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# Correlation and path analysis in sugarcane advanced clones

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**Abstract**
Selection is a regular process in plant breeding programmes that plant breeders must perform in order to obtain superior cane genotypes. The effectiveness of selecting operations will be determined by the adoption of proper selection criteria. The goal of this study was to look at the inheritable factors that influence the cane yield. In 2022–23, 26 advanced sugarcane clones were planted at the Regional Sugarcane and Rice Research Station, Rudrur, Nizamabad District, Telangana State. These clones were replicated three times in a randomised complete block design. The result of correlation analysis revealed that CCS yield showed a highly significant positive association with cane yield, followed by the number of millable canes ('000/ha), single cane weight at 12th month (kg), cane length at 12th month (cm), shoots at 240 days after planting ('000/ha), and tillers at 120 days after planting ('000/ha), respectively. This indicates that an improvement in these attributes would simultaneously result in an improvement in cane yield and selection based on these characters while being effective. In addition, path analysis showed that the highest positive and direct effect was found for CCS % 12th month (1.791), followed by Brix % 12th month (1.186), CCS yield (0.842), CCS % 10th month (0.526), Sucrose % 10th month (0.351), purity % 12th month (0.166), and it was also observed the number of millable canes ('000/ha) (0.150), single cane weight at harvest (kg) (0.119), shoots at 240 days after planting ('000/ha) (0.018), and cane length at 12 month (cm) (0.016). It was also observed that the number of millable canes (0.586), single cane weight at harvest (kg) (0.429), cane length at 12th month (0.299), Brix % at 12th month (0.289), shoots at 240 days after planting ('000/ha) (0.274), Sucrose % at 12th month (0.252), CCS % at 12th month (0.228), and tillers at 120 days after planting ('000/ha) (0.165) exhibited a high direct effect via CCS yield on cane yield. It is concluded that simultaneous selection for CCS yield, number of millable canes ('000/ha), single cane weight at harvest (kg), cane length at 12 month (cm), shoots at 240 days after planting ('000/ha), and tillers at 120 days after planting ('000/ha) will be more rewarding in selecting desirable sugarcane clonesy.

**Keywords:** Correlation and path, character association, cause and effect and advanced sugarcane clones

## 1. Introduction
Sugarcane (Saccharin spp.) is a perennial herbaceous commercial crop grown across the tropical and sub-tropical regions of India. It is one of the most important crops in the world (Dagar *et al.* 2002) [1]. In India, the crop has occupied (2020-21) [2] of an area of about 4,851 ('000 ha), production is 3,97,657 (‘000 tons), and productivity is 81.98 (tons/ha). Sugar per unit area is determined by the cane yield per unit area and sucrose percent in juice. These two characters are influenced by their component traits. In sugarcane, complex traits like cane yield and quality are influenced by a number of characters. These characters directly and indirectly contribute to the yield (Chaudhary *et al.* 2005) [3]. Swaminathan, M.S. 1991 [4] emphasized that genetic diversity and location-specific varieties are essential for achieving sustainable advances in productivity. Variety is the pivot and the cheapest technology for boosting cane production and productivity through a sugarcane varietal improvement programme and this programme proceeds by choosing parents and making crosses.
Knowledge of character associations among the introduced and local genotypes is of prime importance to begin an effective breeding program. Information about the contribution of various cane and quality characteristics to cane yield is vital for the development of new high-yielding sugarcane cultivars. This could be achieved using the method of path coefficients, which partitions correlations among the traits into components of direct and indirect effects on the dependent variable [S. D. Tyagi *et al.*, 1998] [5]. These would be followed by the development of selection criteria comprising traits with high direct effects for the selection of sugarcane genotypes manifesting a higher yield advantage.

The study of correlations provides information on how strongly traits are genetically associated with one another. Thus, the estimates of correlations among yield components pave the basis for the selection of superior genotypes from the diverse breeding populations. According to Prabhakaran Nair and Singh (1974) [6], path analysis is an effective means of disentangling the direct and indirect causes of association between the yield component and yield.

## 2. Materials and Methods

The experiment was conducted at the Regional Sugarcane and Rice Research Station, Rudrur, Nizamabad District, Telangana State, during the 2022-23 cropping season under black cotton soil, following a randomised block design (RBD) with three replications. 26 advanced clones of sugarcane, including three checks, were used in this experiment. The three-eyed setts of each genotype were planted in a 6 m × 8 rows plot (57.6 $m^2$ size plot). Row-to-row distance was 1.2 m. Setts were planted using the ridge and furrow method. Data were collected on seventeen different yield and quality characters i.e., Germination % at 30 DAP, Tillers at 120 DAP ('000/ha), Shoots at 240 DAP (000/ha), Cane length at 12$^{th}$ month (cm), Cane girth at 12$^{th}$ month (cm), Single cane weight at 12$^{th}$ month (Kg), No.of millable canes at 12$^{th}$ month (000/ha), Brix (%) at 10$^{th}$ months stage (%),Sucrose (%) in juice at 10$^{th}$ month stage, Purity (%) at 10$^{th}$ month stage, Brix (%) at 12$^{th}$ month stage (%),Sucrose (%) at 12$^{th}$ month stage, Purity (%) at 12$^{th}$ month stage, CCS (%) at 10$^{th}$ month stage, CCS (%) at 12$^{th}$ month stage, Sugar yield (CCS yield) at harvest (t/ha), Cane yield at harvest (t/ha).

