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Correlation and path coefficient analysis of cane yield and Bio-chemical and its components in sugarcane varieties (*Saccharum officinarum* L.) under three agro-climatic zones of Chhattisgarh

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Abstract

The present investigation was conducted with a view to determine association between yield and yield contributing traits and thereby to assess the direct and indirect effects of yield components on cane yield. Correlation and path coefficient analysis was undertaken among agronomic and bio-chemical characters of importance in sugarcane. Correlation between agronomic characters revealed positive and significant (P = 0.01) correlation between cane yield (t/ha) with germination % at 45 DAS, number of tillers at 120 DAS, CCS t/ha, node length, cane height, number of millable canes at 360 DAS, single cane weight, cane yield (t/ha) and germination % at 30 DAS while cane yield (t/ha) revealed positive but nonsignificant with cane diameter.

There was a significant and positive correlation among biochemical characters, CCS% exhibited significant and positive correlation with Sucrose %, Pol % , Brix %, Purity % , fibre % on the other hand it showed negative and significant correlation at (P = 0.05) for juice % (-0.250*). Correlation studies indicate that germination % at 45 DAS, number of tillers at 120 DAS and node length are the most important characters for sugarcane yield t/ha. It also revealed that cane height, number of shoots at 240 DAS, single cane weight and germination % at 30 DAS had directly affected cane yield t/ha. However, for biochemical characters, Juice %, Brix %, Pol %, Sucrose %, Purity % and Fibre % was positively and significant correlated at (P=0.01) to CCS %. Path coefficient analysis in the case of agronomic characters revealed that the CCS t/ha, germination % at 30 DAS and number of millable cane at harvest, cane height, number of tillers at 120 DAS were the important characters. It also showed highest indirect effect by node length, germination % at 45 DAS, cane diameter and single cane weight on sugarcane yield.

In bio-chemical characters highest direct effect on CCS% was from sucrose percent followed by Pol percent, purity and fibre percent. Therefore, selection for higher yield in sugarcane can be on the basis of these positively correlated traits with higher direct effect. Those characters which are showing little direct effects but significantly correlated with yield should be selected via other positive significant traits showing higher indirect effect. In nutshell correlation and path coefficient analysis in present study suggests that clones or varieties with high germination %, number of tillers, node length, cane height and other agronomic characters should be used in hybridization programme.

Keywords: Correlation coefficient, path coefficient, CCS t/ha, cane yield, Single cane weight, node length, brix %, Sucrose %, Pol %, Purity %, Juice %, and CCS%

1. Introduction

Sugarcane (*Saccharum spp.*) is an important agro-industrial commercial crop of India which plays a vital role because of its wider adaptability over varying agro climatic conditions and also unique among agricultural crop in the sense that a number of succeeding cane crops are raised from a single planting which is an integral component of sugarcane production system. A number of improved sugarcane cultivars are now available, but many farmers of the state still continue to grow old varieties like CoS 8436 (Rasgulla) and Co 8014 (Mahalaxmi). The productivity and quality of the sugarcane can be substantially enhanced by the adoption of high yielding cultivars. The ultimate goal of any breeding program is the development of improved varieties over the existing commercial varieties. Therefore, it is important to choose superior parents for making crosses and produces high yielding improved cultivars which are associated with improved quality parameters.

In sugarcane, agronomic characters are quantitatively inherited and are highly influenced by the environment. Correlation coefficient analysis can provide direction to breeder for selecting best parents.

However, correlation coefficient, sometimes, may be misleading and thus, need to be portioned into direct and indirect effects. Hence it is important for breeder to know how other characters influence a particular character before selecting the parental material. A path coefficient analysis can successfully be used to partition correlation coefficient into direct and indirect effects. The path coefficient method (Wright 1921, 1923, 1934) [18, 19, 20] provides a simple and flexible method of handling a wide variety of inbreeding problems. It has since emerged as a general statistical method for cause and effect analysis in a system of correlated variables. The direct effect of a character on yield and indirect contribution through other characters can be calculated using path coefficient analysis. A path coefficient is simply a standardized partial regression coefficient. On the basis of direct and indirect effects of independent characters on the dependent character, a plant breeder can apply an appropriate selection method so as to take care of the direct and indirect effects and reach a compromise wherever required. Thus, present study would not only help in the identification of high yielding stable varieties but also for quality canes which will be preferred by the farmers of different sugarcane growing areas of Chhattisgarh state.

