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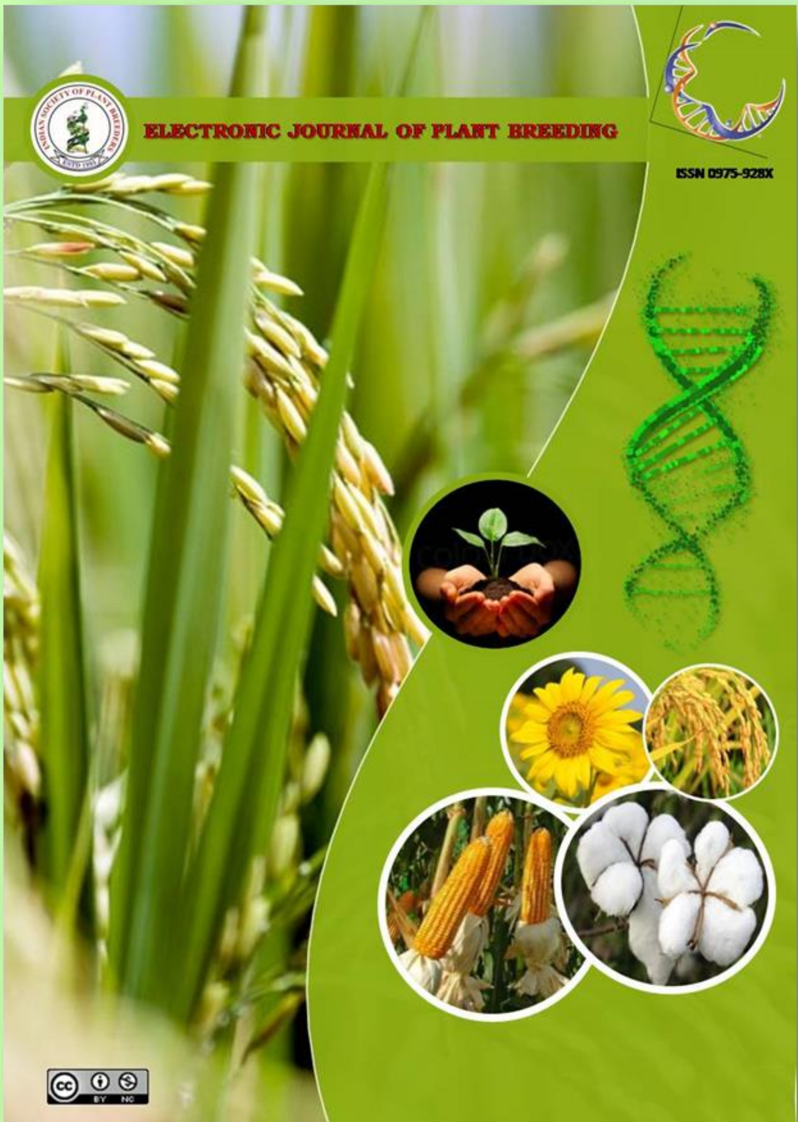

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Research Article

Character association and path analysis for cane yield and its components in interspecific hybrids of *Saccharum* spp.

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Abstract
One hundred and thirty six interspecific hybrids of SSH, SRH and SBH derivation developed utilizing improved clones were assessed for variability and causal effects for cane yield and its related traits. Coefficient of variation was high (38.35 %) for number of millable canes (NMC) and brix (19.70 %) in *S.spontaneum* introgressed hybrid (SSH) and for single cane weight (SCW) (36.74 %) in *S.barberi* introgressed hybrid (SBH). High PCV and GCV were observed for NMC (38.29, 30.67) and sucrose % (34.13, 17.89) in SSH; and SCW (37.57, 34.80) in SBH. High heritability was observed for NMC (0.85) and cane height (0.92) in SSH and for SCW (0.86) and cane thickness (0.80) in SBH. Yield and quality traits had low to high genetic correlation (r_g=0.1181 to 0.8428). SCW (r_g=0.8428) and NMC (r_g=0.7594) showed the highest positive significant correlation with cane yield. NMC and SCW had the highest direct and positive effect on cane yield and suggested as important selection criteria for sugarcane yield improvement.

Key words
Sugarcane, interspecific hybrid, genetic variability, heritability and cane yield.

