The Andhra Agric. J 64 (3): 533-539, 2017

Genetic Variability, Heritability, Character Association and Path Coefficient Analysis in Sugarcane (*Saccharum officinarum* L.)

N Vennela, D Adilakshmi, K Madhu Kumar, Ch S Ramalakshmi and G Ramesh
Department of Genetic and Plant Breeding, Agricultural College, Naira 532 185

ABSTRACT

Investigation on extent of variability, heritability, character association and path coefficient analysis were conducted in sugarcane. Analysis of variance revealed significant amount of variability for all the characters studied. Moderate variability and high heritability coupled with moderate genetic advance as per cent of mean was observed for cane volume and CCS yield indicating the predominance of additive gene action and hence, direct phenotypic selection may be useful with respect to these traits. Correlation studies revealed that cane yield was found to be significantly and positively correlated with number of millable canes at harvest, single cane weight and CCS yield, while number of millable canes, brix per cent, sucrose per cent, CCS per cent and cane yield with CCS yield at both phenotypic and genotypic level. Path coefficient analysis indicated that the germination per cent at 35 DAP, shoot population at 90 DAP, stalk population at 180 DAP, NMC at harvest, sucrose per cent, CCS per cent, cane length, single cane weight, cane volume and fibre per cent had high positive direct effect on cane yield at phenotypic level and shoot population at 90 DAP, stalk population at 120 DAP, NMC at harvest, brix per cent, purity per cent, CCS per cent, cane length, cane diameter, single cane weight and fibre per cent at genotypic level. Hence, emphasis should be given on those characters while making selection for improvement of cane yield in sugarcane.

Key words: *Correlation, Genetic advance, Heritability, Path Coefficient Analysis, Sugarcane.*

Sugarcane (*Saccharum* spp.) is an important agro industrial crop. In India, it plays a pivotal role in national economy by contributing 1.9% to gross domestic product. Knowledge of heritability of agronomic traits is important in breeding programmes sugarcane. Genotypic and phenotypic coefficients of variation along with heritability as well as genetic advance are very essential to improve any trait of sugarcane because this would help in knowing whether or not the desired objective can be achieved from the material. Genetic improvement in cane yield may be achieved by targeting traits closely associated with cane yield. A number of characteristics have been proposed as indirect selection criteria for genetic improvement of yield in plant breeding programmes. Therefore, the present study was carried out to study the variability, heritability, character association and path analysis in sugarcane.

MATERIAL AND METHODS

The material for the present investigation comprised of twenty genotypes of sugarcane grown in randomized block design (RBD) with two replications at Regional Agricultural Research Station, Anakapalle during the crop season 2015-16. Data was recorded for sixteen quantitative and qualitative characters, viz., ination per cent at 35 DAP plot^{-1}, shoot population at 90 DAP plot^{-1}, shoot population at 120 DAP plot^{-1}, stalk population at 180 DAP plot^{-1}, number of millable canes plot^{-1}at harvest, brix per cent, sucrose per cent, purity per cent, cane length (cm), cane diameter (cm) single cane weight (kg), cane volume plot^{-1}, cane yield (t ha^{-1}) and commercial cane sugar yield (t ha^{-1}). Statistical analysis on genetic parameters such as phenotypic coefficient of variation (PCV), genotypic coefficient of variation (GCV) was calculated for all the characters using the formulae given by Burton (1952), heritability in broad sense was calculated using the formula given by Hanson *et al.* (1956) and genetic advance as per cent of mean was estimated by formula suggested by Johnson *et al*. (1955). Correlation coefficients were calculated following Falconer (1964). The direct and indirect contributions of various characters were calculated through path coefficient analysis as per Dewey and Lu, 1959.

RESULTS AND DISCUSSION

The analysis of variance revealed significant differences among the genotypes for all the characters studied indicating a high degree of variability in the material (Table 1). The estimates of GCV, PCV, heritability, genetic advance and genetic advance as percent of mean are presented in Table 2.

