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CORRELATION AND PATH ANALYSIS IN MID-LATE MATURING SUGARCANE CLONES FOR SUGAR YIELD AND ITS ATTRIBUTING TRAITS

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ABSTRACT

An investigation was undertaken to identify thirteen mid-late maturing sugarcane clones in Randomized Block Design with three replications during 2018-19 at Research Farm RPCAU, Pusa, Bihar, to study the correlation and path analysis for sugar yield and its attributing traits. A total of twenty observations were recorded on yield and yield attributing characters. The correlation coefficient analysis revealed that germination % at 45 days, number of shoots at 240 days, no. of milliable canes at harvest, cane height at harvest, pol % in juice at 12 months, purity % at 12 months, CCS % at 12 months, brix at 12 months, single cane weight, extraction %, and pol % in cane showed a highly significant and positive correlation with CCS t/ha (sugar yield). Path coefficient analysis revealed that the trait Pol % in cane showed a high and positive direct effect on sugar yield, followed by brix % at the 12-month stage, fiber % at harvest, CCS % at 12 months, and brix% at 10 months, while Pol % in juice at 12 months exhibited a maximum negative direct effect on sugar yield followed by pol % in juice at the 10-month stage, CCS % at the 10-month stage. Cane yield and sugar yield are regarded as complex characteristics that are influenced by many components or contributing traits, both positive and negative. Generally, direct selection for cane and sugar yield is ineffective due to low heritability. It is desirable to select indirectly for improvement in cane and sugar yield through other characters.

Keywords **:** Correlation coefficient, path coefficient, genotypic path coefficient analysis, indirect effect, etc.

Introduction

Sugarcane (*Saccharum* spp. hybrid complex), the most important sugar crop of India as well as the world, representing a wide range of agro-climatic conditions, has diversified uses as sweeteners for humans, feed for livestock, organic manure for crop production, and raw material in sugar industrial complex. It is grown in 58.83 lakh hectares in India, with a total production of 494-495 million tones and productivity of 84.48 t/ha (ICAR-sugarcane statistics 2022-2023), whereas it is grown in 2.09 lakh hectares in Bihar, with a production of 1.50 million tones and productivity of 57.5 t/ha (ICAR-sugarcane statistics 2022-2023) mainly in north Bihar Sugarcane plants having heterozygous and polyploidy nature has resulted in the generation of greater genetic diversity. Sugarcane is India's main source of sugar production and one of the most important agro-industrial crops in the world (Anonymous, 1997). It also boosts the national economy by providing direct and indirect employment to about 35 million people in India. For yield improvement in sugarcane through selection, the knowledge of the correlation between yield contributing characters is essential. In sugarcane, the cane and sugar yields are considered to be complex characters. Mid-late maturing sugarcane clones are important in enhancing cane and sugar yield. To improve yield rationally, component traits of yield should be selected. The information on the phenotypic and genotypic interrelationship of cane yield and commercial cane sugar (CCS) yield with their component character interest would greatly help the sugarcane breeder. The major aim of any breeders is to develop a variety with high yield. Correlation analysis helps to identify a traits which are directly correlated to yield. However, the interdependence of these component characters among themselves often influences the direct relationship with yield (both cane and sugar yield). As a result, the information based on the correlation coefficients becomes unstable. On the other hand, path coefficient analysis provides direct and indirect effects of component traits, which helps to understand the true relationship of the character. Wright (1921) and Fisher (1936) elaborated on the use and significance of correlation in plant improvement. The knowledge of the association of various characters is important to increase cane and sugar yield through selection for yield attributing and quality characters. Consideration of genetic relationships between important attributes in exploiting genetic populations through breeding and direction.

