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Association between different productive traits for high cane and sugar yield in early maturing sugarcane

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Abstract
A study was conducted to estimate the association among different traits on cane and sugar yield. Sixteen early maturing sugarcane clones were planted at Dr. RPCAU, Pusa, Bihar. The trial was laid out in Randomized Block Design with three replications during spring season 2016 to genetic studies on early maturing sugarcane for high sucrose and cane yield. The characters studied were germination percentage at 45 DAP, germination percentage at 90 DAP, number of shoots at 120 DAP (000/ha), number of shoots at 240 DAP (000/ha), plant height at 150 days (cm), plant height at 240 days (cm), plant height at harvest (cm), cane diameter at harvest (cm), fibre per cent at harvest, single cane weight (kg), number of millable cane at harvest (000/ha), brix per cent during 8 month stage, pol per cent during 8 months stage, purity per cent during 8 months stage, brix per cent during 10 month stage, pol per cent during 10 months stage, purity per cent during 10 months stage, cane yield (tonne/ha), CCS per cent at harvest and sugar yield (tonne/ha) at harvest. Characters like plant height at 150 days, plant height at 240 days, cane diameter, single cane weight, millable cane, plant height at harvest exhibited significant and positive association with cane yield. Characters namely, plant height at 150 days, plant height at 240 days, cane diameter, cane weight, millable cane, plant height at harvest, brix per cent during 10 month stage, pol per cent during 10 month stage and CCS per cent showed significant and positive association with sugar yield. Therefore, the selection can be practiced for these characters in order to identify the superior clones for improvement of cane and sugar yield in early maturing sugarcane

Keywords: Association between different productive traits, high cane, sugar yield

1. Introduction
Sugarcane belongs to the *Andropogonae* tribe of the family *Poaceae* order *Poales* class *Liliopsida* sub-division *Angiospermae* division *Embryophita siphonogama*. There are three species of cultivated sugarcane within genus *Saccharum* (*S. officinarum*, *S. sinense* and *S. barberi*) and two wild species (*S. robustum* and *S. spontaenum*). In India, total area under sugarcane is 5.307 million ha with a production of 366.80 million tonnes and productivity 69.1 tonnes per ha of which Bihar shares only an area of 0.302 million ha, production of 14.90 million tonnes and productivity of 50.00 tonnes per ha (Indian Sugar, 2016) [2]. A clear cut understanding of correlation of qualitative and quantitative characters of the breeding material is essential for breeder. Yield in sugarcane is dependent on a number of factors. Breeders studied yield component through correlation. Correlation is an important tool of crop improvement. The concept of correlation is used to explore and reveal the relationship between yield and its components. The correlation among yield contributing traits is not only important from theoretical point of view but also for practical value as selection is equally concerned with changing two or more attributes simultaneously.

Material and method
The present investigation was carried out on early maturing sugarcane clones at Pusa farm, Dr. RPCAU, Pusa, Samastipur, Bihar, India during spring season of 2016-2017. The experimental material comprises of sixteen promising sugarcane clones including two checks for genetic studies on early maturing sugarcane for high sucrose and cane yield. Out of sixteen early maturing sugarcane clones, two clones namely BO 153 and CoSe 95422 were used as check. The details of these clones are provided in Table 1. These clones exhibited wide spectrum of variation for various agronomical and morphological characters. The experiment was laid in Randomized block design with three replication. The data were recorded from 5 randomly selected plants from each entry on 20 distinct morphological characters (Table 2). The Phenotypic and genotypic correlation between cane yield and its contributing

traits were estimated using the method suggested by Aljibouri *et.al.* (1958) as well as Panse and Sukhatme (1967) [3].
Correlations were calculated using the following formula:

$$r(X_1, X_2) = \frac{Cov(X_1, X_2)}{\sqrt{V(x_1).V(x_2)}}$$

Where,
$r(x_1, x_2)$ is the correlation between x_1 and x_2
Cov (x_1, x_2) is the covariance between x_1 and x_2
V (x_1) is the variance of x_1
V (x_2) is the variance of x_2
Considering genotypic values (σ^2gi and σ^2gj) the genotypic correlation were calculated:

$$r(g_i, g_j) = \frac{Cov(g_i, g_j)}{\sqrt{V(g_i).V(g_j)}}$$

Where,
r (g_i, g_j) is the genetic correlation between g_i and g_j.
Cov $(g_i\ g_j)$ is the covariance between g_i and g_j.
V (g_i) is the variance of g_i
V (g_j) is the variance of g_j
Similarly, phenotypic correlation was calculated by using phenotypic variance and co-variance by using the following formula:

$$r(p_i, p_j) = \frac{Cov(p_i, p_j)}{\sqrt{V(P_i).V(p_j)}}$$

Where,
r (p_i, p_j) = Phenotypic correlation between p_i& p_j
Cov. $(p_i\ p_j)$ = Covariance between P_i& P_j
V (p_i) = variance of P_i
V (p_j) = variance of P_j
Estimates of correlation coefficients were compared against r-values given in Fisher and Yates (1938) table at (n-2) d.f. at the probability levels of 0.05 and 0.01 to test their significance.

Table 1: List of 16 early maturing sugarcane clones, parentage and their source

S. No	Clones	Parentage	Source
1.	BO 130	BO 91 X BO 43	SRI, Pusa
2.	CoLk 12207	CoLk 8002 GC	Motipur, Bihar
3.	CoLk 12208	LG 95053 Self	Motipur, Bihar
4.	CoP 11436	BO 91 X Co 62198	SRI, Pusa
5.	CoP 11437	BO 91 X Co 62198	SRI, Pusa
6.	CoP 11438	CoSe 92423 GC	SRI, Pusa
7.	CoP 12436	BO 91 GC	SRI, Pusa
8.	CoP 12437	CoS 8408 GC	SRI, Pusa
9.	CoP 14436	BO 108 GC	SRI, Pusa
10.	CoP 14437	CoSe 96260 GC	SRI, Pusa
11.	CoP 15436	BO 91 GC	SRI, Pusa
12.	CoP 15437	BO 108 GC	SRI, Pusa
13.	CoSe 11452	CoSe 96268 GC	Seorahi, U.P
14.	CoSe 12451	CoSe 94257 X CoS 92254	Seorahi, U.P
15.	BO 153 (check)	BO 131 Self	SRI, Pusa
16.	CoSe 95422 (check)	BO 91 X Co 453	Seorahi, U.P

Table 2: List of characters studied and their abbreviations

S.N.	Symbol	Characters
1.	X_1	Germination percentage at 45 DAP
2.	X_2	Germination percentage at 90 DAP
3.	X_3	Number of Shoots 120 DAP (000/ha)
4.	X_4	Number of Shoots 240 DAP (000/ha)
5.	X_5	Plant Height at 150 Days (cm)
6.	X_6	Plant Height at 240 Days (cm)
7.	X_7	Plant Height at harvest (cm)
8.	X_8	Cane Diameter at harvest (cm)
9.	X_9	Fiber per cent at harvest
10.	X_{10}	Single Cane Weight (kg)
11.	X_{11}	Millable Cane at harvest (000/ha)
12.	X_{12}	Brix per cent during 8 Month Stage
13.	X_{13}	Pol per cent during 8 Month Stage
14.	X_{14}	Purity per cent during 8 Month Stage
15.	X_{15}	Brix per cent during 10 Month Stage
16.	X_{16}	Pol per cent during 10 Month Stage
17.	X_{17}	Purity per cent during 10 Month Stage
18.	X_{18}	Cane Yield (tonne/ha)
19.	X_{19}	CCS per cent at harvest
20.	X_{20}	Sugar Yield (tonne/ha)

