable from a study of it, at the early stages.

It was observed that the regression coefficients did not tend to group together, but were dispressed fairly well all over the observed range. (Figure 2).

The highly specific nature of the Brix-Sucrose relationship with reference to varieties recommended itself as a useful index in the characterisation and classification of varieties. But as the regression equation is the mathematical expression for the Brix-Sucrose relationship, and as it invariably consists, in this particular case, of the regression coefficient and the subtraction factor, it is difficult to define a variety simultaneously in terms of the regression coefficient and the subtraction factor, both of which are capable of independent variation.

The difficulty could be overcome satisfactorily only if the regression coefficient and the subtraction factor are somehow related mathematically, this possibility being rather remote. Anyway, to test the relationship, if any, between the two factors, correlation coefficient was worked out for the relationship regression coefficient—subtraction factor. Surprisingly, a very high correlation coefficient (about ·95) was obtained for the relationship, thus indicating that the subtraction factor is predictable from the regression coefficient itself.

When the two factors were plotted on a graph (Figure 2) the points arranged themselves along 3 imaginary lines, the middle line being almost the same as the regression line drawn with the regression equation for the regression coefficient — subtraction factor correlation, and the other two lines lying on either side at almost equal distances.

It was thought possible that the varieties examined fell under three different heads with characteristic behaviour with reference to Regression coefficient — subtraction factor relationship. Hence the points lying along each of the three imaginary lines were separated out and correlation coefficients calculated for each of the 3 groups. The separation into the groups had brought about a decided increase in the correlation coefficients, all of which were now of the order of ·99 [ Table 4, Serial No. 3 (2) (a), (b) and (c) ].

From the dispersion of the points, it was also observed that there was a tendency towards a slight curvilinearity in the relationship. This was statistically tested and the results indicated that there was a slight curvilinearity, and that the curve was a better fit for the observed data than the straight line (Figure 2).

*Relationship between Regression Coefficient and Slope of Regression Line:* According to definition, the regression coefficient is the rate of change of Sucrose for unit change in Brix. The slope of the regression line expressed in terms of the tangent of the angle that the line subtends to the horizontal is also the rate of change of Sucrose for unit change in Brix. The slope of the regression line can readily be obtained by plotting a few points for Brix-Sucrose, and drawing a smooth representative straight line through them. Hence if a relationship between the regression coefficient and the tanget of the angle of slope could be established, the method of plotting a few points and measuring the slope of the line passing through them suggested itself as a rapid means of determining the regression coefficient. Mathematical considerations outlined below indicated that the regression coefficient was numerically equal to the tangent of the angle of slope of the regression line, thus rendering the rough and ready determination of regression coefficient rapidly feasible.

Please Refer Fig. 3.

1. $Y = byx. X - k$ (Regression equation for Brix-Sucrose, where X = Brix, Y = Sucrose, k = Subtraction factor)
2. When $X = O$, $Y = -k$.
3. In figure 3, if $BC = k$, then $BA = \frac{k}{\tan BAC}$ or $\frac{k}{\tan \angle A}$
4. BA is the value of X, when $Y = O$.
5. From equation, when $Y = O$, $X = \frac{k}{byx}$ or $BA = \frac{k}{byx}$
6. From 3 and 5 above, $\frac{k}{\tan \angle A} = \frac{k}{byx}$; Hence $byx = \text{Tan} \angle A$

Thus it is seen that it is possible to build up the regression equation rapidly for any given variety, starting from the slope of the line drawn through a few of the points. As the tangent of this angle is equal to Regression coefficient, and as the subtraction factor also can be derived from the regression coefficient, the approximate regression equation can be rapidly constructed out of a few data and the variation of Sucrose with Brix roughly, but quickly, predicted for a variety.

*Relationship between the Earlines or Lateness of Varieties and Brix-Sucrose Regression:* As Brix-Sucrose regression was highly characteristic of varieties and was little affected by cultural or manurial variations it was considered worthwhile to determine whether the regression coefficient could be utilised for determining the ripening points of varieties, and classifying them as early or late. The hand refractometer readings for middle internode of the varieties studied had been taken by the Agronomy staff as early as 9–12–'57. The Hydrometer Brix had been determined at harvest (9–3–'58) in connection with the present study of the 24 varieties, and the average for each variety had been worked out by giving weightage for weight of each sub-group in a variety (Table 3). The Hydrometer Brix was converted to Refractometer Brix using the equation $Y = 2.3X + 4.9$, arrived at by the author and co-workers in connection with a previous investigation.