Material and Methods

The present investigation was carried out to assess the character association in 13 promising mid-late maturing sugarcane clones listed in Table 1. All the 13 mid-late maturing sugarcane clones, including two checks, were planted in Randomized Block Design with three replications during 2018-19 at Dr. Rajendra Prasad Central Agricultural University, Pusa, Bihar, following all the recommended packages and practices for raising sugarcane good crop. A total of 150 three-budded sets of all the clones were planted under field conditions along with checks, and from each replication, each variety was planted in a plot of 6 rows of 6 meters in length, each with a spacing of 0.9 meters between rows. Twenty observations were recorded on five random selected plants in each replication for the characters, such as germination percentage at 45 days, number of tillers at 120 DAP (000/ha), number of shoots (000/ha) at 240 days plant height at harvest (cm), cane diameter at harvest (cm), fiber % at harvest, extraction % at harvest, single cane weight (Kg), number of milliable cane (000/ha) at harvest, Brix % at 10-month stage, pol % in juice at 10 months stage, purity % at 10 months stage, CCS % at 10-month stage, brix % at 12-month stage, pol % in juice at 12 months stage, purity % at 12 months stage, CCS %at 12-month stage, pol % in cane, cane yield t/ha) and CCS tonnes/ha (sugar yield) at harvest. The magnitude of association between two characters is measured by a statistics correlation coefficient (r), a ratio of the covariance between the two variables, and the geometric mean of their variances. The value of the simple correlation coefficient ranges from -1 to +1, with the extreme values indicating perfect association, i.e., all the variability in one character can be accounted for a linear function of the other. The data were statistically analyzed using the R-packages to study genotypic and phenotypic correlation coefficient and path coefficient analysis.

Results and Discussion

Thus, a knowledge of the association between pairs of traits for cane and sugar yield and its component characters, which are less susceptible to environmental variation and are, therefore, capable of being measured with precision, can obliviously be useful for a judicious approach to improving sugar yield. The knowledge and relation of component characters with sugar yield among themselves provide guidelines for plant breeders to improve sugar yield by selecting correlated component characters. However, it is very useful in the selection of parent clones either for cane yield or sugar yield quality parameters based on the information available on the nature of the association of characters. It also focuses on the importance of selecting a genotype as a parent in hybridization. Correlation estimates among various characters have been represented in Tables 2 and 3. In the present investigation, the characters *viz.* germination % at 45 days, number of shoots at 240 days, no. of milliable canes at harvest, cane height at harvest, pol % in juice at 12 month, purity % at 12 months, CCS %12 months, brix at 12 month, single cane weight, extraction %, pol % in cane showed a highly significant and positive correlation with CCS t/ha (sugar yield) both at the phenotypic and genotypic level. These characters play a greater role as an important contributing character to higher sugar yield. A similar result was also found by Pandya *et al.* (2017), who reported CCS (t/ha) had a highly significant and positive correlation with almost all the characters except cane diameter, Tena *et al.* (2016) reported that cane yield showed a strong positive and highly significant correlation with sugar yield, Kheni *et al.* (2015) reported that cane yield was highly significantly and positively correlated sugar yield (t/ha), Bora *et al.* (2014) also found a high and significant correlation between the traits sugar recovery and brix, between sugar recovery and sucrose, Singh *et al.* (2005) observed for no. of milliable cane, stalk weight, and stalk height had significant and positive association with sugar yield. Thippeswamy *et al.* (2003) observed that genotypic correlation coefficients for NMC, stalk weight, and stalk height had significant and positive associations with cane yield and sugar yield. Khan *et al.* (2012) observed cane yield is positively correlated with sugar yield. These yield-contributing characters also possessed highly significant and positive associations among themselves. Godwa *et al.* (2016) found that the cane yield, considered the most important character of sugarcane, was positively and significantly correlated with sugar yield; Navneet *et al.* (2010) reported that sugar yield showed positive and significant correlation with brix, pol, purity %, Tyagi *et al.* (2012) reported that cane yields significant positive association with Sugar yield per plot. Khadian and Mehla (2006) also found positive and highly significant correlations with juice quality traits brix, pol, purity, and commercial cane sugar percentages. Ali *et al.* (2018) also reported a highly positive and significant association of sugar yield with cane yield. For cane yield, all the characters under study showed significant and highly significant positive correlations with all the traits except cane diameter at harvest. Similar results were also reported by Ali et al. (2018), which showed highly positive genotypic and phenotypic associations of cane yield with all the traits. Ali *et al.* (2017), Alam *et al.* (2017), and Agrawal & Kumar (2018) also reported that cane yield showed positive and significant association with almost all the traits under his study. The sugar cane crop's quantum depends on the cane yield and sugar yield characters. The obtained result gives evidence that the selection of genotypes based on no. of milliable canes at harvest, cane height at harvest, pol % in juice at 12 months, purity % at 12 months, CCS % at 12 months, brix at 12 months, single cane weight, extraction %, pol % in cane is helpful in improvement of yield and yield contributing characters. These characters play a greater role as an important contributing character to higher sugar yield.