Moderate PCV and low GCV were recorded for cane volume while low PCV and GCV were recorded for germination per cent at 35 DAP, shoot population at 90 DAP, shoot population at 120 DAP, stalk population at 180 DAP, number of millable canes at harvest, brix per cent, sucrose per cent, purity per cent, commercial cane sugar percent, cane length, cane diameter, single cane weight, fibre per cent and cane yield. Sanghera *et al*. *(*2014) observed low GCV and PCV in germination per cent at 35 DAP. Sireesha *et al*. (2009) observed low GCV and PCV in shoot population at 90 DAP, stalk population at 120 and 180DAP. Arun Kumar (2014) reported low GCV and PCV in brix per cent, sucrose per cent and purity per cent. Japheth et *al*. (2014) reported low GCV and PCV in cane length, cane diameter, single cane weight, fibre per cent and cane yield. Moderate PCV and GCV were observed in CCS yield. Similar results were reported by Tadesse and Dilnesaw (2014).

High heritability values coupled with moderate genetic advance as per cent of mean values were recorded for stalk population at 120 DAP and 180 DAP, sucrose per cent, CCS per cent, cane diameter, cane volume, fibre per cent, cane yield and CCS yield. The results indicate the predominance of additive gene action in the inheritance of these characters and the desired results may be obtained by simple selection. Similar results were reported by Sanghera *et al. (*2015).

High heritability and low genetic advance as per cent of mean were recorded for germination per cent at 35 DAP, shoot population at 90 DAP, NMC at harvest, brix per cent, purity per cent, cane length and single cane weight. The results indicate the predominance of non additive gene action in the inheritance of these characters and the desired results may not be obtained by simple selection. Sanghera *et al. (*2015) reported high heritability and low genetic advance as per cent of mean in germination per cent at 35 DAP. Singh *et al*. (2004) reported high heritability and low genetic advance as per cent of mean in shoot population at 90 DAP. Similarly, Anbanandan and Saravanan (2010) reported high heritability and low genetic advance as per cent of mean in number of millable canes, brix per cent, purity per cent, cane length and single cane weight.

In general genotypic correlation coefficients were higher than phenotypic correlation coefficients indicating strong inherent association between characters governed largely by genetic causes and are generally less subjected to environmental forces. Cane yield showed positive and significant correlation with NMC at harvest (0.860**) and CCS yield (0.772**)at both phenotypic and genotypic level (Table 3). Similar results were reported by Masri *et al*. (2015). This trait exhibited positive and significant correlation with single cane weight at phenotypic and genotypic level indicating that these characters can be improved simultaneously. Similar results are reported by Sanghera *et al*. (2015).

Path coefficient analysis indicated that the germination per cent at 35 DAP, shoot population at 90 DAP, stalk population at 180 DAP, NMC at harvest, sucrose per cent, CCS per cent, cane length, single cane weight, cane volume and fibre per cent had high positive direct effect on cane yield at phenotypic level (Table 4). Shoot population at 90 DAP, stalk population at 120 DAP, NMC at harvest, brix per cent, purity per cent, CCS per cent, cane length, cane diameter, single cane weight and fibre per cent at genotypic level (Table5). Sanghera *et al*. (2015) observed positive direct effect of cane length and cane diameter on cane yield. Guddadamath *et al*. (2014) reported positive direct effect of single cane weight and number of millable canes on cane yield. Masri *et al*. (2015) observed positive direct effect of sucrose per cent on cane yield.

The correlation and path coefficient analysis revealed that the characters *viz.,* cane length, cane diameter, single cane weight, and number of millable canes recorded highly significant positive association with cane yield and also high positive direct effect as well as indirect effect through other characters. Hence, simultaneous selection based on cane length, cane diameter, single cane weight and number of millable canes appears more promising in improving the cane yield in sugarcane.

Table 1. Analysis of variance for yield and yield components among 20 genotypes of sugarcane (*Saccharum officinarum* L.).

S.No.	Source Degree of freedom	Replications 1	Treatments 19	Error 19
		MEAN SUM OF SQUARES		
1	Germination percent at 35 DAP/plot	0.01	29.23**	4.12
2	Shoot population at 90DAP/plot	4.90	367.28**	38.16
3	Stalk population at 120DAP/plot	122.50	593.26**	99.23
4	Stalk population at 180 DAP/plot	34.22	426.96**	51.96
5	NMC at harvest/plot	4.90	232.13**	54.00
6	Brix percent	0.13	2.56**	0.34
7	Sucrose percent	0.33	2.55**	0.34
8	Purity percent	0.80	7.46**	1.31
9	Commercial Cane Sugar percent	0.09	1.62**	0.17
10	Cane length (cm)	235.22	587.70**	287.69
11	Cane diameter (cm)	0.06	0.09**	0.01
12	Single cane weight (kg)	0.00	0.039**	0.10
13	Cane volume/ Plot	11.94	11.28**	2.81
14	Fibre percent	0.01	1.58**	0.03
15	Cane Yield (t/ha)	0.02	138.59**	3.94
16	CCS Yield (t/ha)	0.19	5.29**	0.32

Table 2. Variability, heritability and genetic advance as per cent of mean for yield, yield components and quality parameters in sugarcane (*Saccharum officinarum* L.) genotypes.