The percentage of Refractometer Brix on 9–12–'57 to that at harvest (9–3–'58) gives a quantitative expression to the earliness or lateness of varieties, as early varieties would have reached Brix values very near the Brix at harvest (maximum Brix), and consequently would have registered high percentages, the reverse being true of late varieties. (These percentages are denoted as "ripeness indices" in the following sections).

To determine whether regression coefficient could be related to the earliness or lateness of varieties, correlation coefficient was worked out for regression coefficients and the corresponding ripeness indices. The correletion coefficient came to the low value of ·17 which was not significant.

Examining the pairs of data, it was observed that two groups were distinguishable, the first one consisting of regression coefficients ranging from about 1·0 to 1·5 and the other one of coefficients below 1·0 and above 1·5. Correlation coefficients were worked out separately for the two groups of data, when a striking increase in the correlation coefficient was noticed, the value for the first group [regression coefficients (1·0—1·5)] being positive, and increasing to ·74 and the value for the second group (below 1·0 and above 1·5) being negative and increasing to ·87 (Data for Co. 1186, 1189 and 1231 were omitted, as they followed an irregular trend). *

* NOTE: Further investigation on the subject made after the preparation of the present paper indicated that the varieties could be devided into two groups, i. e. those having regression coefficients lower then 1·35 or higher then 1·35. This grouping, which was more satisfactory in some respects, also indicated high degrees of correlation between regression co-efficient (Brix-Sucrose) and Ripeness index.

There was also slight overlapping of the two groups at the dividing line. The relevant statistical data are given below:

| Group | No. of pairs of values | Correlation co-efficient | Standard error | 't' value (calculated) | 't' value for 1% level of significance | Regression equation |
|---|---|---|---|---|---|---|
| I Below 1·35 Reg. coefficient | 13 | —·84 | ·16 | 5·16 | 3·0 | Y=138·2—50·1X |
| II Above 1·35 reg. cofficient | 8 | —·76 | ·265 | 2·87 | 3·5 | Y=165·9—54·3X |

(X=Regression coefficient for Brix-Sucrose regression)
(Y=Ripeness index)

For more accurate prediction of the Ripeness index (Y) the use of the subtraction factor ($X_2$) from the Brix-Sucrose Regression equation along with the relevant regresssion coefficient ($X_1$) in the following multiple regression equations, will be advantageous.

| Group | Multiple regression Equations |
|---|---|
| I Below 1·35 regression coefficient | $Y=148{\cdot}0-65{\cdot}2\ X_1+1{\cdot}14\ X_2$ |
| II Above 1·35 regression coefficient | $Y=169{\cdot}2-58{\cdot}0\ X_1+{\cdot}131\ X_2$ |

The points denoting regression coefficient - Ripeness index were plotted (Fig. 4). The regression equations for the two groups of data were calculated and the two regression lines drawn. It was observed that the negative correlation line took off from the 100% Ripeness index line at ·79 regression coefficient. This probably is the lower limit for the coefficient. From this point the indices decreased gradually with increase in the coefficient till about 1·1 for the coefficient, when there was a sharp decline from about 90% to about 70%. From this point onwards, the relationship was reversed, and increases in coefficient were accompanied by increases in the index, till about 1·5 for coefficient was reached. Here the corresponding index was again about 90% and there was a sudden drop to about 80%. At this point also the relationship was reversed and thereafter it followed the negative correlation which held good for values of coefficients less than about 1·1. It was noteworthy that the regression at this end of the graph was identical with that at the other end, and also that sudden drops occurred at 2 points at almost the same value for index (about 90).

Expressing the results in terms of earliness or lateness, at the initial stages (about ·8 to 1·1 regression coefficient) increase in coefficient results in a transition from extreme earliness to one represented by about 90% (Fig. 4). At this point, there is a reversal of relationship and the graph starts once more at a point represented by about 70%. which indicates pronounced lateness. From now on an increase of coefficient results in the graph passing through mid-varieties and reaching early varieties once more at about 90% index. Here also there is an abrupt reversal of relationship, and, in the changed relationship, the point represents conditions of mid-varieties, and further increase in the coefficient is accompanied by further change of the varieties to late ones. Certain slight overlappings of the negative and positive correlations were observed near the two points where they met.