Path coefficient analysis

Sugar yields a complex quantitative trait and is associated with a number of independent traits influencing directly and indirectly *via* other characters. Since correlation estimates only measure the interrelationship without specifying the direction and extent of the direct and indirect effect of different component traits to yield, it had been considered useful to find out the extent of the phenotypic relationship of yield with other quantitative traits and to assess the influence of yield attributing traits regarding their direct and indirect effect on yield. Correlation studies and path coefficients provide a clearer and better scenario of the cause-and-effect relationship between pairs of traits.

Path coefficient matrix at the genotypic level (Table 4) showed that the characters *viz.,* cane yield, brix % at 12 months, fiber % at harvest, CCS% at 12 months, brix % at 10 months, single cane weight, purity % at 10 months, no. of millable cane no. of shoots at 120 days, purity % at 12 months, extraction % at harvest and cane height at harvest exhibit a positive and direct effect on CCS t/ha (sugar yield) while pol % at 12 months, pol% in juice at the 10-month stage, CCS% at 10 months, and cane yield, germination % at 45 days, number of shoots at 240 days, cane diameter, exhibited a negative direct effect on sugar yield. Patel *et al.* (2006) reported CCS's highest positive direct effect on cane yield**.** Masri *et al.* (2015) brix had a negative phenotypic and genotypic direct effect on sugar recovery, while sucrose had a large positive phenotypic and genotypic direct effect on sugar recovery. Viradhya *et al.* (2016) reported the highest positive direct effect of sucrose percent cane on cane yield, followed by sugar yield and CCS percent. All the characters contribute directly positive magnitude value towards sugar yield and indirectly *via.* other traits that contribute to their positive numerical values on sugar yield may be considered important contributors toward sugar yield.

Residual effect

The lower value of residual effect in the case of both genotypic as well as phenotypic path coefficients indicates that the all-important characters were studied.

Conclusion

The study observed that genotypic correlation was stronger than phenotypic correlation, indicating an inherent relationship among the traits. Traits like germination % at 45 days, number of shoots at 240 days, no. of milliable canes at harvest, cane height at harvest, pol % in juice at 12 months, purity % at 12 months, CCS %12 months, brix at 12 months, single cane weight, extraction %, pol % in cane showed a highly significant and positive correlation with CCS t/ha (sugar yield). Path coefficient analysis results revealed that the cane yield, brix % at 12 months, fiber % at harvest, CCS% at 12 months, brix % at 10 months, single cane weight, purity % at 10 months, no.of milliable cane, no. of shoots at 120 days, purity % at 12 months, extraction % at harvest and cane height at harvest showed a positive and direct effect on sugar yield.

The character cane diameter exhibited a negative direct effect on CCS t/ha (sugar yield). Phenotypic path coefficient analysis of sugar yield with its component character revealed a highly positive direct effect. brix% at 10 months, followed by cane yield and pol% in cane. Therefore, to improve cane yield, effective selection can be practiced for the characters having high direct effects and for the characters through which indirect effects are mainly exerted on sugar yield.

Table 1 : Planting material of thirteen mid-late sugarcane clones with their sources

S. No.	Genotype	Source of collection
1	CoP 15438	SRI, Pusa
2	CoP 15439	SRI, Pusa
3	CoP 15440	SRI, Pusa
4	CoP 15441	SRI, Pusa
5	CoSe 15453	Seorahi
6	CoSe 15454	Seorahi
7	CoSe 15457	Seorahi
8	CoLk 15468	Motipur, (IISR, Lucknow)
9	CoLk 15469	Motipur, (IISR, Lucknow)
10	CoBln 15502	Assam
11	CoP 2061	SRI, Pusa
12	BO 91 (Check)	SRI, Pusa
13	CoP 9301 (Check)	SRI, Pusa

Table 2 : Genotypic correlation matrix for twenty characters of thirteen mid-late maturing sugarcane clones

