Website : www.asthafoundation.in
Frontiers in Crop Improvement
Vol 10 (1) : 32-35 (January-2022) Print ISSN : 2393-8234 Online ISSN : 2454-6011
Astha Foundation, Meerut (U.P.) India

Variability, Correlation and Path Analysis for Sugar Yield and its Components in Sugarcane

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Abstract

This study was undertaken to determine association of yield components with sugar yield in sugarcane ratoon crop. Higher GCV and PCV was recorded for cane yield, commercial cane sugar (CCS) yield, number of millable canes (NMC) at harvest, internode length and single cane weight indicating that these traits were highly variable and selection may be effective based on these characters. CCS yield had significant and positive correlation with cane yield, number of millable canes at harvest, cane length, single cane weight, internode length and internode number. Path analysis revealed that cane yield exerted a high magnitude of positive direct effect on CCS yield followed by purity percent and brix percent.

Key words : *Sugarcane, sugar yield, variability studies, correlation and path analysis.*

Introduction

Sugarcane (*Saccharum officinarum* L.) is a major economically important crop in tropical and subtropical countries (1). Ratoon is a common practice in most sugarcane growing countries. In India two ratoons are most common and 50 % area is always under ratoon as planting operations and seed costs constitute the largest input of sugarcane production (2). Cane yield of ratoon crop will be declined by 10-15 % due to disease incidence and other environmental constraints with therefore a need for replacement (3), which will exert profound effect on juice recovery ultimately reducing commercial cane sugar (CCS) yield Additionally genotypes can vary substantially in their rationing ability (4). A good ratooning cultivar is one that produces high yields in ratoon crops without compromising on juice quality. Therefore identifying traits contributing to higher CCS yield assumed importance than cane yield alone. The effectiveness of selection for sugar yield and its components depends largely on the genetic variability present in the breeding population and the heritability of the traits. It is necessary to identify traits with highgenetic variation. Sugar yield and cane yield are complex traits which are influenced by many component traitsdirectly and indirectly in sugarcane (5). Information about the nature and magnitude of variability present in the genetic material is of prime importance for breeders to conduct effective selection programs. Genotypic and phenotypic coefficients of variation together with heritability and genetic advance are key elements to improve any trait of sugarcane, as this would assist in knowing whether or not specific objectives targeted could be achieved from a given crop material (6, 7). The objective of the study was to obtain precise information on inter-relationship among yield and quality component traits and to explore their direct and indirect effects of interrelated components on a complex trait CCS yield in ratoon crop of nineteen different sugarcane varieties. This will help to develop reliable selection criteria for selecting high sugar yielding genotypes having high ratoon ability.

Materials and Methods

The present study was carried out at Agricultural Research Station, Perumallapalle, Tirupati during 2010-11 with nineteen sugarcane varieties in ratoon crop. Eleven promising sugarcane clones developed from Agricultural Research Station, Perumallapalle (2003 T 114, 2003 T 121, 2003 T 123, 2003 T 129, 2004 T 67, 2005 T 16, 2003 T 112, 2004 T 68, 2005 T 50, 2005 T 52, 2005 T 89) three cones from Regional Agricultural Research Station, Anakapalle (3 clones: 2002 A 192, 2000 A 213, 2000 A 225) and two clones from Agricultural Research Station, Vuyyuru (: 2002 V 2 and 2002 V 48) along with checks (2003 V 46, Co 6907 and 83 V 15 representing early and mid-late maturing groups) were used in the study. The experiment wasraised after harvesting plant cropin randomized complete block design with three replications during 2010-11. Size of plot for each genotype was 8 m long with 6 rows following aspacing of 80 cm between rows. All recommended agronomic practices were carried out to raise healthy crop. Data were collected on cane length (m), cane diameter (cm), internode number, internode length, single cane weight (kg), number of millable canes at harvest (000/ha), brix per cent, sucrose per cent, CCS per cent, purity percent, cane yield (t/ha) and commercial cane

Received : December-2021; Revised : December-2021; Accepted : December-2021

Table-1 : Heritability, Variability and Genetic advance Estimates for Quantitative and Quality traits in Sugarcane Ratoon.

