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Factor Wise Contribution of Yield and Quality Influencing Characters of *Saccharum officinarum* L.

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ABSTRACT

Twelve sugarcane accessions were sown in the field following randomized complete block design. Data were collected on different characters, and analyzed by step-wise regression and correlation analysis for the estimation of factor-wise contribution toward total cane yield, cane height, leaf area, juice content, brix value and commercial cane sugar. The varieties showed that the characters studied were the best variables and had potential for selection.

Key Words: Sugarcane; Correlation coefficient; Sucrose content

INTRODUCTION

Sugar is an important constituent of our diet, and is mainly obtained from *Saccharum officinarum* L. In Pakistan, sugarcane is planted on an area of 1,155,000 hectares with total annual production of 55,191,000 tons of cane (Anonymous, 1998-99). Among the sugarcane producing countries of the world, Pakistan ranks fifth in terms of overall production, but fifty-seventh position in terms of yield per acre (Anonymous, 2000). Recovery of sucrose from the cane is very low as compared to that recovered in other countries. Thus sugar production in the country is not sufficient to meet the increasing requirements of sugar. Consequently, a huge amount of foreign exchange is spent on the import every year. Therefore, sugarcane breeders are necessitated to exploit the genetic resources for improving yield potential and recovery of sucrose, through selection and breeding of sugarcane genotypes. The purpose of the present study was to evaluate the genetic potential of some of the accessions for yield and yield components and to develop a selection criterion. The data were analyzed by step-wise regression and correlation analysis of sugarcane genotypes. Information obtained here may be used by the research workers for the development of a breeding program aimed to evolve high yielding cultivars of sugarcane.

MATERIALS AND METHODS

The present study was conducted in the Department of Plant Breeding and Genetics, University of Agriculture, Faisalabad, during 1999-2000. Twelve sugarcane accessions namely SPF-232, SPF-234, CP-43-33, CPF-235, CP-72-2086, Coj-84, RB-82-5336, TCP-81-10, Triton, BF-129, SPSG-26 and one CP-77-400 used as standard variety were planted in the field. The experiment was laid out in randomized complete block design with three replications. Each variety was planted in a plot having four rows each 15.75 m length, row spaced 0.75 m apart. Ten guarded stool of each variety from each replication were randomly taken for recording the data on the following parameters: Cane height (cm), Number of tillers plant^{-1}, Internodal length (cm), Number of leaves plant^{-1}, Leaf area (cm^2), Cane diameter (cm), Cane weight (kg), Juice content (L), Brix value (%), Commercial cane sugar (%), Fibre contents (%), Purity (%) and Sucrose content (%)

The data collected were subjected to analysis of variance technique (Steel & Torrie, 1980). Phenotypic and genotypic correlation coefficients were calculated according to Kwon and Torrie (1964), and their standard error was calculated by the method given by Reeve (1955). Significant coefficient phenotypic correlations (rp) were tested by using the formula given by Steel and Torrie (1980). Coefficients of determination (R^2) were calculated through step-wise regression analysis to construct the regression model for making selection of better sugarcane types.

RESULTS AND DISCUSSION

Analysis of variance of the data given in Table I indicated that differences in cane height and internodal length of all the genotypes were significant ($P \leq 0.05$); where as, in all the remaining characters the differences were highly significant ($P \leq 0.01$). However, for fibre content, the differences were reduced to non-significant ($P \geq 0.05$).

Coefficients of genotypic and phenotypic correlation among 12 characters have been presented in Table II, and these revealed that the correlation of cane height with number of leaves, leaf area, cane weight, juice content, brix value, commercial cane sugar and sucrose percentage were positive and significant at genotypic and phenotypic levels. Similar results about correlation among these characters were reported by Nair and Sreenivasan (1989). The analysis also showed that correlation of cane height with cane

Table I. Mean squares obtained from analysis of variance of different plant characters of *Saccharum officinarum* L.