*Procedure for Determining Earliness or Lateness of Varieties:* The cane varieties are to be grown under normal cultural and manurial schedules, and at about the 6th or 7th month a fairly large number of canes (about 60) are crushed individually, and the number of samples reduced to half by determining the refractometer Brix of all the samples, arranging them in the order of their Brix, with the maximum possible range of values, and mixing every two samples having successive values for Brix. The Hydrometer Brix and Sucrose are determined as usual.

Regression coefficient and regression equation are arrived at by statistically working out Brix-Sucrose correlation. Earliness or lateness of varieties is determined following the graph discussed in detail in the previous section (Fig. 4).

For rapid determination, and in cases where only a few canes of a particular variety are available, the Brix-Sucrose of a few points (say 6) are plotted, covering as wide a range as possible, and a representative straight line graph drawn through them. The tangent of the angle subtended by this graph to the horizontal is determined. This is equal to the regression coefficient. Further details are the same as for the detailed method. In the rapid method, the Brix-Sucrose regression equation can readily be built up by calculating the appropriate subtraction factor for the regression coefficient in question, applying the relevant regression equation for Regression coefficient — subtraction factor. (Table 4, Serial No. 3).

The earliness or lateness of the varieties studied was determined from the two regression lines (Fig. 5) and compared with those given by Sugarcane Breeding Institute, Coimbatore when the varieties were released. The conclusions drawn from the regression lines were found to agree well with those given by Sugarcane Breeding Institute, as can be seen from Table 1 (a).

**Summary and Conclusions:** A detailed study of Brix sucrose relationship was made in respect of 24 varieties recently released from Sugarcane Breeding Institute, Coimbatore. The effect of position of canes in field on the relationship was also studied. Data were statistically analysed for correlation and the relationship between angle of slope of regression line, regression co-efficient and subtraction factor was established. Relationship between earliness or lateness of varieties and regression coefficients was assessed and expressed quantitatively.

The position of canes in a particular plot was not observed to have a marked influence on the Brix-sucrose regression.

From a study of the 23 varieties the striking absoluteness of the Brix-Sucrose relationship was borne out clearly. The relationship was specific to each variety, so that, once the regression had been derived for a variety, it was unnecessary that Sucrose be determined, along with Brix, as the former is almost absolutely correlated with the latter. Moreover, for the same variety the relationship was

exactly the same for low as well as high values of Brix and Sucrose, so that the Brix-Sucrose relationship at later stages could be accurately predicted from a study of the same at the early stages of cane-growth.

In the regression equation for Brix-Sucrose regression, the subtraction factor was highly correlated with the regression coefficient and there was a slight curvilinearity also in the relationship. The existence of a relationship between regression coefficient and subtraction factor results in the singular behaviour of varieties with low rates of sugar increase for unit Brix increase (regression coefficient) to have a low value for the minimum Brix at which sucrose formation starts, and for this minimum Brix to increase progressively with the regression coefficient. In other words, lines taking off farther away from O on X - axis are steeper. The relationship also makes it possible for building up any regression equation from the regression coefficient without the usual statistical calculations, as the other component of the equation, the subtraction factor, can be readily calculated from the regression coefficient.

Mathematical proof has been offered for proving that the regression coefficient is numerically equal to the tangent of the angle subtended by the regression line to the horizontal.

It was observed that the regression coefficient was related to the earliness or lateness of varieties. The relationship was peculiar in that there were positive and negative correlations over different ranges. The course followed by the regression coefficient-ripeness index relationship has been traced in detail.

A method for the determination of the degree of earliness or lateness of varieties mid-way during the growth of cane has been outlined.

**Utility of Findings:** The experimental findings provide a rapid method for determining the degree of earliness or lateness of varieties. A rapid method has also been devised for determining the regression coefficient and for constructing the regression equation. By developing this method, and perfecting it, there is scope for effecting economics in the time and money spent on field experiments for determining the earliness or lateness of cane varieties.

A knowledge of the earliness or lateness of varieties will result in considerable additional income for factories by the preservation of sugar losses due to the crushing of immature or over-ripe, and hence, deteriorating canes. By crushing canes at the optimum ripe period high quality jaggery can be manufactured and losses resulting from bad quality induced by preparation from under-or over-ripe cane can effectively be avoided.

As the regression coefficient appears to be a specific varietal characteristic, it may be possible to breed canes of the required regression coefficients for Brix-Sucrose relationship, and also to produce early, mid or late varieties, by choosing the parents with the required regression coefficients.