Introduction

The cultivated sugarcane hybrids are derived mainly from crosses made between *Saccharum officinarum* and *S. spontaneum* and hybrids of unexploited *Saccharum* spp. have to be incorporated in breeding population to broaden the genetic base of commercial cultivars**.** Although used to a lesser extent, hybrids of S. *robustum* are beneficial in improving stalk diameter, stalk height, vigor and also in inheritance of erect growth habit. Introgression breeding programs involving *S. robustum* (Alarmelu *et al*., 2014) and efforts to explore *S. spontaneum* for yield and stress tolerance were also successful in sugarcane breeding. Many characters have been identified as indirect selection indices in sugarcane breeding programmes (Skinner *et al*. 1987) and yield in sugarcane is dependent on a number of factors. Information on genetic parameters and the interrelationships among cane yield and its components is considered of utmost importance in selection of promising families and genotypes in sugarcane. Cane height, cane diameter and number of millable stalks were found to be positively associated with cane yield (Tyagi and Lal 2007 and Jamoza *et al*., 2014) and these characters were given more emphasis in varietal developmental programmes. High heritability estimates for yield and yield related traits, and correlation and path analysis were used to assess the variability and relative importance of yield component traits (Pillai and Ethirajan 1993, Chaudhary 2001 and Viradiya *et al*., 2016)**.** Knowledge of relationship of yield and quality component traits for cane yield improvement is desirable to adopt the most appropriate selection criteria in breeding. In the present study, an attempt was made to generate information on genetic parameters and direct and indirect causal effects of yield components and quality traits on cane yield in sugarcane hybrids introgressed with *S.* spontaneum, *S. robustum* and *S. barberi* respectively SSH, SRH and SBH for formulating an effective breeding strategy.

Materials and Methods

The experimental material comprised eight families involving improved *S. spontaneum*, improved *S. robustum*, *S. barberi* (Pathri) and Co canes developed through biparental hybridization during 2012 flowering season and the resulting progenies were categorized into three introgressed group's *viz. S. spontaneum* (Co 98003 x PIS-15, CoC 671 x SES 90, Co 88025 x SIP 93-8 and SIP 93-434 x Co 8371) introgressed hybrids as SSH, *S. robustum* (PIR 96-285 x CoT 8201, PIR 00-1058 x Co 775 and PIR 00-1002 x Co 94008) introgressed hybrids as SRH and *S. barberi* (Pathri) x Co 87268 introgressed hybrids as SBH. Seedlings were evaluated in two replications during the crop season 2013. Observations were recorded on traits *viz.* NMC/clump, SCW, cane thickness, cane height and H.R brix at 300 days. A total of 136 selected clones (SSH-66, SRH-42 and SBH-28) were evaluated in RBD trial of three replications and plot size of 6m x 1R for yield and quality traits during two crop seasons i.e. 2014 and 2015 at ICAR-Sugarcane Breeding Institute, Coimbatore. Prescribed agronomic and cultural practices were followed. Agronomic characters such as NMC/row, cane thickness, cane height, SCW, cane yield/row, and quality traits *viz.,* brix % and sucrose % were recorded at 360 days. The observations were recorded on three canes in each entry selected randomly in each replication**.** Data was analyzed using appropriate statistical design. Coefficient of variation (CV), genotypic (GCV) and phenotypic coefficient of variation (PCV), broad sense heritability (h^2) and genetic advance as percentage of mean (GAM) with 5 % selection intensity were estimated (Singh and Chaudhary 1985). The direct and indirect effects were studied through Path analysis (Dewey and Lu 1959).

Results and Discussion

Wide variability for NMC/clump, cane thickness, SCW, cane height and H.R brix (Table 1) was observed in seedling population. SSH exhibited high genetic variation with CV % ranging from 15.94 - 38.35 %. Similar studies (Liu *et al*., 2012 and Govindaraj *et al*., 2014) also showed that *S. spontaneum* possess abundant genetic variation for quantitative traits. NMC ranged from 5 to 23 and 4 to 18 with mean values of 12.54 and 9.35 in SSH and SRH respectively. Maximum cane height was recorded in SSH (345 cm) followed by SRH (315 cm) with an average of 222.28 cm and 212.58 cm respectively. Similarly CV % was also high for NMC and cane height (cm) in SSH (38.35, 15.94) and SRH (31.55, 16.61) comparatively with SBH. Cane thickness showed moderate variation with the maximum CV % of 16.04 in SSH. Earlier James *et al*., (2017) reported that *S. spontaneum* recorded highest CV for quantitative traits viz., cane thickness, cane height and brix % evaluated in a diversity panel selected from the world collection of sugarcane (*Saccharum* spp) and related grasses. CV % for SCW was almost same in SSH, SRH and SBH; mean value was nearly 1 kg in SBH. The highest mean value of H.R brix (18.29) was in SBH, which ranged from 16 to 22.4. Sushir *et al*., (2011) also reported a similar finding that the interspecific hybrids of *S. barberi* were superior for brix % than those developed involving *S. spontaneum* or *S. robustum*. Hybrids those performed superior over the mean values for NMC, cane thickness, SCW, cane height and H.R brix in each introgressed group's (SSH-66, SRH-42 and SBH-28) were further investigated for variability, heritability and genetic advance for quality and yield traits.

