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CORRELATION AND PATH COEFFICIENT ANALYSIS AMONG EARLY CLONES OF SUGARCANE (*Saccharum* spp.)

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ABSTRACT

This study was conducted to determine the contribution of different traits to cane yield in sugarcane (*Saccharum* spp.). Nineteen early sugarcane clones were evaluated in a randomized block design with three replications at Agricultural Research Station (ARS), Perumallapalle, Tirupati, during 2023-2024 for eighteen characters. In this study number of nodes per cane, cane length, cane diameter, single cane weight, total leaf weight, reducing sugars per cent and CCS yield showed positive and significant association with cane yield. Path analysis indicated that emphasis should be laid out on SCW and NMC for getting higher cane yield and among quality parameters, sucrose per cent has to be taken into consideration for getting higher CCS per cent.

KEYWORDS: Character association, path coefficient analysis, yield attributes, sugarcane.

INTRODUCTION

Sugarcane is an important commercial crop that grows as tall perennial grass. The cultivation of sugarcane is primarily for its thick stems which serve as the source of sugar. About eighty per cent of sugar is produced from sugarcane and twenty per cent is produced from sugar beet. Among all the regions worldwide, India stands out as a significant player in the sugarcane and sugar industry with an area of 5.88 million hectares, producing 494.2 million tonnes of cane, at a productivity rate of 84.48 tonnes per hectare. (Directorate of Economics and Statistics, 2022-2023). Sugarcane is a versatile crop being a rich source of food (sucrose, jaggery and syrups), fiber (cellulose), fodder (green top, bagasse and molasses), fuel and chemicals (molasses and alcohol). With the continuous increase in population, the demand for sugar is also rising. Meeting the needs of this expanding population within limited agricultural space necessitates increasing productivity per unit area and over time.

Correlation coefficients play a significant role in understanding the relationship between the characters by providing a quantitative measure of the strength and direction of the relationships between the characters, allowing researchers to gain valuable insights into the selection criteria to be followed. By understanding the correlation between the characters, breeders can select genotypes with desirable traits with less efforts. This can result in sugarcane varieties that are more productive, profitable, and resistant to disease. Therefore, this experiment was conducted to study the relations of eighteen characters with sugarcane yield.

MATERIAL AND METHODS

The experimental material for the present investigation consisted of nineteen early sugarcane clones which were planted in a Randomized Block Design with three replications at Agricultural Research Station (ARS), Perumallapalle, Tirupati, during 2023-2024. The observations were recorded on eighteen characters *viz.,* germination at 30 DAP, tillers at 120 DAP, shoots at 240 DAP, number of millable canes, number of nodes per cane, cane length, cane diameter, single cane weight, top leaf weight, fibre per cent, juice extraction per cent, brixper cent, sucrose

Correlation and path coefficient analysis among early clones of sugar cane per cent, purity per cent, reducing sugars per cent, Commercial cane sugar per cent, Commercial cane sugar yield (t/ha) and cane yield (t/ha). Correlation and path coefficients were calculated using INDOSTAT software. The total correlation coefficients of various yield and quality characters with regard to cane yield and CCS per cent were partitioned into components of direct and indirect effects following the method adopted by Dewey and Lu (1959).

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RESULTS AND DISCUSSION

The study examines the correlation between cane yield per hectare and its component traits. Positive and highly significant association was recorded with SCW (0.737**), TLW (0.308**), reducing sugars per cent (0.341**), CCSY (0.908**), number of nodes per cane (0.297*), cane length (0.291*) and cane diameter (0.280*). This indicates that improvements in these traits are likely to result in significant increases in cane yield. Therefore, these traits should be primary targets in breeding programmes aimed at enhancing yield. It has positive and non significant association with germination per cent at 30 DAP (0.087), tillers at 120 DAP (0.026), shoots at 240 DAP (0.02), number of millable canes (0.14) and Purity per cent (0.007). This suggests that while these traits might contribute to yield, their impact is relatively minor compared to the highly significant traits.

Cane yield had negative and non-significant association with fibre per cent (-0.16), juice extraction per cent (-0.201), brix per cent (-0.134), sucrose per cent (-0.14) and CCS per cent (-0.142). This implies that higher values of these juice quality traits do not significantly decrease cane yield. However, the negative direction of the correlation suggests a potential trade-off; improving these juice quality traits might not lead to higher cane yield. These results are in accordance with Gowda *et al*. (2016) and Pandya and Patel (2017), Krishna and Kamat (2017), Hiremath *et al.* (2015) and Kumar *et al.* (2021).