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TABLE 1

*Brix & Sucrose Data for Co. 527: Study of Correlation Variation in the Same Field*

| First Row. | | | | | | Second Row. | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Clump No. | Brix % | Sucrose % | Clump No. | Brix % | Sucrose % | Clump No. | Brix % | Sucrose % | Clump No. | Brix % | Sucrose % |
| 1. | 15·8 | 12 9 | 11. | 17·7 | 14·8 | 1. | 18·5 | 16·1 | 11. | 16·5 | 14·0 |
| 2. | 16·3 | 13·1 | 12. | 18·0 | 15·6 | 2. | 18·6 | 16·8 | 12. | 16·4 | 14·2 |
| 3. | 15·4 | 11·0 | 13. | 17·1 | 15·0 | 3. | 18·5 | 16·0 | 13. | 11·1 | 7·4 |
| 4. | 11·9 | 8·2 | 14. | 17·7 | 15·3 | 4. | 17·2 | 15·0 | 14. | 11·1 | 7·4 |
| 5. | 10·8 | 6·8 | 15. | 15·7 | 12·5 | 5. | 17·9 | 15·4 | 15. | 15·8 | 13·3 |
| 6. | 13·1 | 9·3 | 16. | 16·9 | 14·6 | 6. | 17·8 | 15·6 | 16. | 15·6 | 12·1 |
| 7. | 14·1 | 10·7 | 17. | 12·4 | 9 0 | 7. | 17·1 | 14·8 | | .. | .. |
| 8. | 17·3 | 15·2 | 18. | 13·9 | 10·3 | 8. | 16·9 | 14·5 | | .. | .. |
| 9. | 15·8 | 12·6 | 19. | 9·6 | 5·8 | 9. | 16·1 | 13·3 | | .. | .. |
| 10. | 19·2 | 16 2 | 20. | 14·1 | 11·1 | 10. | 15·1 | 12·2 | | .. | .. |
| | .. | .. | 21. | 14·7 | 12·0 | | .. | .. | | .. | .. |

TABLE 1-A

*Comparison of Earliness or Lateness of Varieties Determined by Regression, and as given by Sugarcane Breeding Institute, Coimbatore.*

| S. No. | Variety No. | Earliness or lateness from regression lines. (1) | Earliness or lateness from Sugarcane Br. Inst. information (2) | Agreement of (1) & (2) | S. No. | Variety No. | Earliness or lateness from regression lines. (1) | Earliness or lateness from S. B. I. information (2) | Agreement of (1) & (2) |
|---|---|---|---|---|---|---|---|---|---|
| 1. | 1172 | Late-mid | Mid | V. Fair | 10. | 1206 | Late | Mid | Poor |
| 2. | 1176 | Mid | Mid | Good | 11. | 1213 | Late-mid | Late | V. Fair |
| 3. | 1178 | Late | Early | Poor | 12. | 1217 | Late | Mid | Fair |
| 4. | 1179 | Late | Late | Good | 13. | 1215 | Late | Late | Good |
| 5. | 1187 | Late-mid | Mid | Fair | 14. | 1216 | Mid | Mid | Good |
| 6. | 1200 | Mid | Mid | Good | 15. | 1217 | Late | Late | Good |
| 7. | 1202 | Mid-Early | Mid | V. Fair | 16. | 1218 | Early | Late | Poor |
| 8. | 1204 | Mid | Mid | Good | 17. | 1228 | Late | Late | Good |
| 9. | 1205 | Late | Mid | Fair | 18. | 1230 | Late-mid | Early | Poor |

Classification: Ripeness index: (1) 70—80: Late: (2) 80—90: Mid; & (3) 90—100. Early.