2. Materials and Method

The experimental material consisted of 24 diverse origin varieties of sugarcane brought from Central Sugarcane Research Station, Padegaon, District Satara, (Maharashtra), Vasant Dada Sugarcane Institute, Pune (Maharashtra) and Zonal Agriculture Research Station, Pawarkheda, District Hoshangabad, (Madhya Pradesh) which is maintained at Sant Kabir College of Agriculture and Research Station, Kawardha District Kabirdham, under Central Zone.
The details of the sugarcane varieties distributed to rest of the two centre Raj Mohini College of Agriculture and Research Station, Azirima, Ambikapur, (Northern Hills) and Shheed Gundardhar College of Agriculture and Research Station, Kumharawand, Jagdalpur,(Bastar Plateau) with their mean data of agronomic characters was given in Table 7.
Experiment was conducted in Randomized Block Design (RBD) with two replications. The 200 single eye bud of each variety were raised in poly bags at nursery. The gross plot size for each variety was consisted of 6 rows each of six meter length with row to row spacing of 120 cm and plant to plant distance is 60 cm a part. In each plot 66 poly bag plantlets were transplanted to main field. The net plot was consisted of middle 4 rows with a row to row spacing of 120 cm that is 4.8m with each of 4.8 meter length with 23.04 m^2 each net plot area. The data were analyzed by software OPSTAT from CCS Haryana Agriculture University, Hisar.

3. Characters studied and observation procedure

The trial was harvested in January 2019 when the age of the crop was 12 months. Data were recorded on the following characters **–**

3.1 Agronomic characters

The entire crop period in sugarcane can be conveniently partitioned into germination phase, tillering phase, grand growth phase and maturity phase. The germination phase starts from planting up to 45 days followed immediately by tillering phase from 45 to 120 days. Grand growth phase commences from 120 days and continues up to 270 days and soon after the maturity phase begins and proceeds up to harvest (360 to 400 days).
Data on important characters under study were recorded for different crop growth phases as detailed below.

3.1.1 Germination °/o at 30 and 45 days

Number of germinated eye buds per poly bags was recorded at 30 and 45 days after planting, total number of visible germinates in poly bags of each variety were counted and the cumulative total for each variety was used to compute germination percentage considering 200 number of poly bags raised for each variety. In each plot total 66 poly bags were transplanted in main plots after 35 to 40 days of nursery raised. The number of poly bags established in main plot was counted to determine the field establishment of the plantlets and mortality in each plot is calculated.

3.1.2 Tillers at 120 days ('000/ha)

Total number of tillers was counted in each gross plot of each replication at 120 days of crop stage. Number of tillers per plot was converted to tillers per hectare using net plot size.

3.1.3 Shoots at 240 days ('000/ha)

Total cane forming shoots were counted in each net plot of each replication at 240 days of crop stage. Number of shoots per plot was converted to shoots per hectare using net plot size.

3.1.4 Stalk height at 360 days (cm)

The stalk length was measured in centimeters by cutting the stalks of five randomly selected canes from ground level in net area of each genotype in each replication and removing the top portion (i.e. millable stalk/cane length).

3.1.5 Stalk diameter at 360 days (cm)

The stalk diameter was measured from three spots i.e. bottom, middle and top portion of cane at harvest from tagged plants. The diameter measured at three spots was averaged out and recorded as diameter of cane in cm.

3.1.6 Internodes /stalk at 360 days

The number of internodes was counted from five previously selected canes from bottom, middle and top at harvest and the average was worked out to report as internodes per stalk.

3.1.7 Stalk weight at 360 days (kg)

Five canes tagged randomly in each net plot and each replication, were used for taking observations of single cane weight, stalk length, stalk diameter and internodes per stalk**.** The single cane weight was measured in kg of previously selected five plants and average of this was recorded as single cane weight.

3.1.8 Number of millable canes/ha (NMC) at 360 days (‘000/ha)

The count for number of millable canes was done at harvest from net plot. The data of net plot were converted to hectare basis.

3.1.9 Cane yield at harvest (t/ha)

The net plot was harvested separately after removing border lines. The canes were detrashed and millable canes were prepared by cutting top portion. The weight of these millable canes adding weight of sample canes for each experimental plot was recorded in kilogram and then it was converted into tonnes per hectare by multiplying it with conversion factor.