Traits	NT 120	NS240	NMC	CH12M	CD12M	B12M	PJ10M	P10M	CCS10M	B12M	PJ12M	P12M	CCS 12	SCWH	FH	EH	PolC	CY	SY
G45D	0.894**	0.798**	0.726**	0.582**	-0.621**	-0.016	0.032	0.275	0.089	0.016	0.066	0.554**	0.085	0.458**	-0.054	0.383*	0.091	0.707**	0.575**
NT120		0.865**	0.738**	0.443**	-0.359*	0.006	0.004	0.075	0.025	0.228	0.271	0.586**	0.285	-0.002	0.140	0.313*	0.255	0.403**	0.412**
NS240			1.096**	0.500**	-0.589**	0.562**	0.584**	0.415**	0.579**	0.521**	0.564**	0.849**	0.579**	0.242	-0.009	0.671**	0.615**	0.800**	0.786**
NMC				0.496**	-0.619**	0.494**	0.522**	0.419**	0.532**	0.637**	0.671**	0.834**	0.682**	0.464**	0.296	0.763**	0.648**	0.854**	0.864**
CH12M					-0.077	-0.017	0.013	0.164	0.003	-0.231	-0.178	0.401**	-0.156	0.726**	-0.005	-0.018	-0.186	0.745**	0.541**
CD12						-0.100	-0.096	-0.004	-0.132	-0.105	-0.077	0.155	-0.056	0.095	0.312*	-0.462**	-0.170	-0.276	-0.218
B10M							0.992**	0.525**	0.988**	0.513**	0.492**	0.235	0.485**	0.080	0.188	0.487**	0.485**	0.350*	0.362*
PJ10M								0.632**	0.996**	0.523**	0.510**	0.310*	0.507**	0.145	0.210	0.509**	0.499**	0.408**	0.418**
P10M									0.666**	0.350*	0.387*	0.621**	0.411**	0.448**	0.276	0.368*	0.348*	0.567**	0.523**
CCS10M										0.541**	0.528**	0.310*	0.525**	0.166	0.191	0.504**	0.523**	0.425**	0.438**
B12M											0.997**	0.673**	0.992**	0.155	0.398**	0.682**	0.968**	0.444**	0.672**
PJ12M												0.730**	0.999**	0.208	0.406**	0.698**	0.970**	0.497**	0.722**
P12M													0.760**	0.654**	0.397*	0.711**	0.682**	0.875**	0.988**
CCS12M														0.240	0.420**	0.710**	0.965**	0.524**	0.746**
SCW															0.171	0.552**	0.184	0.863**	0.781**
FH																0.314*	0.171	0.298	0.338*
EH																	0.670**	0.755**	0.786**
PolC																		0.462**	0.692**
CY																			0.956**

**** 1 % level of significance, * 5% level of significance**

G45D-Germination percentage at 45 DAP, NT120- Number of tillers at 120 DAP (000/ha), NS240 Number of shoots (000/ha) at 240 days, NMC- of millable cane (000/ha) at harvest CH12M- Cane height at 12 month (cm), CD12-Cane diameter at 12 month (cm), B10M- Brix % at 10-month stage, PJ10M- pol % in juice at 10 months stage, P10M- purity % at 10 months stage, CCS10M-CCS % at 10-month stage, B12M-brix % at 12-month stage, PJ12M-pol % in juice at 12 months stage, P12M-purity % at 12 months stage, CCS12M-CCS %at 12-month stage, SCW-single cane weight (Kg), FH-Fiber % at harvest, EH-Extraction % at harvest, PolC- Pol % in cane, CY-cane yield t/ha), and SY-CCS tonne/ha (sugar yield) at harvest

Table 3 : Phenotypic correlation matrix for twenty characters of thirteen mid late maturing sugarcane clones