Result and discussion
The correlation coefficient provides symmetrical measurement of degree of association between characters. It determines character association for improvement yield and other economic characters. Since the association pattern among yield contributing traits helps to select the superior genotypes from divergent population based on more than one interrelated characters. Thus, the information on correlation of yield with related traits is the prerequisite to form an effective selection strategy aimed at its improvement.
There are two dependable variables in case of correlation one is cane yield and another is sugar yield. Strong correlation

was exist between cane yield and sugar yield and the correlation value are 0.9990 and 0.9832, respectively at genotypic and phenotypic level from the perusal of Table No II and I(Appendix). In present study as evidence from findings (Table 4.4a and 4.4b) out of twenty characters studied plant height at 150 days, plant height at 240 days, cane diameter, single cane weight, millable cane, plant height at harvest and sugar yield showed positive and significant genotypic correlation with cane yield. Whereas, it is also observed that there were positive and significant association between above characters with sugar yield. In addition to that there were three more characters namely brix per cent during 10 month stage, pol per cent during 10 month stage and CCS per cent showed positive and significant genotypic association with sugar yield. Similar result were also reported by earlier workers namely, Tadesse and Dilnesaw (2014) [6] for positive and highly significant association between cane yield and single cane weight and millable cane number, cane diameter. Therefore, they stated that more emphasis should be given on number of millable cane and cane height and those characters positively correlated with them.

Sanghera *et al.* (2015) [2] reported that cane yield was found to be significantly and positively correlated with NMC at 10 months, stalk length, single cane weight, cane diameter and germination percentage at 45 days indicating the importance of these characters to be involved in selection criteria and Tena *et al*. (2016) [7] studied that cane yield showed strong positive and highly significant correlation with millable cane number, single cane weight, stalk height and sugar yield. There was also positive significant correlation of tiller count and cane diameter with cane yield. Cane and sugar yield are the end product of interaction of many factors known as contributing components hence it is complex trait understanding of the interaction of characters among themselves and with the environment has been of great use in the plant breeding.

The aim of correlation studies is primarily to know the suitability of various characters for indirect selection because selection for one or more characters result in correlated response for several other characters **(**Searle, 1965) [4] and the pattern of variation will also be changed (Weddington and Robertson, 1966) [8]. This is due to correlation between different characters of plant could arise because of linkage, pleiotropy or developmentally influenced functional relationship. This correlation studies provide information on the nature and extent of association between any two pairs of metric characters. From this it could be possible to bring about genetic up gradation in one character by selection of other pair. The genotypic correlation coefficient values were higher than phenotypic values from the perusal of table no 4.4a, 4.4b, 4.4c and 4.4d. This indicated that strong intrinsic association were somewhat masked at phenotypic level due to environmental effect (Singh *et al.* 2002) [5].

Table 4.4(a): Inter-relationship of different cane yield attributing characters at genotypic levels

S. N.	Characters	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15	X16	X17	X19
X1	Germination percentage at 45 DAP	1.0000																	
X2	Germination percentage at 90 DAP	0.5779	1.0000																
X3	No. of Shoots at 120 DAP (000/ha)	-0.2109	0.2147	1.0000															
X4	No. of Shoots at 240 DAP (000/ha)	-0.4662	0.1880	0.6630	1.0000														
X5	Plant Height at 150 Days (cm)	0.3537	0.7182	-0.1038	-0.1074	1.0000													
X6	Plant Height at 240 Days (cm)	0.0919	-0.0625	-0.0254	-0.4759	0.2987	1.0000												
X7	Plant Height at harvest (cm)	0.4099	0.4125	-0.0234	0.1343	0.6459	0.3909	1.0000											
X8	Cane Diameter at harvest (cm)	0.1467	0.0342	0.2115	0.0146	0.3018	0.5319	0.2866	1.0000										
X9	Fiber per cent at harvest	0.1430	-0.0917	-0.1663	-0.2841	-0.4170	-0.3001	-0.5848	-0.7797	1.0000									
X10	Single Cane Weight (kg)	-0.0635	0.2923	0.3286	-0.0601	0.7912	0.6037	0.4716	0.8032	-0.6574	1.0000								
X11	Millable Cane at harvest (000/ha)	0.1058	0.0524	-0.6275	-0.4019	0.3373	0.1710	0.1898	0.0608	0.0674	-0.1568	1.0000							
X12	Brix per cent during 8 Month Stage	-0.0480	-0.1321	0.2621	0.3087	0.2137	0.3723	0.4207	0.4265	-0.2156	0.2807	-0.0067	1.0000						
X13	Pol per cent during 8 Month Stage	-0.0101	-0.0761	0.2970	0.3767	0.2315	0.3463	0.4421	0.4200	-0.2395	0.2693	0.0366	0.9968	1.0000					
X14	Purity per cent during 8 Month Stage	0.2907	0.4424	0.3633	0.5719	0.1978	-0.1632	0.2715	0.0464	-0.2652	0.0016	0.3405	0.0786	0.1727	1.0000				
X15	Brix per cent during 10 Month Stage	0.0091	0.0698	0.3868	0.0457	0.0742	0.5668	0.2986	0.4652	-0.5206	0.2764	-0.2654	0.5195	0.5077	-0.0719	1.0000			
X16	Pol per cent during 10 Month Stage	-0.0012	0.1160	0.3131	-0.0675	0.2785	0.6121	0.4143	0.4282	-0.5232	0.3576	-0.0686	0.4482	0.4501	0.0619	0.9482	1.0000		
X17	Purity per cent during 10 Month Stage	0.0309	0.0914	-0.5063	-0.3066	0.4588	-0.1828	0.0557	-0.4720	0.2226	-0.0159	0.7192	-0.5186	-0.4920	0.2587	-0.8483	-0.5898	1.0000	
X19	CCS per cent at harvest	0.0242	0.1513	0.2809	-0.1044	0.3785	0.5653	0.4737	0.3248	-0.4737	0.3667	0.0320	0.4038	0.4138	0.1452	0.8515	0.9755	-0.3897	1.0000
X18	Cane Yield (tonne/ha)	-0.0148	0.2810	0.0211	-0.2532	0.9014	0.6721	0.5329	0.8252	-0.5977	0.8801	0.3295	0.2748	0.2818	0.1460	0.1558	0.3242	0.3047	0.3797