Significant differences were observed among the hybrids and between the introgressed groups; for all the traits studied (Table 2). Estimated PCV was higher than GCV for yield and quality traits studied in SSH, SRH and SBH. The variability was maximum in progenies of *S. spontaneum* for all the traits studied expect cane thickness and SCW. The high variability was probably due to the allelic difference between the *S. spontaneum* clones and commercial hybrids used in the crosses (Bakshi Ram and Hemaprabha 1992). High difference between PCV and GCV was observed for SCW and sucrose % in SSH and for cane yield/row in SBH, this suggests the phenotypic expressions of traits in the respective groups were highly influenced by environmental effects (Bakshi Ram and Hemaprabha 1992, Bakshi Ram, 2005). Characters such as NMC and cane height in SRH; NMC, cane height, cane thickness and SCW in SBH showed narrow difference between PCV and GCV. Highest estimates of PCV and GCV were observed for NMC (SSH and SRH) followed by SCW (SBH), explains that these traits were highly variable and selection may be effective based on these characters. Earlier Chaudhary (2001) and Bhatnagar *et al*., (2003) also reported high values of genotypic and phenotypic coefficient of variation for NMC and SCW in sugarcane varieties. High PCV and moderate GCV was observed for cane height (SBH), cane yield/row (SSH and SBH), SCW (SRH), brix % and sucrose % (SSH) indicates the genetic variability present in the respective introgressed groups for further improvement. The variability was minimum for cane thickness (SSH and SRH); brix % and sucrose % (SRH and SBH). Nair *et al*., (1980) and Ghosh and Singh (1996) also reported limited genetic variability for quality characters in *S. officinarum* and early maturing clones of sugarcane respectively. In contrast, Alarmelu *et al*., 2014 observed moderate PCV and GCV for brix % and sucrose % in interspecific hybrid derivatives of *S. officinarum* and *S. robustum*.

High h^2 with high GCV estimate for NMC (SSH and SRH), SCW (SBH) and high h^2 with moderate GCV estimate for cane height (SBH) indicates that the genetic variance is highly heritable for the traits in the respective group's. Moderate h^2 with moderate GCV for cane yield/row and sucrose % in SSH suggests that the selections from the group for hybridization will be effective in improvement of both quality and cane yield. This result is in conformity with the observation of Bakshi Ram and Hemaprabha (1992), where high heritability values for quality characters were reported in progenies of *S. spontaneum*. Low h^2 with high PCV for cane yield/row in SRH and SBH reflects the genotypic expression of trait is being masked by environmental effects and non-additive gene action.

Cane height with highest h^2 and high genetic advance and NMC with high h^2 and moderate genetic advance in SSH and SRH indicates low environmental influence and control of the traits by additive gene effect. Ram and Shanker (1997) reported moderate to high expected genetic gain for NMC, SCW and commercial cane sugar yield in interspecific progenies of sugarcane. Alarmelu *et al*., (2014) reported higher estimates of heritability coupled with higher genetic advance for NMC in interspecific hybrids of improved clones of *S. officinarum* crossed with *S. robustum*. The relative expected genetic advance as % of mean was high for SCW in SBH (66.40) followed by NMC in SSH (64.41) and SRH (50.59) and cane height in SSH (36.42). High heritability and high GA with moderate to high GCV for NMC and cane height were observed in all three introgressed groups. Rahman and Bhuiyan (2009) also reported high heritability values coupled with high genetic advance for cane height in indigenous and exotic promising clones of *S. officinarum*. Similar trend was also observed for number of tillers, cane height and number of internodes/stalk in *Saccharum* complex hybrid as reported by Kumar *et al*., (2004). Simple phenotypic selection of the traits NMC and cane height will be reliable in selecting parents for hybridization to improve cane yield in further breeding cycles.