As recommended, agronomic operations like weeding, earthing-up and irrigation were done as per the required schedule, and plant protection measures were followed during the crop period.

### 2.1 Brix % at 10 and 12 month stage

It is a measure of total soluble solids present in the juice. It was taken directly by using a Brix hygrometer. 250 ml juice was taken in measuring cylinder and hygrometer was dipped into the juice then reading was recorded from the juice level. These readings were corrected to the temperature at 20 °C by using temperature correction chart (Spencer and Meade 1955) [7].

### 2.2 Sucrose % at 10 and 12 month stage

The sucrose per-cent in juice was done according to Spencer and Meade (1955) [7] method. It was estimated with the help of Polari scope. First 100 ml juice was taken in conical flask and 4 gm Honey dry lead sub acetate was added and mixed well by shaking the flask. After few minutes this solution was filtered twice through a dry Whatsman no. 1 filter paper and the abstract was collected into a clean and dry beaker. The abstract poured into the Polari meter tube. These tubes were placed in the Polari scope. Thereafter Pol values were recorded by polarising the clear juice in Polari scope this value called dial reading. Sucrose Per cent in juice was obtained by referring the brix and dial reading to Schmitz's table.

### 2.3 CCS Percent

CCS % is determined by formula

$$[S-(B-S) \times 0.4] \times 0.73$$

Where,

S = Sucrose percent in juice (pol %). B = Brix percent in juice.

### 2.4 CCS yield (t/ha)

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

### 2.5 Purity % at 10 and 12 month stage

$$\text{Purity percent of juice} = \frac{\text{Sucrose percent in juice}}{\text{Corrected Brix}} \times 100$$

All the data were subjected to statistical analysis to test the differences among sugarcane advanced clones for various traits. Analysis of variance was done for partitioning the total variation due to treatments and replications according to procedure given by Panse and Sukhatme (1985) [8]. Correlation coefficients between different traits were determined as described by Singh and Chaudhary (1979) [9]. Path coefficients were determined following the method suggested by Dewey and Lu (1957) [10]. Data were analyzed using Indostat software (Indostat Inc. Hyderabad, India).

## 3. Results and Discussions

Numerous biotic and abiotic factors affect phenotypic selection, and the selection is usually misleading. This means that choosing crops based on the set of traits that strongly correlate with cane yield will be beneficial for any crop development program. Correlation studies on various yield and yield-attributing variables will reveal the degree and direction of association between various features, which is the key to the selection process to generate high-yielding cultivars. Path coefficient analysis gives the fundamental details regarding the immediate and delayed effects of several independent variables on the final dependent variable, cane yield.

The correlation between cane yield and its attributes (Table 1 and figure 1) revealed that CCS yield showed a highly significant positive association with cane yield, followed by the number of millable canes ('000/ha), single cane weight at 12m (kg), cane length at 12$^{th}$ month (cm), shoots at 240 days after planting ('000/ha), and tillers at 120 days after planting ('000/ha) respectively. This indicates that an improvement in these attributes would simultaneously result in an improvement in cane yield and selection based on these characters while being effective. These results are in conformation with Tabassum *et al*., (2023) [11] for CCS yield, number of millable canes ('000/ha), Single cane weight at 12$^{th}$ month (Kg), cane length at 12$^{th}$ month (cm) and Tillers at 120 DAP ('000/ha); Singh *et al.*, (2022) [12] for sugar yield, Single cane weight at harvest and Number of millable cane at harvest; K Imtiaz Ahmed *et al.*, (2019) [13] for, number of millable canes ('000/ha), single cane weight at 12$^{th}$ month (Kg), cane length at 12$^{th}$ month (cm) and CCS yield; M. M. Pandya and P. B. Patel (2017) [14] for number of millable canes, single cane weight and CCS yield; Swamy Gowda S *et al*., (2016) [15] for CCS yield, single cane weight at 12$^{th}$ month (kg), number of millable canes ('000/ha) and cane length at 12$^{th}$ month (cm) and Esayas Tena *et al.* (2016) [16] for number of millable canes, single cane weight, cane length and CCS

yield and girth of cane.

The positive but non-significant association was observed for cane girth at 12th month (cm), Brix % 12th month. There is a negative significant correlation with Purity % 12th month and a negative non-significant correlation with Brix % 10th, Sucrose % 10th, and Purity % 10th, Sucrose % 12th, and CCS % 10th months, respectively. These results are confirmed by Swamy Gowda S. N. *et al.* (2016) [15] for Brix % 12th month and Tyagi *et al*. (2012) [17] for sucrose % 12th month.

Germination % at 30 DAP exhibits a positive significant correlation with tillers at 120 DAP ('000/ha), shoots at 240 DAP ('000/ha), whereas the negative correlation is single cane weight at 12th month (kg) and a positive non-significant correlation with No. of millable canes ('000/ha), Cane girth at harvest (cm), Brix % 10th, Sucrose % at 10th, and CCS % at 10th months. These results are in conformance with Tabassum *et al*. (2023) [11] for Tillers at 120 ('000/ha).