Table 4.4(c): Inter-relationship of different cane yield attributing characters at phenotypic levels

S. N.	Characters	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15	X16	X17	X19
X1	Germination percentage at 45 DAP	1.0000																	
X2	Germination percentage at 90 DAP	0.3369*	1.0000																
X_3	No. of Shoots at 120 DAP (000/ha)	-0.1294	0.2503	1.0000															
X4	No. of Shoots at 240 DAP(000/ha)	-0.1483	0.2208	0.4438**	1.0000														
X5	Plant Height at 150 Days (cm)	0.1439	0.5105**	-0.0432	-0.0787	1.0000													
X_6	Plant Height at 240 Days (cm)	0.0738	-0.0979	-0.0490	-0.3715**	0.3740**	1.0000												
X_7	Plant Height at harvest (cm)	0.2349	0.3557*	0.0150	0.1917	0.5036**	0.2144	1.0000											
X_8	Cane Diameter at harvest (cm)	0.0315	0.0039	0.1824	-0.1305	0.2585	0.3353*	0.2360	1.0000										
X9	Fibre per cent at harvest	-0.0705	-0.1433	-0.1738	-0.2290	-0.0449	-0.1332	-0.3700**	-0.3186*	1.0000									
X10	Single Cane Weight (kg)	-0.0199	0.2458	0.2001	0.0398	0.5627**	0.4242**	0.2770	0.6295**	-0.2974*	1.0000								
X11	Millable Cane at harvest (000/ha)	0.2045	0.0429	-0.3680*	-0.1338	-0.0115	-0.0393	0.1990	-0.0513	-0.2590	-0.1178	1.0000							
X12	Brix per cent during 8 Month Stage	0.0890	-0.0785	0.2256	0.3236*	0.1066	0.2327	0.3580*	0.2567	-0.2524	0.2282	0.0464	1.0000						
X13	Pol per cent during 8 Month Stage	0.1207	-0.0476	0.2653	0.3498*	0.1003	0.2142	0.3764**	0.2666	-0.2589	0.2257	0.0495	0.9867**	1.0000					
X14	Purity per cent during 8 Month Stage	0.1735	0.2454	0.2935*	0.2690	0.0560	-0.0985	0.1983	0.0980	-0.0965	0.0531	0.0855	0.0450	0.1962	1.0000				
X15	Brix per cent during 10 Month Stage	0.0583	0.0333	0.3236*	0.1498	0.1219	0.3312*	0.1341	0.2413	-0.2477	0.2559	-0.0944	0.4026**	0.3815**	-0.0746	1.0000			
X16	Pol per cent during 10 Month Stage	0.0310	0.0799	0.2616	0.1160	0.2518	0.3273*	0.2183	0.2120	-0.2553	0.3055*	-0.0107	0.3613*	0.3445*	-0.0104	0.9537**	1.0000		
X17	Purity per cent during 10 Month Stage	-0.1347	0.0665	-0.3242*	-0.2092	0.1846	-0.2721	0.0730	-0.1531	0.2006	-0.0355	0.2006	-0.3421*	-0.3159	0.1985	-0.6315*	-0.4065*	1.0000	
X19	CCS per cent at harvest	0.0117	0.0901	0.2289	0.0814	0.3132*	-0.2904*	0.2692	0.1761	-0.1983	0.2940*	0.0238	0.3173*	0.3063*	0.0444	0.8784**	0.9756**	-0.2395	1.0000
X18	Cane Yield (tonne/ha)	0.0960	0.2167	-0.0435	-0.0417	0.4587**	0.3373*	0.3501*	0.5352**	-0.4033**	0.8070**	0.4855**	0.2362	0.2362	0.0942	0.1840	0.2722	0.0677	0.2789