Path analysis of cane yield and yield attributing traits

The path coefficient analysis of different yield characters on cane yield were analyzed and presented in Table 2 and Fig. 1.

In the present study, it was observed that the SCW (1.0845) and NMC (0.7840) had high positive effect on cane yield. This indicates that heavier individual canes and higher number of millable canes significantly increase the total yield per hectare. The characters, cane length (0.0902), cane diameter (0.0588), number of nodes per cane (0.0406), total leaf weight (0.0234), germination per cent at 30 DAP (0.0075) and shoots at 240 DAP (0.0055) had negligible positive direct effect on cane yield. While these traits do contribute to yield, their impact is relatively small compared to SCW and NMC. These results are in accordance with the Krishna and Kamath (2018), Pandya and Patel (2017), Anbanandhan (2019), Hiremath *et al*. (2015), Agrawal and Kumar (2018) and Sanghera *et al.* (2014).

Conversely, negative and low direct effect on cane yield was exhibited by tillers at 120 DAP (-0.0240) and fibre per cent (-0.0533). This indicates that managing the number of tillers and fibre per cent is important to avoid any potential negative impact on yield. The above results are in accordance with Hiremath *et al.* (2015), Priya (2013) and Kumar *etal.* (2021).

The phenotypic residual effect of 0.1428 indicates that the characters included in the present study are contributing 85.72 per cent of variability pertaining to the dependent variable i.e. cane yield per hectare. Hence, apart from the characters under the consideration, some other characters (cane density, internodal length etc.,) may be included in further studies, to further bring down the residual effect.

Path analysis of CCS per cent and quality attributing traits

The path coefficient analysis of different quality characters on CCS per cent were analyzed and represented in Table 3 and Fig. 2.

In the present study, it was observed that the sucrose per cent had very high positive direct effect on CCS per cent (1.1842). This strong relationship indicates that increasing the sucrose content in sugarcane directly leads to a substantial increase in CCS per cent. Therefore, sucrose per cent is a critical trait for improving CCS per cent and should be given primary focus in breeding programmes.

Direct selection for higher sucrose content is highly effective for enhancing CCS per cent.

Purity per cent (0.0854) and juice extraction per cent (0.0011) had negligible positive direct effect on CCSper cent. Although it is beneficial, purity per cent and juice extraction per cent is less critical for direct selection in breeding programs aimed at increasing CCS per cent.

The study underscores the importance of sucrose per cent as a major contributor to higher CCS per cent. Breeding programs should prioritize the direct selection of higher sucrose content to effectively enhance CCS per cent. This trait has the most significant positive impact and is essential for improving sugar yield.

Table 1. Correlation coefficients among yield and quality characters

	G per cent	T-120	S- 240	NMC	Nodes	CL	CD	SCW	TLW	F per cent	J extr per cent	B per cent	S per cent	P per cent	Red. S per cent	CCS per cent	CCSY
Gper cent	**1**																
T-120	0.605**	**1**															
S- 240	0.671**	0.678**	**1**														
NMC	0.582**	0.704**	0.741**	**1**													
Nodes	0.127	0.068	0.331**	0.159	**1**												
CL	-0.061	-0.074	0.133	0.001	0.622**	**1**											
CD	0.011	-0.321	-0.373**	-0.261	-0.261*	-0.417**	**1**										
SCW	-0.328**	-0.429**	-0.491**	-0.549**	0.097	0.192	0.405**	**1**									
TLW	-0.219	-0.268*	-0.406**	-0.316*	-0.149	-0.126	0.504**	0.465**	**1**								
F per cent	0.098	0.296*	0.315*	0.439**	0.224	0.143	-0.320*	-0.409**	-0.240	**1**							
J extr per cent	-0.081	-0.003	-0.127	-0.186	-0.212	-0.044	-0.072	-0.030	0.196	-0.222	**1**						
B per cent	-0.560**	-0.519**	-0.631**	-0.464**	-0.426**	-0.412**	0.220	0.228	0.142	-0.173	-0.116	**1**					
S per cent	-0.573**	-0.528**	-0.622**	-0.437**	-0.378**	-0.347**	0.151	0.206	0.117	-0.121	-0.115	0.970**	**1**				
P per cent	0.130	0.128	0.231	0.252	0.309*	0.371**	-0.324*	-0.166	-0.148	0.260	0.029	-0.417**	-0.184	**1**			
Red.s per cent	0.024	-0.123	-0.018	-0.067	0.349**	0.360**	0.096	0.317*	0.199	-0.116	0.106	-0.390**	-0.359**	0.215	**1**		
CCS per cent	-0.565**	-0.518**	-0.601**	-0.409**	-0.344**	-0.306*	0.112	0.186	0.100	-0.087	-0.112	0.931**	0.992**	-0.057	-0.339**	**1**	
CCSY	-0.149	-0.180	-0.226	-0.022	0.145	0.151	0.318*	0.783**	0.339**	-0.175	-0.241	0.260	0.280	-0.014	0.176	0.282*	**1**
CY	0.087	0.026	0.020	0.140	0.297*	0.291*	0.280*	0.737**	0.308*	-0.160	-0.201	-0.134	-0.140	0.007	0.341**	-0.142	0.908**