Phenotypic correlation coefficients were higher than genetic correlations in all the three introgressed groups studied (Table 3). Among the groups, in SSH all the traits except cane thickness showed positive and significant correlation with cane yield. NMC (r_g=0.7593, r_p=0.8218) and SCW (r_g=0.5980, r_p=0.6625) showed the highest positive and significant correlation for cane yield. Phenotypic correlation between cane height and cane yield was positively significant but however the genotypic correlation was non-significant. Quality traits (brix %: r_g=0.2919 and sucrose %: r_g=0.2729) showed positive association with cane yield, which indicates that the population can be simultaneously improved for yield and quality. NMC showed significant and negative correlation with cane thickness (r_p= -0.2832) and SCW (r_p= -0.2859). Alarmelu *et al*., (2014) reported similar correlation between the traits on evaluation of interspecific hybrids of *S. officinarum* and *S. spontaneum*. Bakshi ram and Hemaprabha (1992) identified NMC as an important trait for cane yield improvement and also reported significant negative correlation between NMC and SCW in *S. spontaneum* mating group. In our study, SCW was significantly and positively correlated with cane thickness (r_g=0.7873, r_p=0.8825). Similar results were reported (Bora *et al.*, 2014 and Jamoza *et al*., 2014) in sugarcane hybrid population.

On comparison with SSH and SBH, in SRH all the traits studied were positively and significantly correlated with cane yield. SCW (r_g=0.8428) followed by cane thickness (r_g=0.5707), NMC (r_g=0.4027) and cane height (r_g=0.3273) showed the highest positive and significant correlation with cane yield. Alarmelu *et al*., (2014) also reported SCW with highest positive and significant correlation on cane yield in back cross population of *S. robustum*. Brix % showed positive non-significant genotypic correlation (r_g=0.2237) and positive significant phenotypic correlation (r_p=0.3878) with cane yield. Correlation between cane yield and sucrose % was positive and significant at both phenotypic and genotypic level. Earlier, Bakshi Ram and Hemaprabha (1992) reported cane diameter and SCW as selection parameters to develop better quality genotypes among the hybrids of *S. robustum*. In our study also, cane thickness and SCW showed positive significant correlation with brix % (r_g=0.3062, r_p=0.3191) and sucrose % (r_g=0.3282, r_p=0.3748), which indicates that cane thickness and SCW will aid in selection for high yield genotypes with better quality.

In SBH, SCW (r_g=0.5851) and cane height (r_g=0.5636) were highly correlated with cane yield. NMC and cane thickness showed significant positive correlation with cane yield. Quality traits were negatively correlated with cane yield and its component traits studied which indicates low chances of occurrence of progenies combining both yield and quality in backcross generations. But these elite clones with high quality can be further utilized in crosses to develop progenies with improved cane yield, while maintaining the quality on par with commercial checks. NMC had the highest positive direct effect on cane yield in SSH (0.4638) followed by SRH (0.4407) and SBH (0.1234) (Table 4). The indirect effects of NMC through SCW and cane thickness were negative while the indirect effect through cane height, brix % and sucrose % were positive in SSH. In SRH, NMC showed positive indirect effects through cane thickness and brix %. The positive indirect effect of NMC through quality traits in SSH and SRH suggest improvement on cane yield which will also increase sugar yield in further backcrosses. In SBH, NMC exhibited the negative indirect effects through quality traits (brix % and sucrose %). Similar findings (Tena *et al.,* 2016) of negative indirect effect of NMC on cane yield through brix % and sucrose % in local and exotic genotypes of Ethiopia were reported.

Cane thickness had a low positive direct effect on cane yield in SSH and SRH (0.2814 and 0.3246, respectively), however in SBH it has the highest positive direct effect (0.5051). Doule and Balasundaram (2007) reported highest positive direct effect of cane thickness than other traits on sugar yield studied in hybrid derivatives of *Saccharum* spp. The indirect effects through cane height, NMC, brix % and sucrose % were low and negative in SSH and SRH. In SSH, cane thickness had a negative and significant correlation to cane yield (-0.3789) but the direct effect was positive (0.2814) and this indicates that it can be used as a secondary variable in selection for cane yield. Cane thickness exhibits high positive indirect effect through SCW (0.4010) in SRH with direct effect (0.3246), hence the breeding strategy is to consider clones with good cane thickness along with SCW (with significant indirect effects) for hybridization and selection to develop high yielding types from SRH. In SBH the indirect effect of cane thickness was positive only through sucrose % (0.2464) and cane height (0.0217).