3.1.10 Commercial Cane Sugar (CCS) at harvest (t/ha)
The Commercial Cane Sugar (CCS) at harvest was calculated by multiplication of Cane yield at harvest (t/ha) with CCS% expressed in percent as under

$$\text{CCS (t/ha)} = \frac{\text{Cane yield (t/ha) x CCS\%}}{100}$$

3.2 Bio-chemical characters
Sampling canes for quality analysis
For study of juice quality parameters two canes were randomly harvested from each plot and each replication at 360 DAS, tagged cane plants were cut into small pieces of 45 to 50 cm, weighed and juice was extracted by crushing in the mechanical crusher. The juice was collected in a previously weighed bucket containing 0.5 g HgC12 as preservative. The juice thus extracted was used for further analysis of juice quality parameters.

3.2.1 Juice Brix% at 360 days
The Juice sample collected earlier was mixed thoroughly and passed through 150 mesh sieve in order to remove suspended particles. The sieved cane juice was filled in 1000 ml measuring cylinder. The brix hydrometer was then gradually lowered in it and allowed to float. The observation was recorded when the brix hydrometer became steady. Care was taken that the brix hydrometer remained vertical without touching the sides of the cylinder.
The temperature of juice was noted and the recorded reading was corrected at 20 °C temperature using standard conversion table (George, 1963).

3.2.2 Sucrose% Juice at 360 days
Juice sample of 100 ml from each treatment was taken and transferred in 250 ml measuring flask. Horne's lead sub acetate was added for good clarification. The mixture was shaken and the mixed solution was filtered through aflutted filter paper. The filterate was collected in a clean dry 100 ml beaker. The clear filterate was taken in a 200 mm calibrated pol percent tube for polarimeter observation.
The polariscopic reading was noted. The sucrose (pol) percentage was obtained from polariscope, reading (George, 1963).

$$\text{Sucrose\% Juice} = \frac{\text{Purity\% x Brix\%}}{100}$$

3.2.3 Juice Purity% at 360 days
The percent purity coefficient was computed by following equation.

$$\text{Purity coefficient (\%)} = \frac{\text{Sucrose (\%) juice}}{\text{Corrected brix}} \text{ x100}$$

3.2.4 CCS % at 360 days
The character commercial cane sugar percent (CCS %) was calculated as below:

CCS% = [Sucrose % in Juice X 1.022 – Juice Brix X 0.292]

3.2.5 Fibre% Cane at 360 days
For working out fibre% cane, 250g of small pieces of bottom, middle and top portion of cane were filled in rapipol containing 1000 ml of water. Rapipol was adjusted for 15 minutes. After each 15 minutes rapipol was automatically stopped and cane fibre pieces mixed with water. The mixture was filtered through muslin cloth. The fibres were dried at 110°c to constant weight and fibre % was calculated by using the formula described as below.

$$\text{Fibre \% cane} = \frac{\text{Dry Weight x 100}}{\text{Fresh weight}}$$

3.2.6 Pol % cane at 360 days
It is obtained from Pol % juice and Fibre % cane using the formulae-

$$\text{Pol \% cane} = \frac{\text{Sugar \% Juice x [100 – (10 + Fibre \% cane)]}}{100}$$

4. Association analysis
4.1 Correlation coefficients analysis
Correlation coefficients analysis measures the mutual relationship between various characters at genotypic (g), phenotypic (p) and environmental levels with the help of formula suggested by Miller *et al.* (1958)".

4.2 Path analysis
The concept of path coefficient analysis was originally developed by Wright (1921) [18], but the technique was first used for plant selection by Dewy and Lu (1959). According to which path analysis deals the indirect and direct contribution of the independent variable or attribute on the dependent variable or attribute. While reviewing the path coefficient values are re-casted following the scale of Lenka and Mishra, 1973 (0.00 to 0.09 = negligible, 0.10 to 0.19 = low, 0.20 to 0.29 = moderate, 0.30 to 0.99 = high, >1.00 = very high) where ever possible. As it is more precise and accurate to estimate path coefficients based on genotypic correlation, mostly the genotypic path coefficient analysis have been discussed depending upon availability of information.