Traits	NT 120	NS240	NMC	CH12M	CD12M	B12M	PJ10M	P10M	CCS10M	B12M	PJ12M	P12M	CCS 12	SCWH	FH	EH	PolC	CY	SY
G45D	0.564**	0.553**	0.596**	0.475**	-0.467**	-0.129	-0.087	0.211	-0.041	0.074	0.108	0.287	0.125	0.389*	-0.045	0.286	0.129	0.571**	0.512**
NT120		0.465**	0.320*	0.107	-0.204	0.026	0.047	0.059	0.094	0.225	0.234	0.210	0.233	0.049	0.039	-0.042	0.235	0.254	0.222
NS240			0.689**	0.347*	-0.517**	0.433**	0.430**	0.235	0.446**	0.355*	0.369*	0.314*	0.363*	0.188	0.012	0.341*	0.389*	0.516**	0.517**
NMC				0.404**	-0.417**	0.401**	0.408**	0.293	0.389*	0.468**	0.497**	0.480**	0.502**	0.381*	0.205	0.600**	0.476**	0.830**	0.827**
CH12M					-0.091	0.023	0.049	0.186	0.041	-0.173	-0.126	0.256	-0.103	0.494**	-0.028	0.024	-0.122	0.531**	0.401**
CD12						-0.107	-0.093	0.024	-0.106	-0.118	-0.095	0.073	-0.071	0.064	0.260	-0.314*	-0.169	-0.203	-0.183
B10M							0.987**	0.405**	0.961**	0.438**	0.416**	0.109	0.401**	0.042	0.134	0.246	0.406**	0.318*	0.290
PJ10M								0.540**	0.984**	0.452**	0.437**	0.160	0.426**	0.080	0.150	0.258	0.424**	0.351*	0.317*
P10M									0.580**	0.321*	0.354*	0.360*	0.369*	0.272	0.181	0.246	0.329*	0.373*	0.360*
CCS10M										0.445**	0.429**	0.147	0.419**	0.105	0.129	0.275	0.422**	0.357*	0.316*
B12M											0.991**	0.399**	0.981**	0.158	0.297	0.382*	0.966**	0.364*	0.597**
PJ12M												0.514**	0.998**	0.203	0.310*	0.401**	0.972**	0.410**	0.642**
P12M													0.564**	0.395*	0.242	0.351*	0.482**	0.534**	0.616**
CCS12M														0.230	0.321*	0.408**	0.967**	0.429**	0.659**
SCW															0.120	0.340*	0.188	0.811**	0.756**
FH																0.197	0.078	0.211	0.221
EH																	0.377*	0.560**	0.598**
PolC																		0.383*	0.623**
CY																			0.939**

** 1% level of significance , * 5 % level of significance

G45D-Germination percentage at 45 DAP, NT120-Number of tillers at 120 DAP (000/ha), NS240 Number of shoots (000/ha) at 240 days, NMC- of millable cane (000/ha) at harvest CH12M- Cane height at 12 month (cm), CD12-Cane diameter at 12 month (cm), B10M-Brix % at the 10-month stage, PJ10M- pol % in juice at 10 months stage, P10M- purity % at 10 months stage, CCS10M-CCS % at 10-month stage, B12M-brix % at the 12-month stage, PJ12M-pol % in juice at 12 months stage, P12M-purity % at 12 months stage, CCS12M-CCS %at the 12-month stage, SCW-single cane weight (Kg), FH-Fiber % at harvest, EH-Extraction % at harvest, PolC- Pol % in cane, CY-cane yield t/ha), and SY-CCS tonne/ha (sugar yield) at harvest

Table 4 : Genotypic Path coefficient matrix (direct and indirect effect) of twenty characters of mid-late maturing sugarcane clones on CCS t/ha (sugar yield)