SCW showed highest positive direct effect on cane yield in SRH (0.989) followed by SBH (0.4846) and SSH (0.4189). SCW had positive indirect effect on cane yield through cane thickness (0.2651), cane height 0.0251), brix % (0.0228) and sucrose % (0.0392) except NMC (-0.1696) in SSH. In SRH, the indirect positive effect was only through brix % (0.0065); whereas in SBH it showed positive indirect effect through cane thickness (0.1481), cane height (0.0665) and sucrose % (0.1659). These high positive estimates of direct and indirect effects with high positive significant correlation indicate that truncated selection with SCW as important variable for cane yield may provide satisfactory gain in all three groups. Singh et al. (2001) also identified SCW as important component of cane yield studied in sugarcane germplasm.

Cane height was found to have positive direct effect on cane yield (SSH: 0.1149, SRH: 0.0215 and SBH: 0.2472). The positive indirect effect of cane height through SCW (0.2904), cane thickness (0.0774) and brix % (0.0126) has resulted in positive and highly significant (r_g=0.5636) correlation between cane yield and cane height as in SBH. Bakshi Ram and Hemaprabha (1992) also identified cane height as an important character in association with cane yield in *S. barberi* mating group. In SRH, the negative indirect effects through NMC (-0.082), cane thickness (-0.0058), brix % (-0.0031) and sucrose % (-0.0198) were balanced by the highest positive indirect effect through SCW (0.4165); hence the total correlation was positive and significant with cane yield. In SSH the negative indirect effects of cane height through NMC (-0.0059), cane thickness (-0.0340), brix % (-0.0146) and sucrose % (-0.0082) resulted in low positive non-significant genotypic correlation between cane yield and cane height.

Brix % had positive direct effects on cane yield in SSH (0.0929) and SRH (0.1703), while in SBH it was negative. The indirect effects of brix % through SCW and cane thickness was large and positive in SSH, SRH and SBH, while the indirect effects through NMC and cane height were low, positive or negative. Doule and Balasundaram (2007) studied positive indirect effect of brix % through cane thickness and negative indirect effects through NMC and cane height on sugar yield in *Saccharum* hybrids. Singh and. Hence the present study suggests simultaneous selection of brix % along with SCW and cane thickness would be adequately beneficial in combining both yield and quality. Sucrose % showed positive direct effect on cane yield only in SSH (0.0525). The indirect effects through cane yield components such as cane thickness and SCW were high and positive in SSH and SRH. Sugar yield can be improved by simultaneous selection for cane yield and quality traits, hence from our findings it is concluded the improvement on sucrose %, cane thickness and SCW will have positive response on sugar yield improvement. Doule and Balasundaram (2007) also reported that NMC and sucrose % had a dominant role in determining the sugar yield evaluated in interspecific hybrids of *Saccharum*.

Large amount of variability developed through introgressive hybridization in sugarcane is available for further exploitation by breeders. Highest estimate of GCV for NMC in SRH and SCW in SBH with high heritability for cane height (SSH), SCW (SBH), NMC (SSH) and cane thickness (SBH) ensures the population evaluated can be effectively utilized for cane yield improvement. High estimates of GCV and high heritability for NMC in SSH and SRH indicates the invasiveness of *S. spontaneum* and *S. robustum* genome for high tillering capacity in the interspecific hybrids generated. The study identified twenty six superior clones with NMC/row greater than 110, SCW (Kg) over 0.65 and cane height (cm) beyond 300 as potential parents for future use. Path analysis revealed that NMC and SCW had the highest direct effect on cane yield. Hence the study identified NMC and SCW as key yield component traits to be considered for selection for cane yield improvement in *Saccharum* interspecific hybrids. However, NMC was negatively correlated with cane thickness and SCW; hence a suitable selection method where a minimum millable cane number can be fixed before considering cane thickness and SCW is recommended for simultaneous improvement of the traits. Cane height showed high indirect contribution through SCW to cane yield and cane thickness had high positive direct impact on cane yield in SBH. High heterotic vigor observed for NMC, SCW and cane height will be of use in sustaining the yield potential in future generations.