TABLE 2

*Brix Sucrose Data for Sugarcane Varieties Studied*

| S. No. | Variety No. (Co.) | Group 1 | | Group 2 | | Group 3 | | Group 4 | | Group 5 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Brix | Sucrose | Brix | Sucrose | Brix | Sucrose | Brix | Sucrose | Brix | Sucrose |
| 1. | 1172 | 16·04 | 12·65 | 17·19 | 14·68 | 18·86 | 15·95 | 19·06 | 17·00 | 19·68 | 17·48 |
| 2. | 1176 | 14·68 | 11·62 | 17·26 | 13·92 | 18·06 | 15·70 | 19·09 | 17·17 | 20·09 | 18·46 |
| 3. | 1178 | 16 63 | 12·13 | 16·91 | 12·72 | 17·68 | 14·20 | 18·64 | 15·82 | 19·38 | 16·30 |
| 4. | 1179 | 16·42 | 11·76 | 16·51 | 11·45 | 17·82 | 13·67 | 18·00 | 14·08 | 19·21 | 15·85 |
| 5. | 1186 | 14·82 | 11·58 | 15·26 | 11·63 | 17·26 | 14·91 | 17·81 | 15·90 | 19·26 | 16·58 |
| 6. | 1187 | 17·30 | 13·92 | 18·31 | 16·22 | 18·51 | 16·95 | 19·78 | 18·03 | 21·43 | 20·52 |
| 7. | 1189 | 11·98 | 6 74 | 12·48 | 7·62 | 15·43 | 11·75 | 16·94 | 13·52 | 18·40 | 12·16 |
| 8. | 1194 | 14·88 | 10·67 | 14·58 | 10·38 | 15·08 | 9·81 | 15·88 | 11·68 | 16·18 | 11·80 |
| 9. | 1200 | 15·14 | 11·85 | 18·11 | 14 69 | 19·84 | 17·48 | 20·52 | 18·20 | 20·87 | 18·59 |
| 10. | 1202 | 15·24 | 10·47 | 15·15 | 10·26 | 15·94 | 12·04 | 18·53 | 16·10 | 19·59 | 16·76 |
| 11. | 1204 | 13·96 | 9·60 | 15·06 | 12·09 | 16·74 | 14·45 | 17·84 | 15·80 | 18·78 | 16·28 |
| 12. | 1305 | 15·38 | 11·39 | 16·98 | 12·70 | 17·88 | 13·97 | 18·88 | 15·29 | 19·46 | 16·29 |
| 13. | 1206 | 17·83 | 13·89 | 18·46 | 15·30 | 20·24 | 17·76 | 20·36 | 18·20 | 20·80 | 18·85 |
| 14. | 1213 | 13·44 | 8·44 | 15·01 | 10 62 | 18·71 | 15·57 | ... | ... | ... | ... |
| 15. | 1214 | 13·78 | 8·70 | 16·28 | 12·35 | 17·08 | 13·70 | 18·29 | 15·60 | 19·04 | 16·81 |
| 16. | 1215 | 13·54 | 10·10 | 14·04 | 11·00 | 16·64 | 14·00 | 18·62 | 16·36 | 20·42 | 18·39 |
| 17. | 1216 | 15·64 | 12·70 | 16·83 | 14·21 | 17·29 | 15·03 | 19·82 | 18·08 | 20·03 | 18·78 |
| 18. | 1217 | 13·03 | 9·69 | 13·62 | 9·87 | 14·84 | 11·42 | 18·75 | 16·24 | 19·36 | 17·49 |
| 19. | 1218 | 9·84 | 3·55 | 9·90 | 3·80 | 13·24 | 6·22 | 13·98 | 9·87 | 15·14 | 8·38 |
| 20. | 1225 | 13·43 | 8·01 | 13·66 | 8·20 | 14·82 | 10·38 | 15·10 | 10·08 | 16·07 | 12·14 |
| 21. | 1228 | 13·30 | 8·15 | 14·00 | 8·71 | 16·78 | 11·87 | 18·06 | 12·57 | 19·98 | 14·68 |
| 22. | 1229 | 18·84 | 15·09 | 19·04 | 16·16 | 20·80 | 17·92 | ... | ... | ... | ... |
| 23. | 1230 | 15·97 | 10·61 | 16·07 | 11·05 | 16·77 | 10·99 | 17·66 | 12·68 | 18·80 | 14·39 |
| 24. | 1231 | 15·36 | 10·88 | 15·37 | 11·15 | 16·66 | 13·56 | 17 45 | 14·38 | 18·56 | 16·37 |