Character	Mean	Heritability in broad sense %	Genotypic coefficient of variation (GCV) %	Phenotypic coefficient of variation (PCV) %	Genetic advance (GA) %	Genetic advance as percent of mean (GAM) %
Cane length (m)	2.11	66.04	16.49	20.29	0.58	27.60
Cane girth (cm)	2.43	11.32	3.42	10.16	0.06	2.37
Internode number	25.93	42.28	7.84	12.05	2.72	10.50
Internode length (cm)	7.30	87.80	22.08	23.56	3.11	42.62
Single cane weight (kg)	1.20	84.18	20.56	22.41	0.47	38.86
NMC at harvest (000/ha)	58.00	89.36	25.17	26.62	28.42	49.00
Brix %	19.78	60.24	4.44	5.72	1.40	7.10
Sucrose %	17.69	66.32	6.74	8.27	2.00	11.30
CCS %	12.31	66.57	8.20	10.05	1.70	13.78
Purity %	89.45	60.95	3.87	4.95	5.56	6.22
Cane yield (t/ha)	66.21	83.26	30.12	33.01	37.49	56.62
CCSyield (t/ha)	8.07	77.02	27.40	31.22	4.00	49.54

Table-2 : Correlation Coefficients among Quantitative and Quality Traits in Sugarcane Ratoon.

Character	Cane length (m)	Cane girth (cm)	Inter node number	Inter node length (cm)	Single cane weight (kg)	NMC at harvest (000/ha)	Brix %	Sucrose%	CCS %	Purity %	Cane yield (t/ha)
Cane girth (cm)	0.367**										
Internode number	0.421**	0.250									
Internode length (cm)	0.729**	0.254	-0.000								
Single cane weight (kg)	0.451**	0.405**	0.068	0.591**							
NMCat harvest (000/ha)	0.656**	-0.045	0.244	0.491**	0.169						
Brix %	-0.133	-0.280*	0.208	-0.366**	-0.312*	-0.023					
Sucrose %	-0.130	-0.382**	0.273*	-0.438**	-0.533**	0.043	0.819**				
CCS %	-0.125	-0.389**	0.270*	-0.432**	-0.557**	0.052	0.726**	0.989**			
Purity%	-0.067	-0.326*	0.220	-0.314*	-0.544**	0.095	0.224	0.742**	0.831**		
Cane yield (t/ha)	0.726**	0.274*	0.305*	0.674**	0.717**	0.720**	-0.211	-0.287*	-0.291*	-0.247	
CCSyield (t/ha)	0.712**	0.188	0.410**	0.559**	0.589**	0.758**	0.028	0.016	0.012	0.010	0.949**

*Significant at 5% level and **Significant at 1% level.

sugar (CCS) yield (t/ha) as per standard procedures. The data were subjected to statistical analyse for estimating 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 (8). Phenotypic correlation coefficients among the characters under study were estimated according to the statistical techniques outlined by (9). The correlation coefficients were further partitioned into direct and indirect effects with the help of path coefficient analysis (8). This will help to develop reliable selection criteria for selecting high sugar genotypes having high ratooning ability.

Results and Discussion

Analysis of variance among sugarcane clones in ratoon crop revealed significant variability for all the traits studied indicating improvement through selection (10). Estimates of phenoypic coefficient of variation (PCV) were higher than genotypic coefficient of variation (PCV) for all traits indicating the interaction of environment on the traits (Table-1). Higher GCV and PCV was recorded for cane yield, CCS Yield, number of millable canes at harvest, internode length and single cane weight indicating that these traits were highly variable and selection may be effective based on these characters. Earlier (6, 11, 12) also reported high values of genotypic and phenotypic coefficient of variation for NMC at harvest and single cane weight.For quality traits, low variability was observed for brix %, sucrose %, CCS % and purity %. (13, 14) also reported limited genetic variability for quality characters in sugarcane. Heritability ranged from 11.32 (Cane girth) to number of millable canes at harvest (89.36) in ratoon crop. High heritability along with high GCV estimates were recorded for cane yield, CCS yield, NMC at harvest, internode length and single cane weight which indicated that the genetic variance was highly heritable for the traits.

Table-3 : Phenotypic path Coefficients for Quantitative and Quality Traits in Sugarcane Ratoon.