*, ** significant at 5% and 1% level respectively

Table 4.4(b): Inter-relationship of different sugar yield attributing characters at genotypic levels

S.N.	Characters	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15	X16	X17	X19
X1	Germination percentage at 45 DAP	1.0000																	
X_2	Germination percentage at 90 DAP	0.5779	1.0000																
X_3	No. of Shoots at 120 DAP (000/ha)	-0.2109	0.2147	1.0000															
X_4	No. of Shoots at 240 DAP (000/ha)	-0.4662	0.1880	0.6630	1.0000														
X5	Plant Height at 150 Days (cm)	0.3537	0.7182	-0.1038	-0.1074	1.0000													
X6	Plant Height at 240 Days (cm)	0.0919	-0.0625	-0.0254	-0.4759	0.2987	1.0000												
X7	Plant Height at harvest (cm)	0.4099	0.4125	-0.0234	0.1343	0.6459	0.3909	1.0000											
X_8	Cane Diameter at harvest (cm)	0.1467	0.0342	0.2115	0.0146	0.3018	0.5319	0.2866	1.0000										
X_9	Fibre per cent at harvest	0.1430	-0.0917	-0.1663	-0.2841	-0.4170	-0.3001	-0.5848	-0.7797	1.0000									
X10	Single Cane Weight (kg)	-0.0635	0.2923	0.3286	-0.0601	0.7912	0.6037	0.4716	0.8032	-0.6574	1.0000								
X11	Millable Cane at harvest (000/ha)	0.1058	0.0524	-0.6275	-0.4019	0.3373	0.1710	0.1898	0.0608	0.0674	-0.1568	1.0000							
X12	Brix per cent during 8 Month Stage	-0.0480	-0.1321	0.2621	0.3087	0.2137	0.3723	0.4207	0.4265	-0.2156	0.2807	-0.0067	1.0000						
X13	Pol per cent during 8 Month Stage	-0.0101	-0.0761	0.2970	0.3767	0.2315	0.3463	0.4421	0.4200	-0.2395	0.2693	0.0366	0.9968	1.0000					
X14	Purity per cent during 8 Month Stage	0.2907	0.4424	0.3633	0.5719	0.1978	-0.1632	0.2715	0.0464	-0.2652	0.0016	0.3405	0.0786	0.1727	1.0000				
X15	Brix per cent during 10 Month Stage	0.0091	0.0698	0.3868	0.0457	0.0742	0.5668	0.2986	0.4652	-0.5206	0.2764	-0.2654	0.5195	0.5077	-0.0719	1.0000			
X16	Pol per cent during 10 Month Stage	-0.0012	0.1160	0.3131	-0.0675	0.2785	0.6121	0.4143	0.4282	-0.5232	0.3576	-0.0686	0.4482	0.4501	0.0619	0.9482	1.0000		
X17	Purity per cent during 10 Month Stage	0.0309	0.0914	-0.5063	-0.3066	0.4588	-0.1828	0.0557	-0.4720	0.2226	-0.0159	0.7192	-0.5186	-0.4920	0.2587	-0.8483	-0.5898	1.0000	
X19	CCS per cent at harvest	0.0242	0.1513	0.2809	-0.1044	0.3785	0.5653	0.4737	0.3248	-0.4737	0.3667	0.0320	0.4038	0.4138	0.1452	0.8515	0.9755	-0.3897	1.0000
X20	Sugar Yield (tonne/ha)	-0.0134	0.2857	0.0552	-0.2698	0.9040	0.7178	0.5595	0.8301	-0.6305	0.8855	0.3132	0.3093	0.3166	0.1471	0.2318	0.4027	0.2388	0.4555