5. Results and Discussion
5.1 Correlation – agronomic characters
Correlation coefficients between the different pair of agronomic characters were calculated to find the relationship among the various characters studied. The values of correlation coefficient are presented in Table 1.
It can be revealed from Table 1 that cane yield (t/ha) had a strong positive and significant correlation with germination % at 45 DAS, number of tillers at 120 DAS, CCS t/ha, node length, cane height, number of millable canes at 360 DAS, cane yield (t/ha) and single cane weight, and germination % at 30 DAS, at (P = 0.01). Highly positive and significant correlation at (P=0.01) was found between cane yield (t/ha) and germination % at 45 DAS, number of millable canes at 360 DAS and number of tillers at 120 DAS, single cane weight and cane diameter, germination at 45 DAS and number of tillers at 120 DAS, cane yield (t/ha) and number of tillers at 120 DAS, germination % at 45 DAS and CCS t/ha and germination % at 45 DAS and germination % at 30 DAS.
Positive and significant correlation was also found between cane yield (t/ha) and node length, CCS t/ha and node length,

cane yield (t/ha) and cane height and CCS t/ha and single cane weight. On the other hand negative and significant correlation was observed between number of millable canes at 360 DAS and cane diameter, number of tillers at 120 DAS and cane diameter while negative and significant correlation at was observed between node length and cane diameter.

5.2 Correlation – biochemical characters

Correlation coefficients between the different biochemical characters were calculated to find the relationship among them. The values of correlation coefficients are presented in Table 4.

It can be revealed from Table 4 that CCS% had a highly positive and significant correlation at (P=0.01) was found with sucrose %, Pol %, brix %, purity % and fibre %. Similarly, highly positive and significant correlation at (P=0.01) was found between Pol % and brix %, Pol % and sucrose %, sucrose % and brix % and purity % and sucrose %. Highly significant but negative correlation for biochemical characters at (P=0.01) was observed between Juice % and Pol %, Juice % and Brix %. Juice % and sucrose % and CCS % and sucrose % had a significant but negative correlation for biochemical characters at (P=0.05).

5.3 Path coefficient analysis – agronomic characters

The correlations between cane yield (t/ha) on one hand and the various characters on the other have been partitioned into direct and indirect effects as shown in Table 3 and 4. The relative influence of all the agronomic characters on cane yield (t/ha) is shown by the direct-effect component of the partitioned total correlation Although the correlation coefficient was positive between cane yield (t/ha) and eight agronomic characters namely; germination % at 45 DAS, number of tillers at 120 DAS, CCS t/ha, node length, cane height, number of millable canes 000'/ha at harvest, single cane weight and germination % at 30 DAS but their direct effect was negligible on cane yield (t/ha). Thus, indirect effects seem to be the cause of the correlation (Table 1). For cane yield (t/ha) vs CCS t/ha (1.595), germination % at 30 DAS (0.883) and weight of millable canes 000'/ha at harvest (0.144) have highest direct effect while cane yield (t/ha) vs. node length (-0.662), germination % at 45 DAS (-0.595) and cane diameter (-0.307) showed positive significant correlation but have indirect effect as shown in Table-3. Thus, correlation explains a true relationship between these two characters. For instance, the direct effect of weight of CCS t/ha on cane yield (t/ha) (1.594) accounted for total correlation between them.

5.4 Path coefficient analysis – bio-chemical characters

The relative influence of the bio-chemical characters on CCS percent is shown by the direct-effect component of the partitioned total correlation. For present CCS% vs. sucrose percent the correlation coefficient between the two characters is quite close to its direct effect. Thus, this correlation explains a true relationship and a direct selection through this trait will be effective. In the case of CCS% and Pol percent and CCS% and purity percent the correlation is positive but the direct effect is negligible while CCS% and brix percent show positive correlation but its direct effect is negative. However, CCS% and juice percent (-0.250*) have negative and significant correlation at P = 0.05 also have the indirect effects (-0.002) seem to be the cause of correlation. Thus, in the above sucrose percent seems to be the cause of the correlation (Table 6).

The residual estimate being 0.000, the variables sucrose percent, pol percent, purity percent, and fibre percent explained 99.2 percent of the variability in CCS%. Since residual effect accounts for 0.00 percent of the variability it means that most of the factors which influence the dependent character (percent CCS %) has been considered. The current study reported that sucrose percentages were the most reliable characters in selecting for high commercial cane sugar genotypes. Hooda *et al*. (1990) [9] carried out path coefficient analysis on percentage brix, pol, purity and reducing sugars and reported that although correlation were generally high for all traits, direct effects affecting commercial cane sugar was low or negative.