Positive and significant associations were observed for tillers at 120 DAP ('000/ha), Germination % at 30 DAP, shoots at 240 DAP ('000/ha), No. of millable canes ('000/ha), Brix % at 10th, Sucrose % at 10th, and CCS at 10th months. While there is no significant positive correlation with the cane length at 12th (cm), purity % 10th, purity % 12th, months and CCS yield. Tillers at 120 DAP ('000/ha) recorded a significant negative association with the single cane weight at harvest (kg) and a non-significant negative association with the cane girth at harvest (cm), Brix % 12th, Sucrose % 12th, and CCS % 12th months. These results are in conformity with Tabassum *et al*. (2023) [11] for Tillers at 120 ('000/ha), Swamy Gowda S. N. *et al.* (2016) [15] for single cane weight at harvest (kg), cane girth at harvest (cm), Brix % 12th, and CCS % 12th months.

The number of millable canes ('000/ha) revealed that there was a significant positive correlation with tillers at 120 DAP ('000/ha), shoots at 240 ('000/ha), CCS yield and cane length at 12th month (cm), and a non-significant positive correlation with Germination % at 30 DAP and purity % at 10th month. While there is a significant negative association with cane length at 12th month (cm) and non-significant negative association with single cane weight at harvest (kg), Brix % 10th, Sucrose % 10th, CCS % 10th, Brix % 12th, Sucrose % 12th, purity % 12th, and CCS % 12th months, selection based on the number of millable canes ('000/ha) improves yield. These results are in conformity with Tabassum *et al*. (2023) [11] for CCS yield.

Single cane weight at harvest (kg) was significantly and positively correlated with cane girth at 12th (cm), cane length at 12th months (cm), and CCS yield, with and without significant positive association with the Brix % 10th, Sucrose % 10th, CCS % 10th, Brix % 12th, Sucrose % 12th, and CCS % 12th months. The trait recorded that there was a significant negative correlation with Germination % at 30 DAP, Tillers at 120 ('000/ha). The number of millable canes ('000/ha), purity % 10th, and purity % 12th months have a non-significant negative relation. These results are in line with the earlier reports of Tabassum *et al*. (2023) [11] for cane girth at 12th (cm), cane length at 12th (cm), and CCS yield; Swamy Gowda S. N. *et al.* (2016) [15] for CCS yield.

Cane girth at 12th (cm) was significantly and positively correlated with single cane weight at harvest (kg), and there was a positive non-significant association with Germination % at 30 DAP, cane length at 12th (cm), Brix % at 12th, Sucrose % at 12th months, and CCS yield with the cane girth at 12th (cm), and a significant negative correlation with the number of millable canes ('000/ha). It also recorded a non-significant negative correlation with the tillers at 120 DAP ('000/ha), shoots at 240 DAP ('000/ha), Brix % 10th, Sucrose % 10th, Purity % 10th, CCS % 10th, and Purity % 12th months. These results are in line with the earlier reports of Tabassum *et al*. (2023) [11] for CCS yield and Swamy Gowda S. N. *et al.* (2016) [15] for single cane weight at harvest (kg).

Cane length at 12th month (cm) was significantly and positively correlated with the number of millable canes ('000/ha), single cane weight at harvest (kg), and CCS yield. It also exhibits a positive, non-significant association with Germination % at 30 DAP, tillers at 120 DAP ('000/ha), shoots at 240 DAP ('000/ha), and cane girth at 12th month (cm). The trait recorded that there was a significant negative association with purity % 12th month. It was a negative, non-significant association with Brix % 10th, Sucrose % 10th, Purity % 10th, CCS % 10th, Brix % 12th, Sucrose % 12th, and CCS % 12th months. Selection based on the Cane length of 12m cm improves yield. These results are in conformity with Tabassum *et al*. (2023) [11] for CCS yield and Swamy Gowda S. N. *et al.* (2016) [15] for single cane weight at harvest (kg).

Brix % 10th were significantly and positively correlated with tillers at 120 DAP ('000/ha), Sucrose % 10th, CCS % 10th, Brix % 12th, Sucrose % 12th, purity % 12th, and CCS % 12th months. Positive, non-significant association with germination % at 30 DAP, single cane weight at harvest (kg), purity % at 10th, and CCS yield Negative non-significant correlation with shoots at 240 DAP ('000/ha), number of millable canes ('000/ha), cane girth at 12th (cm), and cane length at 12th month (cm). Selection based on the Brix % at 10th month improves quality.

Sucrose % 10th shows a positive significant correlation with Brix % 10th, Tillers at 120 DAP ('000/ha), Purity % 10th, CCS % 10th, Brix % 12th, Sucrose % 12th, Purity % 12th, and also exhibits a positive non-significant association with Germination % at 30 DAP, single cane weight at harvest (kg) and CCS yield. It recorded a non-significant negative correlation with the shoots at 240 DAP ('000/ha), number of millable canes ('000/ha), cane girth at 12th (cm), and cane length at 12th month (cm).