S.No	Character	Coefficient of variation		Heritability (%) (broad sense)	Genetic advance as per cent of mean (5% level)
		PCV %	GCV %		
1	Germination percent at 35 DAP/ plot	5.18	4.49	75.30	8.03
2	Shoot population at 90 DAP/plot	5.93	5.34	81.20	9.91
3	Stalk population at 120 DAP/plot	7.28	6.15	71.30	10.70
4	Stalk population at 180 DAP/plot	6.26	5.54	78.30	10.09
5	NMC at harvest/plot	5.79	4.58	62.30	7.44
6	Brix per cent	5.86	5.12	76.30	9.20
7	Sucrose per cent	6.51	5.69	76.30	10.24
8	Purity per cent	2.31	1.94	70.10	3.34
9	Commercial Cane Sugar per cent	7.21	6.45	80.00	11.89
10	Cane length (cm)	7.27	4.26	34.30	5.13
11	Cane diameter (cm)	9.68	8.17	71.30	14.22
12	Single cane weight (kg)	5.473	4.20	59.00	6.66
13	Cane volume per plot	11.99	9.29	60.10	14.84
14	Fibre per cent	6.59	6.45	95.70	12.99
15	Cane yield (t/ha)	7.19	6.99	94.50	14.01
16	CCS yield (t/ha)	10.86	10.20	88.40	19.77

Table 3. Estimates of phenotypic and genotypic correlation coefficients among cane yield and juice quality parameters in sugarcane (*Saccharum officinarum* L.) genotypes.

Character	Germination% at 35 DAP/ plot	Shoot population at 90 DAP/ plot	Stalk population at 120 DAP/plot	Stalk population at180 DAP/plot	NMC at harvest / plot	Brix %	Sucrose %	Purity %	CCS %	Cane length (cm)	Cane diameter (cm)	Single cane weight (kg)	Cane volume/ Plot	Fibre %	Cane Yield (t/ha)	CCS Yield (t/ha)
Germination percent at 35 DAP/plot	**1.000**	0.731**	0.478*	0.538**	0.196	-0.013	-0.012	0.064	-0.053	0.157	0.183	0.045	0.257	0.141	0.178	0.099
Shoot population at 90DAP/ plot	0.809*	**1.000**	0.824**	0.868**	0.154	0.010	-0.007	0.018	-0.019	0.071	0.297	-0.092	0.293	-0.296	0.223	0.147
Stalk population at 120 DAP/plot	0.447*	0.888**	**1.000**	0.942**	0.155	-0.020	-0.054	-0.020	-0.047	-0.048	0.008	0.094	-0.010	-0.434*	0.073	0.019
Stalk population at 180 DAP/plot	0.543**	0.605**	0.012	**1.000**	0.197	0.059	0.024	-0.042	0.019	-0.081	0.031	0.096	-0.015	-0.362	0.121	0.096
NMC at harvest/plot	0.161	0.214	0.093	0.200	**1.000**	0.247	0.203	-0.128	0.215	-0.035	-0.059	0.126	-0.067	0.027	0.722**	0.629**
Brix percent	-0.045	0.002	0.022	0.061	0.352	**1.000**	0.881**	-0.305	0.933**	0.129	-0.384	0.155	-0.244	-0.174	0.153	0.701**
Sucrose percent	-0.022	0.003	0.036	0.056	0.270	0.871**	**1.000**	0.071	0.963**	0.049	-0.335	0.193	-0.249	-0.042	0.092	0.684**
Purity percent	0.113	0.069	0.112	0.127	-0.059	-0.366	0.071	**1.000**	-0.108	-0.028	-0.047	0.201	-0.054	0.217	-0.249	-0.225
CCS percent	-0.086	-0.014	0.025	0.045	0.287	0.954**	0.974**	-0.172	**1.0000**	0.049	-0.336	0.148	-0.252	-0.098	0.131	0.731**
Cane length (cm)	0.319	0.102	-0.103	-0.065	-0.120	0.169	0.068	-0.067	0.112	**1.000**	-0.031	-0.214	0.574**	-0.066	0.158	0.145
Cane diameter (cm)	0.370	0.399	0.054	0.102	0.058	-0.369	-0.315	-0.081	-0.292	-0.023	**1.000**	-0.368	0.799**	0.196	0.174	-0.099
Single cane weight (kg)	-0.110	-0.153	-0.065	0.040	-0.322	0.248	0.279	0.348	0.220	-0.367	-0.414	**1.000**	-0.419	0.262	0.557**	0.293
Cane volume/ Plot	0.487*	0.411	0.012	0.072	-0.010	-0.268	-0.262	-0.089	-0.220	0.449*	0.882**	-0.525*	**1.000**	0.126	0.233	-0.009
Fibre percent	0.166	-0.298	-0.511*	-0.417	-0.009	-0.242	-0.093	0.271	-0.152	-0.219	0.259	0.317	0.139	**1.000**	-0.153	-0.161
Cane Yield (t/ha)	0.222	0.258	0.107	0.139	0.860**	0.173	0.103	-0.229	0.142	0.202	0.264	0.755**	0.319	-0.156	**1.000**	0.772**
CCS Yield (t/ha)	0.116	0.182	0.093	0.126	0.786**	0.701**	0.667**	-0.259	0.707**	0.229	0.009	0.404	0.100	-0.196	0.800**	**1.000**