Characters	Replications	Genotypes	Error
Cane height	80.028	177.604*	65.210
Number of tillers per plant	0.361	3.202**	0.937
Internodal length	2.083	1.765*	0.598
Number of leaves per plant	3.111	9.444**	2.566
Leaf area	72.250	3465.765**	540.492
Cane diameter	0.067	0.161**	0.031
Cane weight	0.952	3.577**	0.327
Juice content	0.014	2.345**	0.018
Brix value	0.049	0.291**	0.032
C.C.S.	0.005	0.360**	0.005
Purity	0.004	5.221**	0.011
Fibre	0.000035	0.00012^{NS}	0.000055
Sucrose	0.008	0.321**	0.001
Degree of freedom	2.0	11	22

diameter and purity was positive and significant at both genotypic and phenotypic levels.

Number of tillers was shown to have positive and significant correlation with number of leaves, leaf area, cane weight and brix value at both genotypic and phenotypic levels. Correlation coefficients also revealed that number of tillers had positive correlation with cane diameter and sucrose at both the levels. Singh *et al.* (1983) reported similar observation about correlation among these characters. Internodal length was positively and non-significantly correlated with brix value at both genotypic and phenotypic levels. Internodal length was negatively and non-significantly correlated with leaf area, cane diameter, cane weight, juice content and sucrose at both the levels. Association of number of leaves with cane weight was positively significant.

Association of leaf area with cane diameter, cane weight, juice content and brix value were positive and significant at both the levels. Similar observations were noted by Sankaranarayan and Shunmugasundaram (1981). Leaf area exhibited positive and significant correlation with sucrose at both genotypic and phenotypic levels. It was revealed that correlation between cane diameter with juice content was positive at both genotypic and phenotypic levels but significant at genotypic level and highly significant at phenotypic level.

Cane weight exhibited positive and significant correlation with juice content at genotypic and phenotypic levels. Relationship of cane weight with brix value, commercial cane sugar and sucrose percentage were positive and non-significant at genotypic level, but positive and highly significant at phenotypic level. The results are in accordance with Gill *et al.* (1983) and Singh *et al.* (1983).

Correlation of juice content was positive and significant at genotypic and phenotypic levels with commercial cane sugar and sucrose (Table II). Similar correlation of brix value with sucrose appeared to be positive and significant at both the levels. Similar observations about genetic correlation between these characters were reported by Chang (1996).

Correlation of commercial cane sugar with purity and sucrose was revealed to be positive and significant at both the levels, and agency but positive and highly significant at phenotypic level with those of Patel *et al.* (1993), Das *et al.*

Table II. Genotypic (rg) and phenotypic (rp) correlation coefficient among charcters of sugarcane accessions

	No.of tillers	Internodal legnth	No.of leaves plant^{-1}	Leaf area	Cane diameter	Cane weight	Juice content	Brix value	C.C.S	Purity	Sucrose
Cane height	0.1752	0.2451*	0.4135*	0.5714*	0.5073*	0.7830*	0.9301*	0.4697*	0.7156*	0.3641*	0.6698*
	0.0849	0.1143	0.3863**	0.4888**	0.3120*	0.6703**	0.7470**	0.3292**	0.5692**	0.2936*	0.5229**
No.of tillers		-0.2679	0.9634*	0.4918*	0.5780	0.5053*	0.2645	0.5484*	0.3067	-0.1148	0.4709
		-0.1465	0.7512**	0.3720**	0.4170**	0.3945**	0.2395	0.5141**	0.2553	-0.0941	0.4014**
Internodal length			-0.7327	-0.3977	-0.3358	-0.3218	-0.3587	0.0505	-0.5419	-0.5219	-0.2977
			-0.5974**	-0.2745	-0.1451	-0.2511	-0.2596	0.0581	-0.4519**	-0.4271**	-0.2419
No.of leaves/				0.1392*	0.1253	0.4795*	0.2760	0.3667	0.3664	0.0847	0.3545
plant				0.1486	0.0549	0.4466**	0.2447	0.3225*	0.3333**	0.0738	0.2983*
Leaf area					0.8594*	0.8008*	0.8000*	0.4532*	0.1912*	-0.1009	0.3418*
					0.7144**	0.6815**	0.7375**	0.3800**	0.1721	-0.0949	0.3057*
Cane diameter						0.5168	0.6515*	0.4961	0.3804	0.1797	0.4344
						0.4415**	0.5849**	0.4266**	0.3619**	0.1594	0.4130**
Cane weight							0.9694*	0.4541	0.3804	0.0303	0.4344
							0.9299**	0.4065**	0.3619**	0.0287	0.4130**
Juice content								0.4225	0.4680*	0.1610	0.5121*
								0.3999**	0.4620**	0.1597	0.5101**
Brix value									0.3343	-0.3909	0.6401*
									0.3081*	-0.3669**	0.5991**
C.C.S										0.6732*	0.9184*
										0.6687**	0.9104**
Purity											0.3416
											0.3405*