The present study showed that percent juice and fibre is the least important components of CCS%. Similar results were obtained by Kang *et al*. (1989) [10]. Although it is desirable to select directly from important characters, selection is often made of correlated characters on which selection is more economical. For example, during early stages of selection the breeder measures brix with a hand refractor meter in order to select for sugar content. Since brix measures the total soluble solids in the juice and a high proportion of these solids consist of sucrose, the correlation is usually high enough to make brix a very useful correlated character for selection. Singh *et al*. (1994) [15] studied direct and indirect effects of characters affecting cane yield of five sugarcane crosses. Information on six traits which include number of millable stalks, stalk weight, stalk height, stalk diameter, brix percentage and sucrose percentage were collated. Current path coefficient analysis showed that CCS t/ha, germination % 30 DAS followed by number of millable cane had the greatest direct effect on cane yield. The direct effects of stalk height and number of tillers at 120 DAS, on cane yield was generally very low. In bio-chemical path coefficient analysis showed sucrose percent had the greatest direct effect on CCS%.

Table 1: Genotypic Correlations Matrix

	30 Days Ger. %	45 Days Ger. %	Cane Height (cm)	Diameter (cm)	Node Length	Single Cane Weight (kg)	No. of tillers 120 days ('000/ha)	No. of Millable Cane at harvest ('000/ha)	CCS t/ha	Yield t/ ha
30 Days Ger. %										
45 Days Ger. %	0.840^{**}									
Cane Height(cm)	0.278^{*}	0.387^{**}								
Diameter (cm)	0.197^{NS}	0.048^{NS}	-0.205^{NS}							
Node Length	0.450^{**}	0.567^{**}	0.652^{**}	-0.241^{*}						
Single Cane Weight(kg)	0.406^{**}	0.482^{**}	0.394^{**}	0.957^{**}	0.275^{*}					
No. of tillers 120 days ('000/ha)	0.625^{**}	0.906^{**}	0.526^{**}	-0.394^{**}	0.603^{**}	-0.052^{NS}				
No. of Millable Cane at harvest	0.172^{NS}	0.561^{**}	0.371^{**}	-0.626^{**}	0.488^{**}	-0.201^{NS}	1.005^{**}			

('000/ha)										
CCS t/ha	0.324**	0.870**	0.649**	0.166^{NS}	0.766**	0.725**	0.610**	0.524*		
Yield t/ ha	0.560**	1.222**	0.749**	0.110^{NS}	0.776**	0.680**	0.884**	0.700**	0.868**	

Table 2: Path Coefficient (Direct Effects)

30 Days Ger. %	45 Days Ger. %	Cane Height (cm)	Diameter (cm)	Node Length	Single Cane Weight(kg)	No. of tillers 120 days ('000/ha)	No. of Millable Cane at harvest ('000/ha)	CCS t/ha
0.883	-0.595	0.030	-0.307	-0.662	-0.054	0.013	0.144	1.595

Residual are 0.29906

Table 3: Terms on rhs of path equation

Characters	30 Days Ger. %	45 Days Ger. %	Cane Height (cm)	Diameter (cm)	Node Length	Single Cane Weight(kg)	No. of tillers 120 days ('000/ha)	No. of Millable Cane at harvest ('000/ha)	CCS(t/ha)	Yield t/ha
Yield t/ ha Vs 30 Days Ger. %	0.88322	-0.50015	0.00829	-0.06030	-0.29775	-0.02199	0.00783	0.02472	0.51632	0.560
Yield t/ ha Vs 45 Days Ger. %	0.74207	-0.59529	0.01156	-0.01457	-0.37547	-0.02610	0.01134	0.08089	1.38789	1.222
Yield t/ ha Vs Cane Height(cm)	0.24522	-0.23054	0.02986	0.06295	-0.43157	-0.02134	0.00658	0.05348	1.03421	0.749
Yield t/ ha Vs Diameter (cm)	0.17366	-0.02829	-0.00613	-0.30668	0.15917	-0.05176	-0.00493	-0.09014	0.26532	0.110
Yield t/ ha Vs Node Length	0.39736	-0.33772	0.01947	0.07376	-0.66182	-0.01488	0.00754	0.07031	1.22216	0.776
Yield t/ ha Vs Single Cane Weight(kg)	0.35900	-0.28714	0.01178	-0.29340	-0.18208	-0.05410	-0.00065	-0.02895	1.15583	0.680
Yield t/ ha Vs No. of tillers 120 days ('000/ha)	0.55234	-0.53921	0.01570	0.12092	-0.39901	0.00282	0.01251	0.14487	0.97288	0.884
Yield t/ ha Vs No. of Millable Cane at harvest ('000/ha)	0.15153	-0.33415	0.01108	0.19184	-0.32294	0.01087	0.01258	0.14410	0.83552	0.700
Yield t/ ha Vs CCS t/ha	0.28595	-0.51807	0.01937	-0.05102	-0.50720	-0.03921	0.00763	0.07550	1.59474	0.868