* and ** indicates Significance at 5% and 1% level, respectively

Values above diagonal indicate phenotypic correlation and values below diagonal indicate genotypic correlations

Table 4. Estimates of direct and indirect effects (Phenpotypic) of yield components and juice quality parameters on cane yield in sugarcane at phenotypic level.

Character	Germination% at 35 DAP / plot	Shoot population at 90 DAP/ plot	Stalk population at 120 DAP/plot	Stalk population at180 DAP/plot	NMC at harvest / plot	Brix %	Sucrose %	Purity %	CCS %	Cane length (cm)	Cane diameter (cm)	Single cane weight (kg)	Cane volume/ Plot	Fibre %
Germination percent at 35 DAP/plot	**0.0170**	0.0124	0.0081	0.0091	0.0033	-0.0002	-0.0002	0.0011	-0.0009	0.0027	0.0031	0.0008	0.0044	0.0024
Shoot population at 90DAP/plot	0.0731	**0.1000**	0.0824	0.0868	0.0154	0.0010	-0.0007	0.0018	-0.0019	0.0071	0.0297	-0.0092	0.0293	-0.0296
Stalk population at 120DAP/plot	-0.0633	-0.1092	**-0.1325**	-0.1249	-0.0206	0.0027	0.0071	0.0027	0.0062	0.0063	-0.0011	-0.0125	0.0014	0.0576
Stalk population at 180 DAP/plot	0.0351	0.0566	0.0615	**0.0653**	0.0129	0.0039	0.0016	-0.0027	0.0013	-0.0053	0.0020	0.0063	-0.0010	-0.0236
NMC at harvest/plot	0.1536	0.1204	0.1216	0.1545	**0.7827**	0.1931	0.1591	-0.1000	0.1683	-0.0275	-0.0469	0.0986	-0.0524	0.0211
Brix percent	0.0015	-0.0012	0.0023	-0.0068	-0.0282	**-0.1145**	-0.1009	0.0349	-0.1068	-0.0147	0.0439	-0.0178	0.0279	0.0200
Sucrose percent	-0.0007	-0.0004	-0.0033	0.0015	0.0124	0.0539	**0.0612**	0.0044	0.0589	0.0030	-0.0205	0 .0118	-0.0153	-0.0025
Purity percent	-0.0035	-0.0010	0.0011	0.0023	0.0071	0.0170	-0.0040	**-0.0557**	0.0060	0.0015	0.0026	-0.0112	0.0030	-0.0121
CCS percent	-0.0041	-0.0015	-0.0036	0.0015	0.0166	0.0719	0.0742	-0.0083	**0.0771**	0.0037	-0.0259	0.0114	-0.0194	-0.0075
Cane length (cm)	0.0062	0.0028	-0.0019	-0.0032	-0.0014	0.0051	0.0019	-0.0011	0.0019	**0.0394**	-0.0012	-0.0084	0.0226	-0.0026
Cane diameter (cm)	-0.0098	-0.0158	-0.0004	-0.0016	0.0032	0.0204	0.0179	0.0025	0.0179	0.0016	**-0.0533**	0.0196	-0.0426	-0.0104
Single cane weight (kg)	-0.0288	0.0595	-0.0608	-0.0619	-0.0814	-0.1004	-0.1246	-0.1296	-0.0956	0.1386	0.2380	**0.6464**	0.2713	-0.1695
Cane volume/ Plot	0.0008	0.0009	0.0000	0.0000	-0.0002	-0.0007	-0.0007	-0.0002	-0.0007	0.0017	0.0023	-0.0012	**0.0029**	0.0004
Fibre percent	0.0006	-0.0012	-0.0017	-0.0014	0.0001	-0.0007	-0.0002	0.0009	-0.0004	-0.0003	0.0008	0.0010	0.0005	**0.0040**
Cane Yield (t/ha)	**0.1775**	**0.2225**	**0.0727**	**0.1211**	**0.7219**	**0.1525**	**0.0918**	**-0.2495**	**0.1313**	**0.1579**	**0.1735**	**0.5572**	**0.2326**	**-0.1526**
Partial R^2	0.0030	0.0223	-0.0096	0.0079	0.5650	-0.0175	0.0056	0.0139	0.0101	0.0062	-0.0092	0.3602	0.0007	-0.0006