G per cent: Germination at 30 DAP; **T-120**: Tillers at 120 DAP; **S-240**: Shoots at 240 DAP; **NMC**: Number of millable canes; **Nodes**: Number of nodes per cane; **CL**: Cane length; **CD**: Cane diameter; **SCW**: Single cane weight; **TLW**: Total leaf weight; **F per cent**: Fibre per cent; **J extr per cent**: Juice extraction per cent; **Red. s per cent**: Reducing sugars per cent; **CY**: Cane yield; **CCS per cent**: Commercial cane sugar per cent; **CCSY**: Commercial cane sugar yield.

Table 2. Phenotypic path coefficients among cane yield and yield attributing characters

	G per cent	T-120	S- 240	NMC	Nodes	CL	CD	SCW	TLW	F per cent	Correlation with cane yield
G per cent	**0.0075**	-0.0145	0.0037	0.4563	0.0052	-0.0055	0.0006	-0.3555	-0.0051	-0.0052	0.0874
T-120	0.0045	**-0.0240**	0.0037	0.5515	0.0028	-0.0066	-0.0188	-0.4648	-0.0063	-0.0158	0.0262
S- 240	0.0050	-0.0163	**0.0055**	0.5806	0.0134	0.0120	-0.0219	-0.5322	-0.0095	-0.0168	0.0199
NMC	0.0044	-0.0169	0.0041	**0.7840**	0.0064	0.0001	-0.0153	-0.5957	-0.0074	-0.0234	0.1403
Nodes	0.0010	-0.0016	0.0018	0.1243	**0.0406**	0.0561	-0.0154	0.1054	-0.0035	-0.0119	0.2967*
CL	-0.0005	0.0018	0.0007	0.0007	0.0252	**0.0902**	-0.0245	0.2079	-0.0030	-0.0076	0.2910*
CD	0.0001	0.0077	-0.0021	-0.2042	-0.0106	-0.0376	**0.0588**	0.4396	0.0118	0.0170	0.2804*
SCW	-0.0025	0.0103	-0.0027	-0.4306	0.0039	0.0173	0.0238	**1.0845**	0.0109	0.0218	0.7367**
TLW	-0.0016	0.0064	-0.0022	-0.2475	-0.0061	-0.0114	0.0296	0.5045	**0.0234**	0.0128	0.3079*
F per cent	0.0007	-0.0071	0.0017	0.3439	0.0091	0.0129	-0.0188	-0.4434	-0.0056	**-0.0533**	-0.1599

Residual effect = 0.1428. *, ** significant at 5per cent and 1per cent respectively. **G per cent:** Germination at 30 DAP; **T-120**: Tillers at 120 DAP; **S-240**: Shoots at 240 DAP; **NMC**: Number of millable canes; **Nodes**: Number of nodes per cane; **CL**: Cane length; **CD**: Cane diameter; **SCW**: Single cane weight; **TLW**: Total lead weight; **F per cent**: Fibre per cent.