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Table 1. Variability in agronomic traits of interspecific hybrids derived from crosses involving improved *Saccharum* species

Introgressed group/agronomic characters		Number of millable canes/clump	Cane thickness (cm)	Single cane weight (Kg)	Cane height (cm)	H.R brix
SSH (345)	Range	5-23	0.81-2.84	0.23-1.17	155-345	9.4-20.6
	Mean	12.54	1.89	0.68	222.28	15.05
	CV %	38.35	16.04	34.58	15.94	19.7
SRH (209)	Range	4-18	1.88-3.07	0.42-1.27	140-315	15.4-21.2
	Mean	9.35	2.21	0.74	212.58	16.78
	CV %	31.55	14.14	31.42	16.61	12.68
SBH (63)	Range	2-11	2.19-3.36	0.65-1.70	110-265	16-22.4
	Mean	5.14	2.47	0.92	196.85	18.29
	CV %	23.85	10.8	36.74	7.57	9.11

SSH - improved *S.spontaneum* introgressed hybrid; SRH - improved *S.robustum* introgressed hybrid; SBH - *S.barberi* (Pathri) introgressed hybrid. Number of seedlings evaluated in each group is given in parenthesis.

Table 2. Analysis of variance for yield and quality traits in *Saccharum* interspecific hybrids

Trait	Introgression group	Mean sum of squares (genotype)	Mean±S.E	Coefficient of variation		Broad sense heritability (h^2)	Genetic Advance	Genetic Advance as % of Mean (GAM)
				PCV	GCV			
Number of millable canes/row	SSH	760.43**	87.98±14.12	38.29	30.67	0.85	35.47	64.41
	SRH	722.19*	74.79±12.56	36.82	33.93	0.71	27.71	50.59
	SBH	584.41*	55.07±7.88	19.21	16.2	0.64	18.30	28.17
Cane thickness (cm.)	SSH	0.11*	1.91±0.29	12.30	5.23	0.18	0.12	4.59
	SRH	0.12*	2.20±0.23	11.09	6.89	0.39	0.23	8.84
	SBH	0.28*	2.43±0.18	16.26	14.54	0.80	0.65	26.77
Single cane weight (Kg.)	SSH	0.17*	0.78±0.29	32.81	18.38	0.31	0.23	21.22
	SRH	0.14**	1.05±0.24	27.38	17.37	0.40	0.26	22.70
	SBH	0.25*	1.18±0.14	37.57	34.80	0.86	0.65	66.40
Cane height (cm.)	SSH	3638.94**	233.69±9.26	19.30	18.47	0.92	82.23	36.42
	SRH	1958.68**	225.80±12.64	13.68	13.09	0.72	60.24	25.82
	SBH	1768.16**	219.20±8.02	21.81	13.31	0.43	57.98	26.45
Brix %	SSH	12.53**	16.49±1.01	23.26	12.30	0.28	2.61	13.41
	SRH	4.30*	18.13±1.52	8.81	4.32	0.3	1.12	5.42
	SBH	3.88*	20.63±1.31	8.32	5.15	0.38	1.33	6.59
Sucrose %	SSH	18.67*	17.43±1.17	34.13	17.89	0.27	3.18	19.33
	SRH	5.47*	17.24±1.39	11.16	7.70	0.48	1.89	10.95
	SBH	5.03*	18.04±1.78	11.22	5.35	0.33	0.95	5.26
Cane yield/row (Kg.)	SSH	433.32*	74.38±10.60	22.21	17.30	0.59	20.01	26.90
	SRH	455.38*	73.79±11.30	23.19	10.54	0.21	8.27	9.87
	SBH	736.63*	67.39±12.89	30.84	12.67	0.17	8.74	10.73

GCV-Genotypic Coefficient of Variation; PCV-Phenotypic Coefficient of Variation.
*, ** Significant at 5% and 1% probability respectively.
Note: Number of seedlings in SSH, SRH and SBH are 345, 209 and 63 respectively

Table 3. Genotypic and phenotypic correlation coefficient for cane yield with yield component characters and quality traits in interspecific hybrids of improved *Saccharum* species