Table 4: Genotypic Correlations Matrix

	CCS %	Brix%	Sucrose %	Pol %	Purity%	Juice%	Fibre %
CCS %							
Brix%	0.969**						
Sucrose %	0.998**	0.982**					
Pol %	0.976**	0.989**	0.984**				
Purity%	0.954**	0.837**	0.932**	0.871**			
Juice%	-0.250*	-0.337**	-0.270*	-0.343**	-0.077^{NS}		
Fibre %	0.524**	0.371**	0.492**	0.329**	0.688**	0.269*	

*P= 0.05, **P = 0.01

Table 5: Path Coefficient (Direct Effects)

Brix%	Sucrose %	Pol %	Purity%	Juice%	Fibre %
-0.293	1.270	0.011	0.004	-0.002	0.002

Residual are -0.00000

Table 6: Terms on rhs of path equation

Character	Brix%	Sucrose %	Pol %	Purity%	Juice%	Fibre %	CCS%
CCS% Vs Brix%	-0.29343	1.24636	0.01104	0.00358	0.00054	0.00085	0.969**
CCS% Vs Sucrose %	-0.28800	1.26983	0.01099	0.00398	0.00043	0.00113	0.998**
CCS% Vs Pol %	-0.29011	1.24949	0.01117	0.00372	0.00055	0.00075	0.976**
CCS% Vs Purity%	-0.24571	1.18369	0.00973	0.00427	0.00012	0.00158	0.954**
CCS% Vs Juice%	0.09898	-0.34336	-0.00383	-0.00033	-0.00160	0.00062	-0.250*
CCS% Vs Fibre %	-0.10878	0.62463	0.00367	0.00294	-0.00043	0.00229	0.524**