Sucrose % 10th, CCS % 10th, Sucrose % 12th, Purity % 12th, and CCS % 12th had a positive and significant connection with Purity % 10th month. The trait recorded that there was a non-significant positive correlation with Brix % 12th, CCS yield, Tillers at 120 ('000/ha), Germination % at 30 DAP, Shoots at 240 DAP ('000/ha), number of millable canes ('000/ha), Brix % 10th month. Single cane weight at harvest (kg), cane girth at 12th month (cm), and cane length at 12th month (cm) have a negative, non-significant association with purity % 10th month.

Positively significant associations were observed for tillers at 120 ('000/ha), Brix % 10th, Sucrose % 10th, Purity % 10th, Brix % 12th, Sucrose % 12th, Purity % 12th, CCS % 12th with CCS % 10th month, and positive non-significant associations with the single cane weight at harvest (kg) and CCS yield. The trait also shows a negative, non-significant association with shoots at 240 DAP ('000/ha), number of millable canes ('000/ha), cane girth at 12th (cm), and cane length at 12th months (cm).

Brix % 12th month revealed a significant positive correlation with Brix % 10th, Sucrose % 10th, CCS % 10th, Sucrose %

12th, CCS % 12th months and CCS yield and non-significant positive correlation with single cane weight at harvest (kg), cane girth at 12th (cm), Purity % 10th and purity % 12th months. This trait had a negative, non-significant association with Germination % at 30 DAP, tillers at 120 DAP ('000/ha), shoots at 240 DAP ('000/ha), number of millable canes ('000/ha) and cane length at 12th month (cm). As a result, a simple selection of this attribute could be able to improve CCS yield. These results are in conformity with Tabassum *et al*. (2023) [11] for Sucrose % 12th month CCS % 12th; Swamy Gowda S. N. *et al*., (2016) [15] for CCS % 12th months.

Positive significant correlations were noticed for Brix % 10th, Sucrose % 10th, Purity % 10th, CCS % 10th, Brix % 12th, Purity % 12th, CCS % 12th months and CCS yield with sucrose % 12th and positive non-significant correlation with the single cane weight at harvest (kg) and Cane girth at 12th month(cm). The trait also reveals a negative, non-significant correlation with the germination % at 30 DAP, tillers at 120 DAP ('000/ha), shoots at 240 DAP ('000/ha), number of millable canes ('000/ha) and cane length at 12th month (cm). These results are in line with the earlier reports of Tabassum *et al*. (2023) [11] for Purity % 12th, CCS % 12th and CCS yield; Swamy Gowda S. N. *et al*., (2016) [15] for CCS % 12th month and CCS yield.

Purity % 12th month exhibits a positive significant correlation with Brix % 10th, Sucrose % 10th, Purity % 10th, CCS % 10th, Sucrose % 12th and CCS % 12th months. Same results obtained by Tabassum *et al*., (2023) [11] for CCS % 12th and positive non significant correlation with Tillers at 120 ('000/ha) and Brix % 12th month. This trait had a significant negative correlation with the cane length at 12th month (cm). And also exhibit a negative, non-significant correlation with the Germination % at 30 DAP, shoots 240 DAP ('000/ha), number of millable canes ('000/ha), single cane weight at harvest (kg) and cane girth at 12m (cm).

CCS % 12th has a significant positive correlation with Brix % 10th, Sucrose % 10th, Purity % 10th, CCS % 10th, Brix % 12th, Sucrose % 12th, Purity % 12th months and CCS yield. Same results obtained by Tabassum *et al*., (2023) [11] for CCS yield. It exhibits a non significant positive connection with single cane weight at harvest (kg) and cane girth at 12th month (cm). This trait also shows a negative, non-significant correlation with the Germination % at 30 DAP, Tillers at 120 DAP ('000/ha), Shoots at 240 DAP ('000/ha), number of millable canes ('000/ha) and cane length at 12th month (cm).The results were consistent with Om Narayan Verma *et al.*, (2021) [18] for sucrose %, brix % and purity % ; Swamy Gowda S. N *et al*., (2016) [15] for CCS yield**.**

CCS yield has a significant positive correlation with Shoots at 240 DAP ('000/ha), No. of millable canes ('000/ha), Single cane weight at harvest (kg), and Cane length at 12m (cm), CCS % 10th, Brix % 12th, and Sucrose % 12th, and also recorded a non-significant positive connection with Tillers at 120 ('000/ha), Cane girth at 12m (cm), Brix % 10th, Sucrose % 10th, Purity % 10th, and CCS % 10th months. This trait reveals a negative, non-significant correlation with the Germination % at 30 DAP and purity % at 12th month. It revealed that an indirect improvement in CCS yield could be possible if the above-mentioned attributes increased positively.

It is generally recognized that simple correlation does not reflect the underlying relationship between qualities and yield, nor does it explain the relationship between causes and effects between the numerous yield parameters and, ultimately, the yield. By separating the correlation coefficients into direct and indirect effects, the path analysis technique gives insight into the true impact of independent factors on yield.