Table 3. Phenotypic path coefficients among CCS per cent and quality attributes

	Juice extraction per cent	Brix per cent	Sucrose per cent	Purity per cent	Reducing sugars per cent	CCS per cent
Juice extraction per cent	**0.0011**	0.0212	-0.1366	0.0024	-0.0004	-0.1122
Brix per cent	-0.0001	**-0.1834**	1.1486	-0.0356	0.0014	0.9308**
Sucrose per cent	-0.0001	-0.1779	**1.1842**	-0.0157	0.0013	0.9917**
Purity per cent	0.0000	0.0765	-0.2182	**0.0854**	-0.0008	-0.0570
Reducing sugars per cent	0.0001	0.0714	-0.4250	0.0184	**-0.0036**	-0.3387**

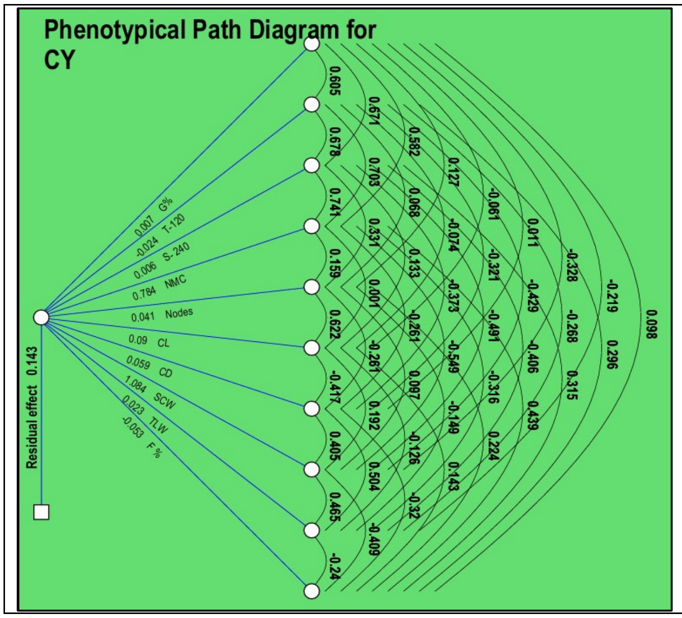

Fig. 1. Phenotypic path diagram among cane yield attributing characters

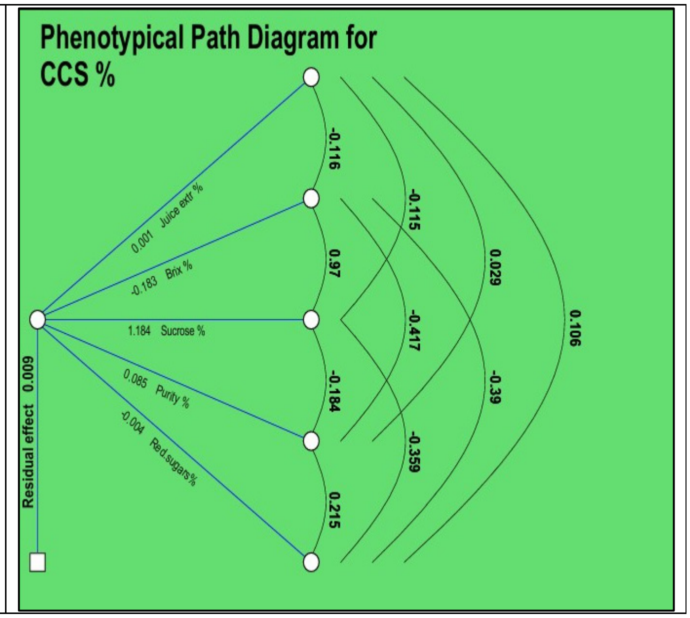

Fig. 2. Phenotypic path coefficients among yield and CCS per cent and quality attributes

Conversely, negative and low direct effect on CCSper cent was exhibited by Brix per cent (-0.1834) and negative and negligible direct effect was exhibited by reducing sugars per cent (-0.0036). Breeding programs should carefully manage these traits to avoid any potential reduction in CCS per cent. While they are important for other quality aspects, their negative impact on CCS per cent requires a balanced approach in selection strategies.

The phenotypic residual effect was 0.009 for early clones indicating that the characters included in the present study are contributing 99.1 per cent of variability for early clones pertaining to the dependent variable i.e. CCS per cent. These results are in accordance with the Thippeswamy *et al.* (2003) and Hiremath *et al.* (2015).

Correlation studies revealed that breeding programmes should focus on improving traits like single cane weight, total leaf weight, CCS yield, number of nodes per cane, cane length, and cane diameter, while taking care of potential trade-offs with juice quality traits.

Path analysis on yield traits revealed that single cane weight and number of millable canes are the most critical traits as they have positive correlation and direct effect on cane yield. Path analysis on quality traits revealed that sucrose per cent is the most important trait for improving CCS per cent.

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