Table no 4.4(d): Inter-relationship of different sugar yield attributing characters at phenotypic levels

S.N.	Characters	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15	X16	X17	X19
X1	Germination percentage at 45 DAP	1.0000																	
X_2	Germination percentage at 90 DAP	0.3369*	1.0000																
X3	No. of Shoots 120 at DAP (000/ha)	-0.1294	0.2503	1.0000															
X4	No. of Shoots 240 at DAP (000/ha)	-0.1483	0.2208	0.4438**	1.0000														
X_5	Plant Height at 150 Days (cm)	0.1439	0.5105**	-0.0432	-0.0787	1.0000													
X_6	Plant Height at 240 Days (cm)	0.0738	-0.0979	-0.0490	-0.3715**	0.3740**	1.0000												
X_7	Plant Height at harvest (cm)	0.2349	0.3557*	0.0150	0.1917	0.5036**	0.2144	1.0000											
X_8	Cane Diameter at harvest (cm)	0.0315	0.0039	0.1824	-0.1305	0.2585	0.3353*	0.2360	1.0000										
X9	Fiber per cent at harvest	-0.0705	-0.1433	-0.1738	-0.2290	-0.0449	-0.1332	-0.3700**	-0.3186*	1.0000									
X10	Single Cane Weight (kg)	-0.0199	0.2458	0.2001	0.0398	0.5627**	0.4242**	0.2770	0.6295**	-0.2974*	1.0000								
X11	Millable Cane at harvest (000/ha)	0.2045	0.0429	-0.3680*	-0.1338	-0.0115	-0.0393	0.1990	-0.0513	-0.2590	-0.1178	1.0000							
X12	Brix per cent during 8 Month Stage	0.0890	-0.0785	0.2256	0.3236*	0.1066	0.2327	0.3580*	0.2567	-0.2524	0.2282	0.0464	1.0000						
X13	Pol per cent during 8 Month Stage	0.1207	-0.0476	0.2653	0.3498	0.1003	0.2142	0.3764**	0.2666	-0.2589	0.2257	0.0495	0.9867**	1.0000					
X14	Purity per cent during 8 Month Stage	0.1735	0.2454	0.2935*	0.2690	0.0560	-0.0985	0.1983	0.0980	-0.0965	0.0531	0.0855	0.0450	0.1962	1.0000				
X15	Brix per cent during 10 Month Stage	0.0583	0.0333	0.3236*	0.1498	0.1219	0.3312*	0.1341	0.2413	-0.2477	0.2559	-0.0944	0.4026**	0.3815**	-0.0746	1.0000			
X16	Pol per cent during 10 Month Stage	0.0310	0.0799	0.2616	0.1160	0.2518	0.3273*	0.2183	0.2120	-0.2553	0.3055*	-0.0107	0.3613*	0.3445*	-0.0104	0.9537**	1.0000		
X17	Purity per cent during 10 Month Stage	-0.1347	0.0665	-0.3242*	-0.2092	0.1846	-0.2721	0.0730	-0.1531	0.2006	-0.0355	0.2006	-0.3421*	-0.3159*	0.1985	-0.6315**	-0.4065**	1.0000	
X19	CCS per cent at harvest	0.0117	0.0901	0.2289	0.0814	0.3132*	0.2904*	0.2692	0.1761	-0.1983	0.2940*	0.0238	0.3173*	0.3063*	0.0444	0.8784**	0.9756**	-0.2395	1.0000
X20	Sugar Yield (tonne/ha)	0.0889	0.2165	-0.0009	-0.0156	0.4781**	0.3510*	0.3583*	0.5236**	-0.4009**	0.8068**	0.4558**	0.2678	0.2650	0.0902	0.3295*	0.4284**	0.0258	0.4391**