For the yield and yield component traits, path coefficient analysis estimates have been presented in Table 2 and Fig. 2. From the path analysis, it was observed that the highest positive and direct effect was found for CCS % at 12th month (1.791), followed by Brix % at 12th month (1.186), CCS yield (0.842), CCS % 10th (0.526), Sucrose % 10th (0.351), Purity % 12th (0.166), No. of millable canes ('000/ha) (0.150), single cane weight at harvest (kg) (0.119), shoots at 240 DAP ('000/ha) (0.018) and cane length at 12th month (cm) (0.016). These results are in line with the earlier reports by Tabassum *et al*. (2023) [11] for CCS yield, number of millable canes ('000/ha) and single cane weight at harvest (Kg); K Imtiaz Ahmed *et al*., (2019) [13] for millable cane, Cane length, single cane weight, and cane girth; Swamy Gowda S *et al*. (2016) [15] for CCS yield, number of millable canes; Esayas Tena *et al*. (2016) [16] for number of millable canes, single cane weight, and sucrose percent; Alam *et al*. (2017) [19] for number of millable canes and cane length; Sanjay Kumar and Devendra Kumar (2014) [20] with number of millable, cane height, and cane weight.

On the other side, the negative and direct effects were found in Sucrose % 12th month (-3.198), Brix % 10th (-0.784), purity % 10th months (-0.372), Germination % at 30 DAP and cane girth at 12th month (cm) (- 0.007). These results were consistent with Tabassum *et al*. (2023) [11] for cane girth at 12th month (cm) and Germination % at 30 and K Imtiaz Ahmed *et al*. (2019) [13] for Brix %.

The characters number of millable canes (0.586), Single cane weight at harvest (kg) (0.429), Cane length at 12th month (0.299), Brix % 12th month (0.289), shoots 240 DAP ('000/ha) (0.274), Sucrose % 12th month (0.252), CCS % 12th month (0.228), and tillers at 120 DAP ('000/ha) (0.165) exhibited a high direct effect via CCS yield on cane yield. Thus, it indicates that improvement in these traits would simultaneously improve cane yield. The results were in conformity with Tabassum *et al*. (2023) [11] for CCS yield. Hence, these traits need to be considered during the selection process.

Based on character association and path analysis, it is concluded that simultaneously selection for CCS yield, number of millable canes ('000/ha), single cane weight at harvest (kg), cane length at 12th month (cm), shoots at 240 DAP ('000/ha), and tillers at 120 DAP ('000/ha) will be more rewarding in selecting desirable sugarcane clones as these characters exhibited highly significant and positive associations with cane yield and among themselves high positive direct and indirect effects on cane yield. The low residual effect (0.039) indicates that the characters included in the study explained a high percentage of the variation in cane yield.

**Table 1:** Correlation coefficient of sugarcane yield with quantitative and quality attributes in advanced sugarcane clones

| Chara. | GER at 30 DAP | Tillers at 120 ('000/ha) | Shoots 240 ('000/ha) | NMC ('000/ha) | SCW at 12 m (Kg) | CG at 12 m (cm) | CL at 12m (cm) | BRIX % 10th | SUCROSE % 10th | PURITY % 10th | CCS % 10th | BRIX % 12th | SUCROSE % 12th | PURITY % 12th | CCS % 12th | CCS (Sugar yield) t/ha | Cane Yield (t/ha) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 |
| 1 | 1.000 | | | | | | | | | | | | | | | | |
| 2 | 0.718*** | 1.000 | | | | | | | | | | | | | | | |
| 3 | 0.483 *** | 0.534*** | 1.000 | | | | | | | | | | | | | | |
| 4 | 0.219 | 0.448*** | 0.628*** | 1.000 | | | | | | | | | | | | | |
| 5 | -0.302** | -0.281* | -0.240 * | -0.188 | 1.000 | | | | | | | | | | | | |
| 6 | 0.218 | -0.157 | -0.182 | -0.2761 * | 0.492*** | 1.000 | | | | | | | | | | | |
| 7 | 0.219 | 0.104 | 0.073 | 0.232* | 0.333** | 0.114 | 1.000 | | | | | | | | | | |
| 8 | 0.088 | 0.269* | -0.118 | -0.062 | 0.075 | -0.132 | -0.105 | 1.000 | | | | | | | | | |
| 9 | 0.097 | 0.296** | -0.062 | -0.047 | 0.047 | -0.140 | -0.159 | 0.941*** | 1.000 | | | | | | | | |
| 10 | 0.044 | 0.131 | 0.136 | 0.024 | -0.065 | -0.044 | -0.187 | 0.045 | 0.380*** | 1.000 | | | | | | | |
| 11 | 0.097 | 0.296** | -0.038 | -0.039 | 0.034 | -0.138 | -0.175 | 0.885 *** | 0.991 *** | 0.504*** | 1.000 | | | | | | |
| 12 | -0.192 | -0.009 | -0.171 | -0.041 | 0.200 | 0.194 | -0.069 | 0.486*** | 0.497 *** | 0.135 | 0.485*** | 1.000 | | | | | |
| 13 | -0.174 | -0.006 | -0.167 | -0.063 | 0.109 | 0.105 | -0.168 | 0.545*** | 0.602 *** | 0.286* | 0.606*** | 0.929*** | 1.000 | | | | |
| 14 | -0.002 | 0.003 | -0.030 | -0.071 | -0.184 | -0.191 | -0.289* | 0.272* | 0.398 *** | 0.434*** | 0.436*** | 0.049 | 0.414*** | 1.000 | | | |
| 15 | -0.161 | -0.004 | -0.159 | -0.069 | 0.070 | 0.066 | -0.200 | 0.547*** | 0.620*** | 0.334** | 0.629*** | 0.866*** | 0.990*** | 0.540*** | 1.000 | | |
| 16 | -0.051 | 0.195 | 0.325 ** | 0.696*** | 0.509*** | 0.115 | 0.355** | 0.141 | 0.161 | 0.082 | 0.164 | 0.343** | 0.299** | -0.032 | 0.271* | 1.000 | |
| 17 | -0.004 | 0.203 | 0.394 | 0.748 | 0.503 | 0.088 | 0.441 | -0.031 | -0.036 | -0.030 | -0.038 | 0.077 | -0.007 | -0.202 | -0.040 | 0.950 | 1.000 |