* significant at 5% level, **significant at 1% level. Residual effect = 0.2050 Bold and diagonal values indicate direct effects

Table 5. Estimates of direct and indirect effects (Phenpotypic) of yield components and juice quality parameters on cane yield in sugarcane.

Character	Germination% at 35 DAP/plot	Shoot population at 90 DAP/ plot	Stalk population at 120 DAP/plot	Stalk population at180 DAP/plot	NMC at harvest / plot	Brix %	Sucrose %	Purity %	CCS %	Cane length (cm)	Cane diameter (cm)	Single cane weight (kg)	Cane volume/ Plot	Fibre %
Germination percent at 35 DAP/plot	**-0.1264**	-0.1023	-0.0565	-0.0687	-0.0204	0.0057	0.0028	-0.0142	0.0108	-0.0403	-0.0468	0.0139	-0.0616	-0.0210
Shoot population at 90DAP/plot	0.1829	**0.2261**	0.2007	0.2048	0.0484	0.0005	0.0006	0.0156	-0.0032	0.0230	0.0902	-0.0347	0.0930	-0.0673
Stalk population at 120DAP/plot	0.0823	0.1635	**0.1842**	0.1864	0.0170	0.0041	0.0066	0.0207	0.0047	-0.0190	0.0099	-0.0120	0.0022	-0.0942
Stalk population at 180 DAP/plot	-0.0959	-0.1598	-0.1785	**-0.1764**	-0.0353	-0.0109	-0.0099	-0.0224	-0.0079	0.0115	-0.0180	-0.0071	-0.0126	0.0735
NMC at harvest/plot	0.0984	0.1308	0.0565	0.1223	**0.6109**	0.2154	0.1650	-0.0360	0.1752	-0.0732	0.0354	-0.1969	-0.0054	-0.0059
Brix percent	-0.0119	0.0006	0.0058	0.0162	0.0923	**0.2619**	0.2281	-0.0958	0.2497	0.0442	-0.0969	0.0650	-0.0701	-0.0634
Sucrose percent	0.0132	-0.0017	-0.0210	-0.0332	-0.1597	-0.5151	**-0.5914**	-0.0417	-0.5757	-0.0404	0.1867	-0.1652	0.1547	0.0551
Purity percent	0.0227	0.0139	0.0226	0.0255	-0.0119	-0.0737	0.0142	**0.2013**	-0.0346	-0.0134	-0.0162	0.0700	-0.0180	0.0545
CCS percent	-0.0380	-0.0062	0.0112	0.0198	0.1269	0.4220	0.4309	-0.0762	**0.4426**	0.0495	-0.1291	0.0975	-0.0972	-0.0672
Cane length (cm)	0.3368	0.1077	-0.1090	-0.0690	-0.1266	0.1786	0.0721	-0.0704	0.1181	**1.0568**	-0.0246	-0.3909	0.4750	-0.2314
Cane diameter (cm)	0.6624	0.7132	0.0957	0.1824	0.1036	-0.6614	-0.5645	-0.1443	-0.5218	-0.0416	**1.7881**	-0.7393	1.5772	0.4628
Single cane weight (kg)	0.0680	0.0947	0.0401	-0.0250	0.1990	-0.1533	-0.1725	-0.2146	-0.1361	0.2284	0.2553	**0.6175**	0.3240	-0.1956
Cane volume/ Plot	-1.0110	-0.8532	-0.0250	-0.1485	0.0183	0.5554	0.5428	0.1853	0.4558	-0.9325	-1.8299	1.0885	**-2.0746**	-0.2891
Fibre percent	0.0388	-0.0695	-0.1194	-0.0972	-0.0023	-0.0566	-0.0218	0.0632	-0.0354	-0.0511	0.0604	0.0740	0.0325	**0.2334**
Cane Yield (t/ha)	**0.2222**	**0.2579**	**0.1072**	**0.1394**	**0.8603****	**0.1726**	**0.1030**	**-0.2297**	**0.1422**	**0.2019**	**0.2643**	**0.7547****	**0.3192**	**-0.1559**
Partial R^2	-0.0281	0.0583	0.0198	-0.0246	0.5255	0.0452	-0.0609	-0.0462	0.0629	0.2134	0.4726	0.4660	-0.6622	-0.0364