Traits	G45D	NT 120	NS240	NMC	CH12M	CD12M	B12M	PJ10M	P10M	CCS10M	B12M	PJ12M	P12M	CCS 12	SCWH	FH	EH	PolC	CY	SY
G45D	**-0.908**	0.745	-0.115	0.743	0.154	0.040	-0.054	-0.087	0.318	-0.139	0.144	-3.478	0.265	0.432	0.554	-0.494	0.098	3.226	-0.868	0.575**
NT120	-0.811	**0.834**	-0.125	0.755	0.117	0.023	0.019	-0.011	0.086	-0.040	2.113	-14.188	0.281	1.445	-0.002	1.282	0.080	9.048	-0.495	0.412**
NS240	-0.724	0.721	**-0.145**	1.121	0.132	0.038	1.880	-1.589	0.479	-0.900	4.823	-29.593	0.406	2.936	0.293	-0.079	0.171	21.799	-0.983	0.786**
NMC	-0.659	0.616	-0.158	**1.023**	0.131	0.040	1.651	-1.419	0.484	-0.827	5.889	-35.168	0.399	3.455	0.560	2.703	0.194	23.001	-1.049	0.864**
CH12M	-0.528	0.369	-0.072	0.508	**0.264**	0.005	-0.058	-0.034	0.190	-0.004	-2.132	9.316	0.192	-0.790	0.877	-0.045	-0.005	-6.595	-0.915	0.541**
CD12	0.564	-0.300	0.085	-0.633	-0.020	**-0.064**	-0.335	0.261	-0.004	0.205	-0.972	4.064	0.074	-0.285	0.115	2.845	-0.118	-6.038	0.339	-0.218
B10M	0.015	0.005	-0.081	0.505	-0.005	0.006	**3.343**	-2.700	0.607	-1.536	4.744	-25.830	0.112	2.459	0.097	1.713	0.124	17.217	-0.430	0.362*
PJ10M	-0.029	0.003	-0.084	0.534	0.003	0.006	3.317	**-2.721**	0.731	-1.556	4.841	-26.771	0.148	2.571	0.175	1.916	0.130	17.708	-0.501	0.418**
P10M	-0.250	0.062	-0.060	0.428	0.043	0.000	1.756	-1.720	**1.156**	-1.036	3.236	-20.283	0.298	2.083	0.541	2.519	0.094	12.352	-0.696	0.523**
CCS10M	-0.081	0.021	-0.084	0.544	0.001	0.009	3.302	-2.721	0.770	**-1.556**	5.007	-27.672	0.148	2.660	0.200	1.748	0.128	18.540	-0.523	0.438**
B12M	-0.014	0.191	-0.075	0.651	-0.061	0.007	1.715	-1.424	0.405	-0.842	**9.250**	-52.281	0.322	5.028	0.188	3.637	0.174	34.349	-0.546	0.672**
PJ12M	-0.060	0.226	-0.082	0.686	-0.047	0.005	1.647	-1.389	0.447	-0.821	9.220	**-52.447**	0.349	5.062	0.252	3.710	0.178	34.398	-0.611	0.722**
P12M	-0.503	0.489	-0.123	0.853	0.106	-0.010	0.785	-0.843	0.719	-0.482	6.223	-38.269	**0.479**	3.853	0.790	3.622	0.181	24.193	-1.075	0.988**

CCS12M	-0.078	0.238	-0.084	0.697	-0.041	0.004	1.622	-1.381	0.475	-0.816	9.178	-52.397	0.364	**5.067**	0.290	3.838	0.181	34.233	-0.644	0.746**
SCW	-0.416	-0.002	-0.035	0.475	0.192	-0.006	0.267	-0.393	0.518	-0.258	1.438	-10.922	0.313	1.218	**1.208**	1.561	0.141	6.543	-1.060	0.781**
FH	0.049	0.117	0.001	0.303	-0.001	-0.020	0.627	-0.571	0.319	-0.298	3.685	-21.312	0.190	2.131	0.207	**9.129**	0.080	6.070	-0.367	0.338*
EH	-0.347	0.261	-0.097	0.780	-0.005	0.030	1.628	-1.385	0.425	-0.784	6.305	-36.605	0.341	3.599	0.666	2.869	**0.255**	23.781	-0.928	0.786**
PolC	-0.083	0.213	-0.089	0.663	-0.049	0.011	1.623	-1.358	0.403	-0.813	8.957	-50.860	0.327	4.890	0.223	1.562	0.171	**35.471**	-0.568	0.692**
CY	-0.642	0.336	-0.116	0.873	0.197	0.018	1.169	-1.110	0.655	-0.662	4.109	-26.066	0.419	2.655	1.042	2.724	0.192	16.391	**-1.228**	0.956**

Residual effect= 0.1638

G45D-Germination percentage at 45 DAP, NT120- Number of tillers at 120 DAP (000/ha), NS240 Number of shoots (000/ha) at 240 days, NMC- of millable cane (000/ha) at harvest CH12M- Cane height at 12 months (cm), CD12-Cane diameter at 12 months (cm), B10M- Brix % at 10-month stage, PJ10M- pol % in juice at 10 months stage, P10M- purity % at 10 months stage, CCS10M-CCS % at 10-month stage, B12M-brix % at 12-month stage, PJ12M-pol % in juice at 12 months stage, P12M-purity % at 12 months stage, CCS12M-CCS %at 12-month stage, SCW-single cane weight (Kg), FH-Fiber % at harvest, EH-Extraction % at harvest, PolC- Pol % in cane, CY-cane yield t/ha), and SY-CCS tonne/ha (sugar yield) at harvest