* Significant at 5 percent level (p≤0.05) ** Significant at 1 percent level (p≤0.01) *** Significant at 0.1 percent level (p≤0.001)

GER at 30 DAP -Germination % at 30 Days after planting, Tillers at 120 DAP ('000/ha), Shoots at 240 DAP (000/ha), NMC- No. of Millable canes at 12th month (000/ha), CL at 12 m (cm) - Cane length at 12th month (cm), CG at 12m (cm)- Cane girth at 12th month (cm), SCW at 12th - Single cane weight at 12th month (Kg), Brix (%) at 10th months stage (%), Sucrose (%) in juice at 10 month stage, Purity (%) at 10 month stage (%), Brix (%) at 12 month stage (%),Sucrose (%) at 12 months stage, Purity (%) at 12 months stage, CCS (%) at 10 months stage, CCS (%) at 12 month stage, Sugar yield (CCS yield) at harvest (t/ha) and Cane yield at harvest (t/ha).

**Table 2:**.Path coefficient of sugarcane yield with quantitative and quality attributes in advanced sugarcane clones

| Chara. | GER at 30 DAP | Tillers at 120 ('000/ha) | Shoots 240 ('000/ha) | NMC ('000/ha) | SCW at 12 m (Kg) | CG at 12m (cm) | CL at 12m (cm) | BRIX % 10th | SUCROSE % 10th | PURITY % 10th | CCS % 10th | BRIX % 12th | SUCROSE % 12th | PURITY % 12th | CCS % 12th | CCS (Sugar yield) t/ha | Cane yield (t/ha) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 |
| 1 | -0.016 | -0.012 | -0.008 | -0.004 | 0.005 | 0.004 | -0.004 | -0.001 | -0.002 | -0.001 | -0.002 | 0.003 | 0.003 | 0.000 | 0.003 | 0.001 | -0.004 |
| 2 | 0.003 | 0.004 | 0.002 | 0.002 | -0.001 | -0.001 | 0.000 | 0.001 | 0.001 | 0.001 | 0.001 | 0.000 | 0.000 | 0.000 | 0.000 | 0.001 | 0.203 |
| 3 | 0.009 | 0.010 | 0.018 | 0.011 | -0.004 | -0.003 | 0.001 | -0.002 | -0.001 | 0.002 | -0.001 | -0.003 | -0.003 | -0.001 | -0.003 | 0.006 | 0.394 |
| 4 | 0.033 | 0.067 | 0.094 | 0.150 | -0.028 | -0.042 | 0.035 | -0.009 | -0.007 | 0.004 | -0.006 | -0.006 | -0.009 | -0.011 | -0.010 | 0.105 | 0.748 |
| 5 | -0.036 | -0.033 | -0.029 | -0.022 | 0.119 | 0.058 | 0.040 | 0.009 | 0.006 | -0.008 | 0.004 | 0.024 | 0.013 | -0.022 | 0.008 | 0.060 | 0.503 |
| 6 | 0.002 | 0.001 | 0.001 | 0.002 | -0.003 | -0.007 | -0.001 | 0.001 | 0.001 | 0.000 | 0.001 | -0.001 | -0.001 | 0.001 | -0.001 | -0.001 | 0.088 |
| 7 | 0.004 | 0.002 | 0.001 | 0.004 | 0.005 | 0.002 | 0.016 | -0.002 | -0.003 | -0.003 | -0.003 | -0.001 | -0.003 | -0.005 | -0.003 | 0.006 | 0.441 |
| 8 | 0.069 | -0.211 | 0.093 | 0.049 | -0.058 | 0.104 | 0.082 | -0.784 | -0.737 | -0.035 | -0.694 | -0.381 | -0.427 | -0.213 | -0.428 | -0.111 | -0.031 |
| 9 | 0.034 | 0.104 | -0.022 | -0.016 | 0.016 | -0.049 | -0.056 | 0.330 | 0.351 | 0.133 | 0.348 | 0.175 | 0.211 | 0.140 | 0.218 | 0.057 | -0.036 |
| 10 | 0.017 | -0.049 | -0.051 | -0.009 | 0.024 | 0.016 | 0.070 | -0.017 | -0.142 | -0.372 | -0.188 | -0.050 | -0.107 | -0.162 | -0.124 | -0.031 | -0.030 |
| 11 | 0.051 | 0.156 | -0.020 | -0.021 | 0.018 | -0.073 | -0.092 | 0.465 | 0.521 | 0.265 | 0.526 | 0.255 | 0.318 | 0.229 | 0.331 | 0.086 | -0.038 |
| 12 | 0.228 | -0.011 | -0.203 | -0.048 | 0.237 | 0.230 | -0.082 | 0.577 | 0.590 | 0.160 | 0.575 | 1.186 | 1.102 | 0.058 | 1.027 | 0.407 | 0.077 |
| 13 | 0.558 | 0.018 | 0.533 | 0.200 | -0.349 | -0.334 | 0.538 | -1.742 | -1.927 | -0.916 | -1.937 | -2.971 | -3.198 | -1.325 | -3.165 | -0.957 | -0.007 |
| 14 | 0.000 | 0.001 | -0.005 | -0.012 | -0.031 | -0.032 | -0.048 | 0.045 | 0.066 | 0.072 | 0.073 | 0.008 | 0.069 | 0.166 | 0.090 | -0.005 | -0.202 |

| | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 15 | 0.288 | -0.008 | -0.285 | -0.124 | 0.125 | 0.118 | -0.359 | 0.979 | 1.110 | 0.598 | 1.127 | 1.551 | 1.772 | 0.968 | 1.791 | 0.484 | -0.040 |
| 16 | 0.043 | 0.165 | 0.274 | 0.586 | 0.429 | 0.097 | 0.299 | 0.119 | 0.136 | 0.069 | 0.138 | 0.289 | 0.252 | -0.027 | 0.228 | 0.842 | 0.950 |

* Significant at 5 percent level (p≤0.05) ** Significant at 1 percent level (p≤0.01) *** Significant at 0.1 percent level (p≤0.001)

GER at 30 DAP -Germination % at 30 Days after planting, Tillers at 120 DAP ('000/ha), Shoots at 240 DAP (000/ha), NMC- No. of Millable canes at 12th month (000/ha), CL at 12m (cm) - Cane length at 12th month (cm), CG at 12m (cm)- Cane girth at 12th month (cm), SCW at 12th - Single cane weight at 12th month (Kg), Brix (%) at 10th months stage (%), Sucrose (%) in juice at 10 month stage, Purity (%) at 10 month stage (%), Brix (%) at 12 month stage (%),Sucrose (%) at 12 months stage, Purity (%) at 12 months stage, CCS (%) at 10 months stage, CCS (%) at 12 month stage, Sugar yield (CCS yield) at harvest (t/ha) and Cane yield at harvest (t/ha).