Character	Cane length (m)	Cane girth (cm)	Internode number	Internode length (cm)	Single cane weight (kg)	NMC at harvest (000/ha)	Brix %	Sucrose %	CCS %	Purity%	Cane yield (t/ha)	CCS yield (t/ha)
Cane length (m)	-0.031	0.014	0.001	-0.006	0.030	0.027	-0.066	0.012	0.048	-0.037	0.719	0.712**
Cane girth (cm)	-0.011	0.037	0.001	-0.002	0.027	-0.002	-0.138	0.036	0.149	-0.180	0.271	0.188
Internode number	-0.013	0.009	0.003	0.000	0.004	0.010	0.103	-0.026	-0.103	0.121	0.302	0.410**
Internode length (cm)	-0.023	0.009	0.000	-0.008	0.039	0.020	-0.181	0.041	0.165	-0.173	0.667	0.559**
Single cane weight (kg)	-0.014	0.015	0.000	-0.005	0.066	0.007	-0.154	0.050	0.213	-0.300	0.709	0.589**
NMC at harvest (000/ha)	-0.020	-0.002	0.001	-0.004	0.011	0.042	-0.011	-0.004	-0.020	0.052	0.713	0.758**
Brix %	0.004	-0.010	0.001	0.003	-0.021	-0.001	0.493	-0.077	-0.278	0.123	-0.209	0.028
Sucrose%	0.004	-0.014	0.001	0.003	-0.035	0.002	0.404	-0.094	-0.378	0.409	-0.284	0.016
CCS %	0.004	-0.015	0.001	0.003	-0.037	0.002	0.358	-0.093	-0.382	0.458	-0.288	0.012
Purity%	0.002	-0.012	0.001	0.002	-0.036	0.004	0.110	-0.070	-0.318	0.551	-0.244	-0.010
Cane yield(t/ha)	-0.022	0.010	0.001	-0.005	0.048	0.030	-0.104	0.027	0.111	-0.136	0.990	0.949**

Residual effect: 0.00636

Genetic advance was higher for cane yield, CCS yield, number of millable canes at harvest, internode length and single cane weight indicating that low environmental influence and control of the traits by additive gene effect. (15) reported higher estimates of heritability coupled with higher genetic advance for number of millable canes.

The association between any two characters is dependent upon their inheritance. If they are inherited together, the relationship between them may be observed. The phenotypic correlation coefficients for all characters are presented in Table-2. CCS yield had significant and positive correlation with cane yield, number of millable canes at harvest, cane length, single cane weight, internode length and internode number. Highly significant positive correlation between cane yield and sugar yield was reported by (16). Cane yield correlation was positive and highly significant with cane length, NMC at harvest, single cane weight, internode length, internode number and cane girth.These results were also in conformity with the findings made earlier by several workers; (17, 18) for NMC, single cane weight, cane length and sugar yield. Cane yield showed negative correlation with all juice quality parameters brix %, sucrose %, CCS % and purity %, where as CCS yield exhibited non significant correlation with quality traits. Similar results were also reported by (19). Cane length was found significantly and positively associated with CCS yield, cane yield, number of internodes, length of internodes, single cane weight. Similar results were reported by (20).

Path coefficient analysis unfolds whether the association of CCS yield with its components is due to the direct effects of component characters or is a consequence of its indirect effects *via* some other traits.In the present study, the path coefficient analysis was based on phenotypic correlation coefficients and direct and indirect effects of characters were determined for CCS yield (Table-3). Path analysis revealed that cane yield exerted a high magnitude of positive direct effect on CCS yield followed by purity percent and brix percent. The characters having direct positive effects must be given importance during the selection process. These results are in confirmation with (21). Very low direct effects of single cane weight, number of millable canes, at harvest, cane girth, internode number and negative direct effect of cane length and internode length were observed on CCS yield even though these traits showed positive and significant correlation on CCS yield which is due to the positive indirect effects via other traits. Negative direct effects of sucrose % and CCS % were found on CCS yield which is in accordance with the results of (22). In case of sugarcane, yield as well as sugar recovery are very important for a good variety, varietal selection on the

basis of contributing components is advantageous (23). Path analysis revealed that the major contribution to enhanced CCS yield was primarily made by cane yield followed by Brix % and Purity % rather than CCS % itself.

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