*, ** significant at 5% and 1% level respectively

Appendix-3

Table 1: Inter-relationship of different sugar yield attributing characters with (special reference to cane yield) at genotypic levels

S. N.	Character	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15	X16	X17	X18	X19
X1	Germination percentage at 45 DAP	1.0000																		
X2	Germination percentage at 90 DAP	0.5779	1.0000																	
X3	No.of Shoots at 120 DAP (000/ha)	-0.2109	0.2147	1.0000																
X4	No.of Shoots at 240 DAP (000/ha)	-0.4662	0.1880	0.6630	1.0000															
X5	Plant Height at 150 Days (cm)	0.3537	0.7182	-0.1038	-0.1074	1.0000														
X6	Plant Height at 240 Days (cm)	0.0919	-0.0625	-0.0254	-0.4759	0.2987	1.0000													
X7	Plant Height at harvest (cm)	0.4099	0.4125	-0.0234	0.1343	0.6459	0.3909	1.0000												
X8	Cane Diameter at harvest (cm)	0.1467	0.0342	0.2115	0.0146	0.3018	0.5319	0.2866	1.0000											
X9	Fibre per cent at harvest	0.1430	-0.0917	-0.1663	-0.2841	-0.4170	-0.3001	-0.5848	-0.7797	1.0000										
X10	Single Cane Weight (kg)	-0.0635	0.2923	0.3286	-0.0601	0.7912	0.6037	0.4716	0.8032	-0.6574	1.0000									
X11	Millable Cane at harvest (000/ha)	0.1058	0.0524	-0.6275	-0.4019	0.3373	0.1710	0.1898	0.0608	0.0674	-0.1568	1.0000								
X12	Brix per cent during 8 Month Stage	-0.0480	-0.1321	0.2621	0.3087	0.2137	0.3723	0.4207	0.4265	-0.2156	0.2807	-0.0067	1.0000							
X13	Pol per cent during 8 Month Stage	-0.0101	-0.0761	0.2970	0.3767	0.2315	0.3463	0.4421	0.4200	-0.2395	0.2693	0.0366	0.9968	1.0000						
X14	Purity per cent during 8 Month Stage	0.2907	0.4424	0.3633	0.5719	0.1978	-0.1632	0.2715	0.0464	-0.2652	0.0016	0.3405	0.0786	0.1727	1.0000					
X15	Brix per cent during 10 Month Stage	0.0091	0.0698	0.3868	0.0457	0.0742	0.5668	0.2986	0.4652	-0.5206	0.2764	-0.2654	0.5195	0.5077	-0.0719	1.0000				
X16	Pol per cent during 10 Month Stage	-0.0012	0.1160	0.3131	-0.0675	0.2785	0.6121	0.4143	0.4282	-0.5232	0.3576	-0.0686	0.4482	0.4501	0.0619	0.9482	1.0000			
X17	Purity per cent during 10 Month Stage	0.0309	0.0914	-0.5063	-0.3066	0.4588	-0.1828	0.0557	-0.4720	0.2226	-0.0159	0.7192	-0.5186	-0.4920	0.2587	-0.8483	-0.5898	1.0000		
X18	Cane Yield (tonne/ha)	-0.0148	0.2810	0.0211	-0.2532	0.9014	0.6721	0.5329	0.8252	-0.5977	0.8801	0.3295	0.2748	0.2818	0.1460	0.1558	0.3242	0.3047	1.000	
X19	CCS per cent at harvest	0.0242	0.1513	0.2809	-0.1044	0.3785	0.5653	0.4737	0.3248	-0.4737	0.3667	0.0320	0.4038	0.4138	0.1452	0.8515	0.9755	-0.3897	0.3797	1.0000
X20	Sugar Yield (tonne/ha)	-0.0134	0.2857	0.0552	-0.2698	0.9040	0.7178	0.5595	0.8301	-0.6305	0.8855	0.3132	0.3093	0.3166	0.1471	0.2318	0.4027	0.2388	0.9990	0.4555