Table 5 : Phenotypic Path coefficient matrix of twenty characters of mid-late maturing sugarcane clones on CCS t/ha (sugar yield)

Traits	G45D	NT 120	NS240	NMC	CH12M	CD12M	B12M	PJ10M	P10M	CCS10M	B12M	PJ12M	P12M	CCS 12	SCWH	FH	EH	PolC	CY	SY
G45D	**-0.033**	-0.019	0.019	-0.001	-0.004	-0.013	-0.246	0.191	0.073	0.002	-0.013	-0.029	-0.009	0.042	-0.006	-0.002	0.002	0.059	0.499	0.512**
NT120	-0.019	**-0.034**	0.016	-0.001	-0.001	-0.006	0.050	-0.102	0.021	-0.003	-0.038	-0.063	-0.007	0.078	-0.001	0.002	0.000	0.108	0.222	0.222
NS240	-0.018	-0.016	**0.034**	-0.001	-0.003	-0.014	0.830	-0.942	0.081	-0.016	-0.060	-0.100	-0.010	0.122	-0.003	0.001	0.002	0.178	0.452	0.517**
NMC	-0.020	-0.011	0.024	**-0.002**	-0.003	-0.012	0.767	-0.894	0.101	-0.014	-0.080	-0.134	-0.015	0.168	-0.006	0.009	0.004	0.218	0.726	0.827**
CH12M	-0.016	-0.004	0.012	-0.001	**-0.007**	-0.003	0.044	-0.108	0.064	-0.002	0.029	0.034	-0.008	-0.035	-0.008	-0.001	0.000	-0.056	0.464	0.401**
CD12	0.016	0.007	-0.018	0.001	0.001	**0.028**	-0.204	0.203	0.009	0.004	0.020	0.026	-0.002	-0.024	-0.001	0.011	-0.002	-0.078	-0.178	-0.183
B10M	0.004	-0.001	0.015	-0.001	0.000	-0.003	**1.915**	-2.160	0.140	-0.034	-0.075	-0.112	-0.003	0.135	-0.001	0.006	0.002	0.186	0.278	0.290
PJ10M	0.003	-0.002	0.015	-0.001	0.000	-0.003	1.890	**-2.189**	0.187	-0.035	-0.077	-0.118	-0.005	0.143	-0.001	0.006	0.002	0.195	0.307	0.317*
P10M	-0.007	-0.002	0.008	-0.001	-0.001	0.001	0.776	-1.183	**0.346**	-0.021	-0.055	-0.096	-0.011	0.124	-0.004	0.008	0.002	0.151	0.326	0.360*
CCS10	0.001	-0.003	0.015	-0.001	0.000	-0.003	1.840	-2.154	0.200	**-0.036**	-0.076	-0.116	-0.005	0.140	-0.002	0.005	0.002	0.194	0.312	0.316*
B12M	-0.003	-0.008	0.012	-0.001	0.001	-0.003	0.839	-0.989	0.111	-0.016	**-0.170**	-0.267	-0.013	0.329	-0.003	0.013	0.002	0.443	0.318	0.597**
PJ12M	-0.004	-0.008	0.013	-0.001	0.001	-0.003	0.796	-0.956	0.123	-0.015	-0.169	**-0.270**	-0.016	0.335	-0.003	0.013	0.002	0.446	0.359	0.642**
P12M	-0.010	-0.007	0.011	-0.001	-0.002	0.002	0.208	-0.351	0.125	-0.005	-0.068	-0.139	**-0.031**	0.189	-0.006	0.010	0.002	0.221	0.467	0.616**
CCS12	-0.004	-0.008	0.012	-0.001	0.001	-0.002	0.768	-0.933	0.127	-0.015	-0.167	-0.269	-0.018	**0.335**	-0.004	0.014	0.002	0.444	0.376	0.659**
SCW	-0.013	-0.002	0.006	-0.001	-0.004	0.002	0.081	-0.174	0.094	-0.004	-0.027	-0.055	-0.012	0.077	**-0.016**	0.005	0.002	0.086	0.709	0.756**
FH	0.002	-0.001	0.000	0.000	0.000	0.007	0.256	-0.329	0.063	-0.005	-0.051	-0.084	-0.008	0.108	-0.002	**0.042**	0.001	0.036	0.185	0.221
EH	-0.010	0.001	0.012	-0.001	0.000	-0.009	0.470	-0.565	0.085	-0.010	-0.065	-0.108	-0.011	0.137	-0.005	0.008	**0.006**	0.173	0.489	0.598**
PolC	-0.004	-0.008	0.013	-0.001	0.001	-0.005	0.777	-0.928	0.114	-0.015	-0.164	-0.262	-0.015	0.324	-0.003	0.003	0.002	**0.459**	0.335	0.623**
CY	-0.019	-0.009	0.018	-0.002	-0.004	-0.006	0.608	-0.769	0.129	-0.013	-0.062	-0.111	-0.017	0.144	-0.013	0.009	0.003	0.176	**0.874**	0.939**