Trait	Introgression groups		Cane yield/ row (Kg)	Number of millable canes/row	Cane thickness (cm)	Single cane weight (Kg)	Cane height (cm)	Brix %
Number of millable canes/row	SSH	r_g	0.7594**	1.0000				
		r_p	0.8218**	1.0000				
	SRH	r_g	0.4027**	1.0000				
		r_p	0.5136**	1.0000				
	SBH	r_g	0.3992**	1.0000				
		r_p	0.4093**	1.0000				
Cane thickness (cm)	SSH	r_g	-0.3789**	-0.2150^{ns}	1.0000			
		r_p	-0.4066**	-0.2232^{ns}	1.0000			
	SRH	r_g	0.5707**	-0.2434^{ns}	1.0000			
		r_p	0.6211**	-0.2996*	1.0000			
	SBH	r_g	0.3875**	-0.0384^{ns}	1.0000			
		r_p	0.4639**	-0.1104^{ns}	1.0000			
Single cane weight (Kg)	SSH	r_g	0.5980**	-0.2029^{ns}	0.7873**	1.0000		
		r_p	0.6625**	-0.2359^{ns}	0.8825**	1.0000		
	SRH	r_g	0.8428**	-0.1611^{ns}	0.7343**	1.0000		
		r_p	0.8908**	-0.2433 ^{ns}	0.8677**	1.0000		
	SBH	r_g	0.5851**	-0.1568^{ns}	0.5993**	1.0000		
		r_p	0.6521**	-0.2493^{ns}	0.6103**	1.0000		
Cane height (cm)	SSH	r_g	0.1492^{ns}	0.1208^{ns}	0.0734^{ns}	0.1869^{ns}	1.0000	
		r_p	0.2864*	0.2835*	0.1575^{ns}	0.2921*	1.0000	
	SRH	r_g	0.3273*	0.0630^{ns}	0.1063^{ns}	0.4212**	1.0000	
		r_p	0.4420**	0.1515 ^{ns}	0.2294^{ns}	0.5742**	1.0000	
	SBH	r_g	0.5636**	0.1505^{ns}	0.5368**	0.4610**	1.0000	
		r_p	0.5957**	0.2783^{ns}	0.6760**	0.5679**	1.0000	
Brix %	SSH	r_g	0.2919*	0.1053^{ns}	0.2781*	0.2223^{ns}	-0.1576^{ns}	1.0000
		r_p	0.3404*	0.2813*	0.3844*	0.2860*	-0.2557^{ns}	1.0000
	SRH	r_g	0.2237^{ns}	0.1914^{ns}	0.3062**	0. 3282**	-0.0182^{ns}	1.0000
		r_p	0.3878*	0.2524^{ns}	0.3191**	0.3748**	-0.1155^{ns}	1.0000
	SBH	r_g	-0.1181^{ns}	-0.2768^{ns}	-0.0158^{ns}	-0.2599^{ns}	0.0263^{ns}	1.0000
		r_p	-0.2632^{ns}	-0.3406*	-0.1173^{ns}	-0.3052*	0.1339^{ns}	1.0000
Sucrose %	SSH	r_g	0.2729*	0.2893*	0.3121*	0.3520*	-0.1618^{ns}	0.9687**
		r_p	0.3654*	0.3433*	0.4014**	0.4120**	-0.2122^{ns}	0.9989**
	SRH	r_g	0.3583*	0.1152^{ns}	-0.0516^{ns}	0.1377^{ns}	0.1172^{ns}	0.9293**
		r_p	0.4121*	0.2055^{ns}	-0.1577^{ns}	0.2543^{ns}	0.2281^{ns}	0.9873**
	SBH	r_g	-0.1185^{ns}	-0.3875*	-0.0669^{ns}	-0.2407^{ns}	-0.0003^{ns}	0.9166**
		r_p	-0.2792^{ns}	-0.2821^{ns}	-0.1742^{ns}	-0.3324*	-0.0095^{ns}	0.9831**

r_g-Genotypic correlation coefficient; r_p-Phenotypic correlation coefficient. *, ** Significant at 5% and 1% probability respectively; ns - non significant.