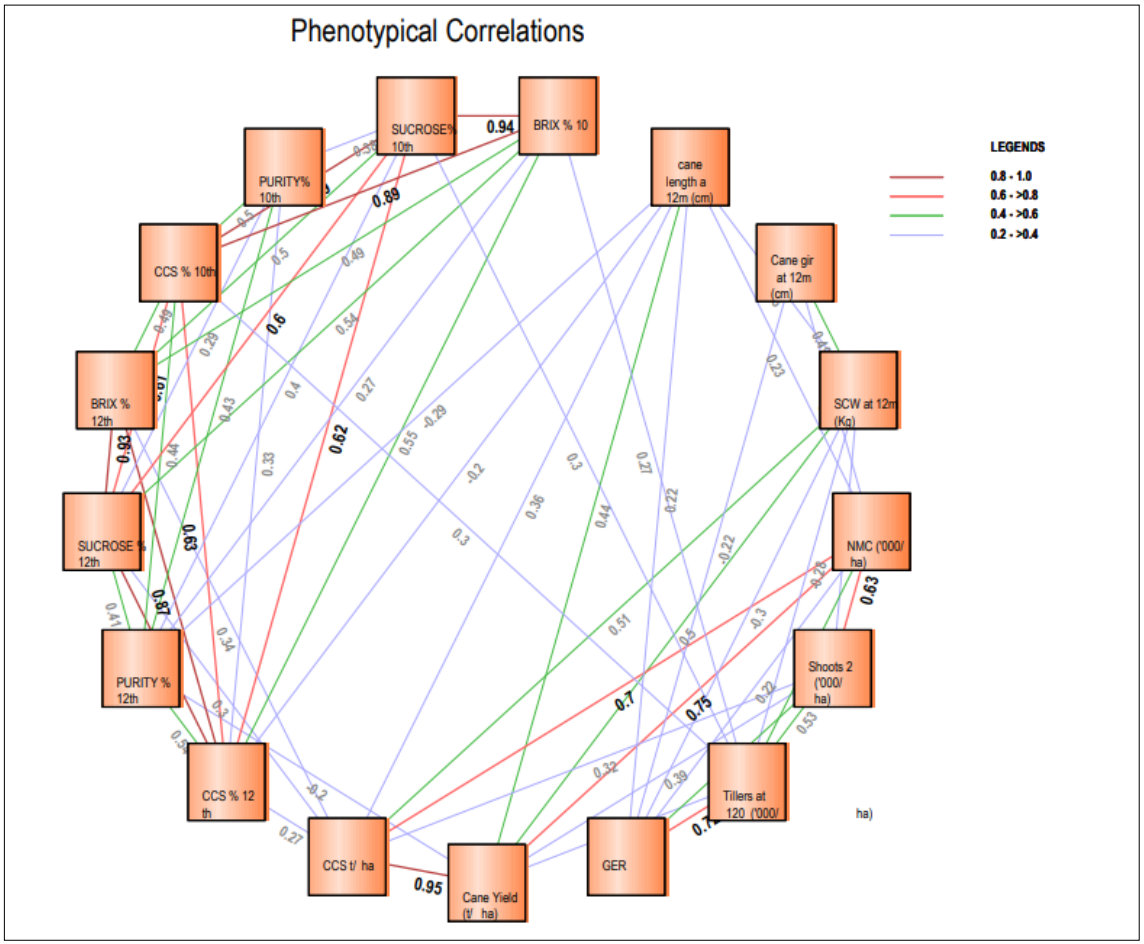


**Fig 1:** Phenotypical correlations

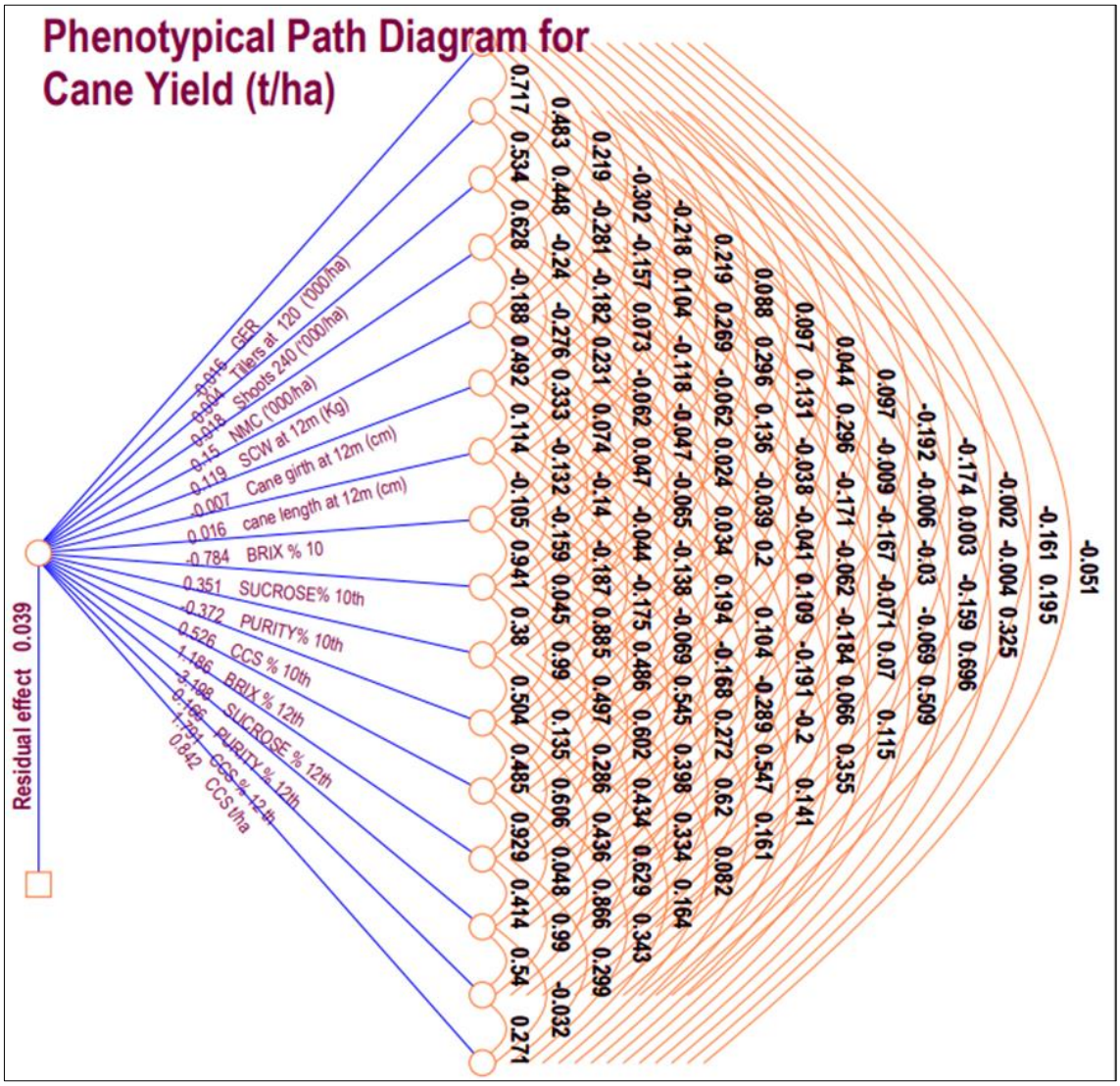


**Fig 2:** Phenotypical path diagram of cane yield (t/ha)

## 4. Conclusion

From the results, it had been seen that CCS % 12th, Brix % 12th, CCS yield, number of millable canes ('000/ha), single cane weight at harvest (kg), shoots 240 ('000/ha), and cane length at 12 m (cm) had both a positive correlation as well as a positive direct effect on cane yield. Hence, direct selection of these traits can be done in sugarcane breeding programs. Improvements in these traits will result in a simultaneous improvement in cane yield.

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