* = Significant; ** = Significant at 0.01 level of probability; NS = Non-significant

(1996) and Gill *et al.* (1983). However, purity and sucrose were although positively correlated, but it was non-significant at genotypic level but positive and significant at phenotypic level.

Regression. The coefficients of determination (R^2) were calculated through best subsets regression analysis. The R^2 value for the dependent variable "Sucrose" of 12 accessions of *Saccharum officinarum* L. fall in the range of 2.6 to 79.0% for internodal length and commercial cane sugar, respectively (Table III). The remaining R^2 values on single factor basis are 4.8, 6.4, 10.0, 11.4, 12.8, 14.0, 25.3, 26.5 and 28.4% for the number of leaves plant^{-1}, leaf area, number of tiller plant^{-1}, purity, cane height, cane weight, juice content, cane diameter and brix value, respectively. The R^2 value increased for 2nd variable model (89.9%) by including commercial cane sugar and purity. A further improvement of 91.9% was obtained by including cane diameter in 2nd variable model. The R^2 value increased to 93.2% by the addition of brix value and number of leaves plant^{-1} in 3rd variable model one variable cane diameter was excluded only in 4th variable model. An increased value of 94.0% was observed in 5th variable model by including again cane diameter in 4th variable model. A further improvement of 94.4% was obtained when number of tillers plant^{-1} included in the 5th variable model. The 7th variable model showed 94.5% value for R^2 by including internodal length. No further improvement were exhibited in the R^2 values when cane weight, leaf area, juice content and cane height included in the 8th, 9th, 10th and 11th variables regression model with sucrose percentage. It may be concluded that maximum increase in variability for sucrose content on single factor basis was caused by commercial cane sugar. So in the present study, commercial cane sugar appeared to be the most important trait responsible for increasing overall sucrose content of *Saccharum officinarum* L. accessions. However, 2nd variable model exhibited that commercial cane sugar and purity were more important traits for increasing overall sucrose in the present accessions. It was also evident that there was gradual increase in sucrose due to increasing in number of variables, but after 7th variable no improvement of sucrose was observed.

CONCLUSIONS

The sugarcane breeders should concentrate on cane weight, leaf area, juice content, brix value and commercial cane sugar to have best genotype for bringing improvement in sugar production in the country.

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Table III. Best subsets regression model for the dependent variable "Sucrose%". The best fitting model is shown for a given number of variables beyond one

No. in model	R-square										
1	2.6	INLT									
1	4.8	NLPP									
1	6.4	LA									
1	10.0	NTPP									
1	11.4	P									
1	12.8	CHT									
1	14.0	CWT									
1	25.3	JC									
1	26.5	CD									
1	28.4	BV									
1	79.0	CCS									
2	89.9	CCS	P								
3	91.9	CCS	P	CD							
4	93.2	CCS	P	-	BV	NLPP					
5	94.0	CCS	P	CD	BV	NLPP					
6	94.4	CCS	P	CD	BV	NLPP	NTPP				
7	94.5	CCS	P	CD	BV	NLPP	NTPP	INLT			
8	94.5	CCS	P	CD	BV	NLPP	NTPP	INLT	CWT		
9	94.5	CCS	P	CD	BV	NLPP	NTPP	INLT	CWT	LA	
10	94.5	CCS	P	CD	BV	NLPP	NTPP	INLT	CWT	LA	JC
11	94.5	CCS	P	CD	BV	NLPP	NTPP	INLT	CWT	LA	JC	CHT

Variable in model; INLT = Internodal length; NLPP = Number of leaves per plant; LA = Leaf area; NTPP = Number of tiller per palnt; P= purity; CHT= Cane height; CWT= Cane weight; JC = Juice content; CD = Cane diameter; BV = Brix value; CCS= Commercial cane sugar

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