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Table 4. Genotypic path analysis showing direct and indirect effects of yield component traits and quality characters on cane yield in *Saccharum* interspecific hybrids

Number of Millable Canes (NMC)/row and Cane yield/row (Kg)			Cane thickness (cm) and Cane yield/row (Kg)			Single Cane Weight (Kg) and Cane yield/row (Kg)		
Direct effect	SSH	0.4638	Direct effect	SSH	0.2814	Direct effect	SSH	0.4189
	SRH	0.4407		SRH	0.3426		SRH	0.989
	SBH	0.1234		SBH	0.5051		SBH	0.4846
Indirect effect via Cane thickness (cm)	SSH	-0.1730	Indirect effect via NMC/row	SSH	-0.2852	Indirect effect via NMC/row	SSH	-0.1696
	SRH	0.1133		SRH	-0.0829		SRH	-0.0549
	SBH	0.0827		SBH	-0.0095		SBH	-0.0729
Indirect effect via SCW (Kg)	SSH	-0.0084	Indirect effect via SCW (Kg)	SSH	-0.3129	Indirect effect via Cane thickness (cm)	SSH	0.2651
	SRH	-0.1593		SRH	0.401		SRH	-0.0401
	SBH	0.07		SBH	-0.076		SBH	0.1481
Indirect effect via Cane height (cm)	SSH	0.4086	Indirect effect via Cane height (cm)	SSH	-0.0024	Indirect effect via Cane height (cm)	SSH	0.0215
	SRH	-0.0052		SRH	-0.0632		SRH	-0.0345
	SBH	0.1443		SBH	0.0217		SBH	0.0665
Indirect effect via Brix %	SSH	0.0425	Indirect effect via Brix %	SSH	-0.0222	Indirect effect via Brix %	SSH	0.0228
	SRH	0.0326		SRH	-0.0181		SRH	0.0065
	SBH	-0.021		SBH	-0.3002		SBH	-0.2071
Indirect effect via Sucrose %	SSH	0.0259	Indirect effect via Sucrose %	SSH	-0.0376	Indirect effect via Sucrose %	SSH	0.0392
	SRH	-0.0194		SRH	-0.0087		SRH	-0.0232
	SBH	-0.0002		SBH	0.2464		SBH	0.1659
Total (direct & indirect effects)	SSH	0.7594	Total (direct & indirect effects)	SSH	-0.3789	Total (direct & indirect effects)	SSH	0.5980
	SRH	0.4027		SRH	0.5707		SRH	0.8428
	SBH	0.3992		SBH	0.3875		SBH	0.5851
Cane height (cm) and Cane yield/row (Kg)			**Brix % and Cane yield/row (Kg)**			**Sucrose % and Cane yield/row (Kg)**		
Direct effect	SSH	0.1149	Direct effect	SSH	0.0929	Direct effect	SSH	0.0525
	SRH	0.0215		SRH	0.1703		SRH	-0.1687
	SBH	0.2472		SBH	-0.0039		SBH	-0.7832
Indirect effect via NMC/row	SSH	-0.0059	Indirect effect via NMC/row	SSH	-0.114	Indirect effect via NMC/row	SSH	-0.1236
	SRH	-0.082		SRH	0.0652		SRH	0.0393
	SBH	-0.0179		SBH	-0.7967		SBH	-0.0050
Indirect effect via Cane thickness (cm)	SSH	-0.0340	Indirect effect via Cane thickness (cm)	SSH	0.1125	Indirect effect via Cane thickness (cm)	SSH	0.1375
	SRH	-0.0058		SRH	0.1058		SRH	0.1028
	SBH	0.2904		SBH	0.1753		SBH	-0.0115
Indirect effect via SCW (Kg)	SSH	0.0970	Indirect effect via SCW (Kg)	SSH	0.1192	Indirect effect via SCW (Kg)	SSH	0.1342
	SRH	0.4165		SRH	0.0377		SRH	0.2362
	SBH	0.0774		SBH	0.0259		SBH	0.1167
Indirect effect via Brix %	SSH	-0.0146	Indirect effect via Cane height (cm)	SSH	-0.0181	Indirect effect via Cane height (cm)	SSH	-0.0186
	SRH	-0.0031		SRH	0.0015		SRH	-0.0096
	SBH	0.0126		SBH	0.0038		SBH	0.1663
Indirect effect via Sucrose %	SSH	-0.0082	Indirect effect via Sucrose %	SSH	0.0994	Indirect effect via Brix %	SSH	0.0909
	SRH	-0.0198		SRH	-0.1568		SRH	0.1583
	SBH	-0.0461		SBH	0.4775		SBH	0.3982
Total (direct & indirect effects)	SSH	0.1492	Total (direct & indirect effects)	SSH	0.2919	Total (direct & Indirect effects)	SSH	0.2729
	SRH	0.3273		SRH	0.2237		SRH	0.3583
	SBH	0.5636		SBH	-0.1181		SBH	-0.1185

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