TABLE 3

*Percentage of Refractometer Brix on 9—12—'57 to 9—3—'58*

*Ripeness index*

*(Y=2/3 x + 4·9, where X & Y are refractometer and Hydrometer Brix respectively)*

| S. No. | Variety No. (Co.) | Refractometer Brix on 9-12-'57 (A) | Hydrometer Brix on 9-3-'58 | Hyd. Brix on 9-3-'58 converted into Ref. Brix (B) | Percentage of A on B | S. No. | Variety No. (Co.) | Refractometer Brix on 9-12-'57 (A) | Hydrometer Brix on 9-3-'58 | Hyd. Brix on 9-3-'58 converted into Ref. Brix (B) | Percentage of A on B |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 1 | 2 | 3 | 4 | 5 | 6 |
| 1. | 1172 | 13·8 | 18·2 | 20·0 | 69 | 13. | 1206 | 17·2 | 19·9 | 22·5 | 76 |
| 2. | 1176 | 15·6 | 18·6 | 20·6 | 76 | 14. | 1213 | 18·6 | 18·7 | 20·7 | 90 |
| 3. | 1178 | 13·2 | 18·1 | 19·1 | 67 | 15. | 1214 | 15·2 | 17·9 | 19·5 | 78 |
| 4. | 1179 | 16·0 | 17 6 | 19·1 | 34 | 16. | 1215 | 13·4 | 18·1 | 19·8 | 68 |
| 5. | 1186 | 18·2 | 17·6 | 19·1 | 95 | 17. | 1216 | 16·0 | 19·8 | 22·4 | 72 |
| 6. | 1187 | 15·8 | 18 8 | 20 9 | 76 | 18. | 1217 | 16·4 | 19·1 | 21·3 | 77 |
| 7. | 1189 | 13·0 | 17·2 | 18·7 | 70 | 19. | 1218 | 13·0 | 11·3 | 9·6 | 100* |
| 8. | 1194 | 15·6 | 15·8 | 16·4 | 95 | 20. | 1225 | 14·6 | 14·8 | 14·9 | 98 |
| 9. | 1200 | 17·8 | 17·9 | 19·5 | 91 | 21. | 1226 | 14·8 | 18·2 | 20·0 | 74 |
| 10. | 1022 | 18·6 | 18·9 | 21·0 | 89 | 22. | 1229 | 16·4 | 19·0 | 21·2 | 78 |
| 11. | 1204 | 17·6 | 16·8 | 17·9 | 98 | 23. | 1230 | 13·6 | 16·8 | 17·9 | 76 |
| 12. | 1205 | 16·0 | 18·0 | 19·7 | 81 | 24. | 1231 | 17·0 | 16·5 | 17·4 | 98 |

N. B. * Assumed.

TABLE 4

*Statistical Data for Correlations*

| S. No. | Correlation of | No. of Data | Correlation coefficient | Standard error | t | t for ·1% level of significance | Regression coefficient | Regression Equation | Values for X & Y in regression equation |
|---|---|---|---|---|---|---|---|---|---|
| 1. | (a) Brix & Sucrose 'A' position in field | | | | | | | | |
| | Block 1 | 21 | ·992 | ·029 | 33·8 | 3·9 | 1·18 | Y=1·18X—5 8 | X=Brix & Y=Sucrose |
| | Block 2 | 16 | ·994 | ·029 | 34·8 | 4·1 | 1·21 | Y=1·21X—6·1 | ,, |
| 2. | —Do— 'B' position | | | | | | | | |
| | Block 1 | 19 | ·995 | ·026 | 38·8 | 3·9 | 1·19 | Y=1·19X—5·7 | ,, |
| | Block 2 | 19 | ·990 | ·035 | 28·3 | 4·0 | 1·18 | Y=1·18X—5·9 | ,, |

TABLE 4 *(Contd.)*

| S. No. | Correlation of | No. of data | Correlation coefficient | Standard error | t | t for ·1% level of significance | Regression coefficient | Regression Equation | Values for X & Y in regression equation |
|---|---|---|---|---|---|---|---|---|---|
| 3. | Regression coefficient & subtraction factor | | | | | | | | X & Y are regression coefficient & subtraction factor for Brix-Sucrose reg equation |
| | (1) (a) Linear | 23 | ·95 | ·068 | 14·0 | 3·8 | 15·3 | Y=15·3X—11·1 | |
| | (b) Curvilinear | | | | | | | Y=9·29—17·54X +12·18X² | |
| | (2) (a) Top group | 6 | ·992 | ·062 | 16·2 | 6·9 | 13·9 | Y=13 9X— 7·8 | ,, |
| | (b) Middle group | 9 | ·997 | ·031 | 31·7 | 5·0 | 15·3 | Y=15·3X—11·0 | ,, |
| | (c) Bottom group | 8 | ·992 | ·053 | 18·7 | 5·4 | 16·0 | Y=16·0X—13·0 | ,, |
| 4. | Regression coefficient and Ripeness factor | | | | | | | | |
| | (1) All values | 20 | —·17 | ·23 | .. | .. | .. | .. | .. |
| | (2) Mid. values | 12 | +·74 | ·22 | 3·42 | *3·1 | 57·5 | Y=57·5X+3·5 | X=Reg. coefficient |
| | (3) Lower and extremes | 8 | —·88 | ·19 | 4·53 | *3·5 | —37·8 | Y=125—37 8X | Y=Ripeness factor |