Table 2: Inter-relationship of different sugar yield attributing characters with (special reference to cane yield) at phenotypic levels

S.N.	Character	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15	X16	X17	X18	X19
X1	Germination percentage at 45 DAP	**1.0000**																		
X_2	Germination percentage at 90 DAP	0.3369*	1.0000																	
X3	No. of Shoots at 120 DAP(000/ha)	-0.1294	0.2503	1.0000																
X4	No. of Shoots at 240 DAP(000/ha)	-0.1483	0.2208	0.4438**	1.0000															
X_5	Plant Height at 150 Days (cm)	0.1439	0.5105**	-0.0432	-0.0787	1.0000														
X_6	Plant Height at 240 Days (cm)	0.0738	-0.0979	-0.0490	-0.3715**	0.3740**	1.0000													
X_7	Plant Height at harvest (cm)	0.2349	0.3557*	0.0150	0.1917	0.5036**	0.2144	1.0000												
X_8	Cane Diameter at harvest (cm)	0.0315	0.0039	0.1824	-0.1305	0.2585	0.3353*	0.2360	1.0000											
X9	Fibre per cent at harvest	-0.0705	-0.1433	-0.1738	-0.2290	-0.0449	-0.1332	-0.3700**	-0.3186*	1.0000										
X10	Single Cane Weight (Kg)	-0.0199	0.2458	0.2001	0.0398	0.5627**	0.4242**	0.2770	0.6295**	-0.2974*	1.0000									
X11	Millable Cane at harvest (000/ha)	0.2045	0.0429	-0.3680*	-0.1338	-0.0115	-0.0393	0.1990	-0.0513	-0.2590	-0.1178	1.0000								
X12	Brix per cent during 8 Month Stage	0.0890	-0.0785	0.2256	0.3236*	0.1066	0.2327	0.3580*	0.2567	-0.2524	0.2282	0.0464	1.0000							
X13	Pol per cent during 8 Month Stage	0.1207	-0.0476	0.2653	0.3498*	0.1003	0.2142	0.3764**	0.2666	-0.2589	0.2257	0.0495	0.9867**	1.0000						
X14	Purity per cent during 8 Month Stage	0.1735	0.2454	0.2935*	0.2690	0.0560	-0.0985	0.1983	0.0980	-0.0965	0.0531	0.0855	0.0450	0.1962	1.0000					
X15	Brix per cent during 10 Month Stage	0.0583	0.0333	0.3236*	0.1498	0.1219	0.3312*	0.1341	0.2413	-0.2477	0.2559	-0.0944	0.4026**	0.3815**	-0.0746	1.0000				
X16	Pol per cent during 10 Month Stage	0.0310	0.0799	0.2616	0.1160	0.2518	0.3273*	0.2183	0.2120	-0.2553	0.3055*	-0.0107	0.3613*	0.3445*	-0.0104	0.9537**	1.0000			
X17	Purity per cent during 10 Month Stage	-0.1347	0.0665	-0.3242*	-0.2092	0.1846	-0.2721	0.0730	-0.1531	0.2006	-0.0355	0.2006	-0.3421*	-0.3159	0.1985	-0.6315*	-0.4065*	1.0000		
X18	Cane Yield (tonne/ha)	0.0960	0.2167	-0.0435	-0.0417	0.4587**	0.3373*	0.3501*	0.5352**	-0.4033**	0.8070**	0.4855**	0.2362	0.2362	0.0942	0.1840	0.2722	0.0677	1.0000	
X19	CCS per cent at harvest	0.0117	0.0901	0.2289	0.0814	0.3132*	-0.2904*	0.2692	0.1761	-0.1983	0.2940*	0.0238	0.3173*	0.3063*	0.0444	0.8784**	0.9756**	-0.2395	0.2789	1.0000
X20	Sugar Yield (tonne/ha)	0.0889	0.2165	-0.0009	-0.0156	0.4781	0.3510	0.3583	0.5236	-0.4009	0.8068	0.4558	0.2678	0.2650	0.0902	0.3295	0.4284	0.0258	0.9832	0.4391

*, ** significant at 5% and 1% level respectively

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