Table 7: Genotype means of agronomic characters

Variety/Clones	30 Days Ger. %	45 Days Ger. %	Cane Height (cm)	Diameter (cm)	Node Length	Single Cane Weight(kg)	No. of tillers 120 days ('000/ha)	No. of Millable Cane at harvest ('000/ha)	CCS(t/ha)	Yield t/ ha
Co 94008 (Shyama)	56.000	62.000	281.733	2.857	11.557	1.800	73.340	68.457	12.550	94.320
Co 0238	29.667	66.667	264.300	2.577	11.217	1.587	86.743	83.430	14.183	106.193
CoN 8177	47.667	63.667	275.300	2.790	10.303	1.690	85.543	76.913	10.990	100.163
CoSnk 05103	44.333	68.000	318.100	2.477	11.800	1.493	118.147	108.467	13.587	116.697
CoSnk 05104	44.667	65.333	297.533	2.863	12.677	1.843	115.853	92.563	11.997	107.083
Co 8201	59.000	72.667	286.300	2.993	9.750	2.057	85.267	62.827	12.060	99.257
MS 10001	46.000	64.667	276.633	3.317	10.003	2.193	84.133	66.460	14.730	104.427
VSI 434	46.333	62.333	266.700	2.910	10.033	1.920	51.090	55.660	11.217	76.560
VSI 3102	45.333	58.000	234.100	3.203	10.490	1.957	64.130	65.367	12.163	93.093
VSI 9805	41.333	62.667	245.567	3.070	10.977	1.707	73.147	60.967	7.393	61.310
Local Jamun	47.333	68.667	338.200	3.187	13.130	2.377	99.667	82.700	16.390	131.220
VSI 8005	45.667	68.333	300.067	3.120	12.263	2.260	80.280	71.783	14.180	106.970
Co 09004	48.333	57.333	332.733	2.620	12.763	1.977	77.503	65.447	13.083	101.630
Co 99006	54.333	54.333	277.400	2.710	12.960	1.663	129.247	98.933	15.197	108.757
CoJN 86-141	16.333	49.667	283.900	2.580	10.570	1.447	65.540	69.460	8.950	61.467
CoJN 86-600	50.333	68.000	310.133	2.673	13.540	1.733	102.653	91.610	14.573	117.647
CoJN 95-05	67.000	71.000	321.300	3.013	12.067	2.087	118.097	76.223	11.930	109.427
CoJN 99-17	70.667	78.000	280.667	2.697	12.370	1.690	122.030	103.233	12.923	109.427
CoS 8436 (Local Rasgula)	47.000	66.000	298.533	3.027	11.237	2.320	127.040	106.603	16.360	142.237
Co 8014 (Mahalaxmi)	59.667	72.667	301.167	2.753	13.190	1.830	130.580	103.947	15.903	130.290
Co 86032 (Nira)	37.000	63.333	290.433	2.843	11.617	1.940	101.383	90.027	14.320	108.540
Co 85004 (Prabha)	41.667	62.000	281.733	2.610	10.740	1.533	100.177	95.620	13.950	100.623
Co 99004 (Damodar)	47.667	69.333	306.833	3.023	14.053	2.057	80.547	79.063	17.943	133.180
CoC 671 (Vasant)	56.333	66.333	324.633	3.017	11.473	2.347	85.063	83.310	15.573	121.983
Mean	47.903	65.042	291.417	2.872	11.699	1.896	94.050	81.628	13.423	105.938

Table 8: Genotypic Means of Bio Chemical Characters

Varieties/ Clones	Brix%	Sucrose %	Pol %	Purity%	Juice%	Fibre %	CCS %
Co 94008 (Shyama)	13.240	21.330	18.993	14.183	86.613	55.433	15.267
Co 0238	13.583	21.987	19.517	14.977	87.210	54.403	13.247
CoN 8177	10.800	19.593	16.113	12.570	80.590	60.373	11.970
CoSnk 05103	11.560	20.040	16.983	13.340	83.067	52.290	11.420
CoSnk 05104	11.060	19.493	16.337	12.593	82.703	56.770	12.890
Co 8201	12.040	20.547	17.597	13.440	84.030	59.313	13.620
MS 10001	13.913	22.177	19.893	14.983	86.940	54.287	14.657
VSI 434	14.517	23.257	20.793	15.983	87.840	56.873	13.113
VSI 3102	13.060	21.523	18.870	14.723	86.837	53.610	11.967
VSI 9805	12.133	21.040	17.830	13.800	83.477	56.500	12.600
Local Jamun	12.423	20.737	18.027	13.850	84.173	59.390	13.147
VSI 8005	13.150	21.317	18.903	14.060	87.853	59.413	15.537
Co 09004	13.193	21.387	18.967	14.423	87.257	58.503	13.917
Co 99006	14.050	22.670	20.173	15.420	87.597	57.707	13.563
CoJN 86-141	14.283	22.407	20.323	15.387	88.197	56.787	14.227
CoJN 86-600	12.387	21.107	18.093	13.990	85.147	56.850	12.680
CoJN 95-05	10.707	18.790	15.787	12.223	81.700	56.007	12.550
CoJN 99-17	11.597	20.003	17.010	12.923	82.923	59.573	14.013
CoS 8436 (Local Rasgula)	11.643	19.507	16.913	12.943	85.877	59.837	13.430
Co 8014 (Mahalaxmi)	12.287	20.007	17.687	13.487	86.873	62.470	13.730
Co 86032 (Nira)	13.313	21.210	19.030	14.407	88.097	59.663	14.283
Co 85004 (Prabha)	13.853	22.307	19.873	15.210	87.757	56.567	13.467
Co 99004 (Damodar)	13.530	21.837	19.423	14.560	88.200	56.927	14.987
CoC 671 (Vasant)	12.697	21.093	18.397	14.193	84.823	59.060	12.817
Mean	12.709	21.057	18.397	14.070	85.658	57.442	13.462

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