* significant at 5% level, **significant at 1% level. Residual effect = 0.07

Bold and diagonal values indicate direct effects

LITERATURE CITED

Anbanandan V and Sarvanan K 2010 Genetic variability in inter specific and inter generic progenies in sugarcane. *Plant archives*. 10(2): 627-632.

Arun Kumar B 2014 Studies on genetic variability parameters, character association and path analysis among yield and yield contributing traits in sugarcane (*Saccharum officinarum* L.). *An International Journal of Life Sciences*. 9(2): 697-700.

Burton, G W 1952 Quantitative inheritance in grasses. *Proceedings of the 6th Inter national Grassland Congress*, Pennsyl vania State College, USA, 23 August 1952. 277-283.

Dewey D R and Lu K H 1959 A correlation and path coefficient analysis of components of crested wheat grass seed production. *Agronomy Journal,* 51: 515-518.

Falconer D S 1964 An introduction to quantitative genetics. *Second edition. Oliver and Boyd Limited.* Edinburgh. 312-324.

Guddadamath S G, Patil S B and Khadi B M 2014 Relative contribution and associations studies among cane yield and their components in sugarcane (*Saccharum* spp. Hybrid). *International Journal of Plant Sciences,* 9(1): 21-26.

Hanson G H, Robinson H F and Comstock R E 1956 Biochemical studies of yield insegregating populations of Korean Lespedeza. *Agronomy Journal*, 48: 267-272.

Japheth E J, James O, Oliver K and Wilson O 2014 Broad-sense heritability estimation and correlation among sugarcane (*Saccharum* spp. hybrids) yield and some agronomic traits in western Kenya. *International Journal of Agricultural Policy and Research*, 2 (1): 16-25.

Johnson H W, Robinson H. F and Comstock R E 1955 Estimates of genetic and environmental variability in Soybean. *Agronomy Journal,* 47: 314-318.

Masri M I, Shaban S A, El-Hennawy H H, El –Taib A B A and Abu-El-Lail F F B 2015 Phenotypic and genotypic correlations and path coefficient analysis in sugarcane at first clonal selection stage. *Egypt Journal of Plant Breeding*, 19(2): 297-321.

Sanghera G S, Kumar R, Tyagi V, Thind K S 2014 Genetic variability for cane yield, earliness and quality traits in sugarcane under subtropical region of India. *International Journal of Current Research*, 6(8): 7763-7765.

Sanghera G S, Tyagi V, Kumar R, Thind K S and B Sharma 2015 Genetic variability, association and their dissection through path analysis for cane yield and its component traits in early maturing sugarcane clones. *Journal of Science,* 5(1): 28-34.

Singh S P and Khan A Q 2004 Interrelationship and path analysis in sugarcane. *Environment and Ecology,* 22 (4): 903-911.

Sireesha M 2009 Character Association, Path Analyses and Selection Indices in Sugarcane (*Saccharum officinarum* L.). M.Sc (Ag.) Thesis. Acharya N. G. Ranga Agricultural University, Hyderabad.

Tadesse F and Dilnesaw Z 2014 Genetic Variability, Heritability and Character Association of Twelve Sugar CaneVarieties in Finchaa Sugar Estate West Wolega Zone Oromia Region of Ethiopia. *International Journal of Advanced Research in Biological Sciences*, 1(7): 131–137.

(Received on 14.07.2016 and revised on 16.02.2017)