* For significance at 1%

TABLE 5

*Statistical Data for Brix-Sucrose Correlations in Sugarcane Varieties Studied.*

| S. No. | Variety No. Co. | No. of Data | Correlation coefficient | Standard error | t | t for ·1% level of significance | Regression coefficient | Regression Equation (X : Brix ; Y=Sucrose, Numeral=Subtraction Factor. ) |
|---|---|---|---|---|---|---|---|---|
| 1. | 1172 | 5 | ·985 | ·098 | 10·1 | 8·6 | 1·24 | Y=1·24 X — 7·0 |
| 2. | 1176 | 5 | ·987 | ·093 | 10·6 | ,, | 1·31 | Y=1·31 X — 8·0 |
| 3. | 1178 | 5 | ·965 | ·151 | 6·4 | *4·6 | 1·49 | Y=1 49 X — 13·0 |
| 4. | 1179 | 5 | ·996 | ·054 | 18·5 | 8·6 | 1·54 | Y=1 54 X — 13·8 |
| 5. | 1186 | 5 | ·976 | ·125 | 7·8 | ,, | 1·25 | Y=1·25 X — 7 1 |
| 6. | 1187 | 5 | ·979 | ·119 | 8·2 | ,, | 1·50 | Y=1·50 X — 11·4 |
| 7. | 1189 | 4 | ·998 | ·040 | 25·0 | 12·9 | 1·40 | Y=1·40 X — 13 0 |
| 8. | 1194 | 4 | ·995 | ·072 | 13·7 | ,, | 0·91 | Y= ·91 X — 2·9 |
| 9. | 1200 | 5 | ·919 | ·228 | 4·0 | *4·6 | 1·10 | Y=1·10 X — 4·6 |
| 10. | 1202 | 5 | ·991 | ·079 | 12·5 | 8·6 | 1·51 | Y=1·51 X — 12·4 |
| 11. | 1204 | 5 | ·979 | ·119 | 8·2 | ,, | 1·42 | Y=1 42 X — 9·8 |
| 12. | 1205 | 5 | ·989 | ·086 | 11·5 | ,, | 1·17 | Y=1·17 X — 6·9 |
| 13. | 1206 | 5 | ·998 | ·033 | 30·6 | ,, | 1·62 | Y=1·62 X — 14·7 |
| 14. | 1213 | 3 | ·996 | ·086 | 11·6 | *9 9 | 1·35 | Y=1 35 X — 11·6 |
| 15. | 1214 | 5 | ·999 | ·017 | 57·7 | 8·6 | 1·55 | Y=1 55 X — 12·2 |
| 16. | 1215 | 5 | ·999 | ·022 | 46·3 | ,, | 1 19 | Y=1·19 X — 5 7 |
| 17. | 1216 | 5 | ·997 | ·041 | 24·2 | ,, | 1·35 | Y=1·35 X — 8·3 |
| 18. | 1217 | 5 | ·997 | ·046 | 21·6 | ,, | 1·22 | Y=1·22 X — 6 6 |
| 19. | 1218 | 4 | ·994 | ·076 | 13·2 | 12·9 | 0 87 | Y=0·87 X — 4·9 |
| 20. | 1225 | 5 | ·985 | ·102 | 9 7 | 8·6 | 1·53 | Y=1·53 X — 12 5 |
| 21. | 1228 | 5 | ·989 | ·087 | 11·3 | ,, | 1·08 | Y=1·08 X — 6 3 |
| 22. | 1230 | 5 | ·971 | ·139 | 7·0 | ,, | 1·30 | Y=1·30 X — 10·3 |
| 23. | 1231 | 5 | ·995 | ·060 | 16·5 | ,, | 1·63 | Y=1·63 X — 13·9 |

* For significance at 1· % level.