RESIDUAL EFFECT = 0.1638

G45D-Germination percentage at 45 DAP,NT120- Number of tillers at 120 DAP (000/ha), NS240 Number of shoots (000/ha) at 240 days, NMC- of millable cane (000/ha) at harvest CH12M- Cane height at 12 month (cm),CD12-Cane diameter at 12 month (cm), B10M- Brix % at 10-month stage, PJ10M- pol % in juice at 10 months stage, P10M- purity % at 10 months stage, CCS10M-CCS % at 10 month stage, B12M-brix % at 12 month stage, PJ12M-pol % in juice at 12 months stage, P12M-purity % at 12 months stage, CCS12M-CCS %at 12 month stage, SCW-single cane weight (Kg), FH-Fiber % at harvest, EH-Extraction % at harvest, PolC- Pol % in cane, CY-cane yield t/ha), , and SY-CCS tonne/ha (sugar yield) at harvest

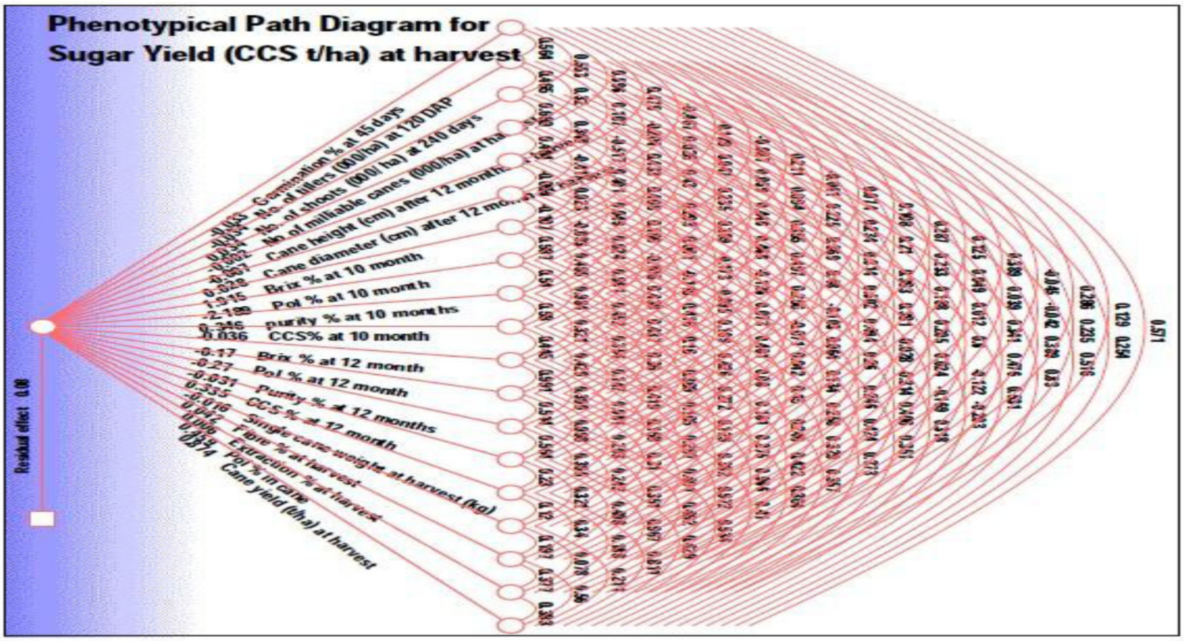

Fig 1 : Phenotypic path diagram for CCS t/ha (sugar yield)

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