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Genetic variability, correlation and path co-efficient in segregating generation of Pearl millet (*Pennisetum glaucum* L.)

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ABSTRACT

In 60 F_3 progenies of pearl millet variability, heritability, genetic advance, correlation and path co-efficient for fifteen metric traits were studied. Stover yield, grain yield, earhead weight plant, total biomass per plant and earhead girth showed high GCV, heritability and genetic advance as percentage of mean. Heritability (broad sense) ranged from 14.93% (av. internode length) to 92.38% (total biomass per plant). The correlation of grain yield with earhead weight, average internode length, total biomass per plant, stover yield, no. of leaves per plant and no. of productive tillers per plant was significant and positive. The path coefficient analysis revealed that stover yield, earhead weight, no. of leaves per plant and average internode length had both direct and indirect effects to account for yield. The characters total biomass per plant and no. of productive tillers per plant showed negative direct effects but had positive indirect effects through no. of leaves per plant, earhead weight and stover yield per plant.

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Key words : Genetic variability, Segregating generation, Pearl millet

INTRODUCTION

Pearl millet (*Pennisetum glaucum* L.) is world's sixth and India's fourth important cereal crop. For bringing desired improvement in the crop plants, the first pre-requisite is the genetic variability with which a plant breeder has to work. Breeding for high yield requires information on the nature and magnitude of variation in the available material. According to Biradar *et al.* (1991), in most of the cases quantum of variability is studied by evaluating the homozygous cultivars, but inferences derived will become more meaningful only when is based on individual plant observations in segregating generation like F_2. The knowledge of association of the yield components inter se and with grain yield is useful for formulating efficient selection criteria for desired improvement. Further, the direct and indirect influence of such component characters on yield can obviously be of considerable use for a rational breeding approach. The present study was thus, undertaken to determine the inheritance pattern of each trait, nature and degree of association between different characters and to establish an understanding for direct and indirect selection of different traits in segregating generation (where selection is actually practiced) will be more meaningful and of immediate practical utility (Sawant *et al.,* 1995).

MATERIALS AND METHODS

The sixty F_3 progenies were chosen for the present studies from F_2 populations of eight crosses *viz.,* J-2290 x G-4 (11), J-2290 x G-5 (08), J-2290 x G-6 (03), J-2340 x G-4 (11), J-2340 x G-5 (08), J-2340 x G-8 (10), JMSB-101x G-7 (08) and PT-5591× G-4 (01). The 60 F_3 progenies were evaluated in Randomized Block Design (RBD) with three replications at the Regional Research Station, Anand Agricultural University, Anand (latitude 22^0 35' N, longitude 73^0 0 E and an altitude of 45.07 meters) Gujarat during Summer 2007. Each genotype was accommodated in plots of two rows of 4 m length and inter row distance of 0.6 m. Observations were recorded on ten random plants in each genotype for fifteen traits *viz.,* Grain yield per plant, days to 50% flowering, plant height, test weight (1000-grain weight), earhead length, earhead girth, average stem thickness, average internode length, earhead weight per plant, number of productive tillers per plant, number of leaves per plant, days to maturity, stover yield per plant, total biomass accumulation per plant and harvest index. The plot means were used to compute the analysis of variance as described by Panse and Sukhatme

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(1978). The various variability parameters were worked out as per Burton (1952). The broad sense heritability and genetic advance was estimated according to Allard (1960).

Results and Discussion

The mean, phenotypic, genotypic variances, phenotypic coefficient of variation, genotypic coefficient of variation, heritability, genetic advance as per cent of mean for all the characters are presented in Table 1.

A wide range of variation was observed for all the traits studied. The genotypic and phenotypic variances were higher for stover yield, grain yield, total biomass per plant and earhead weight indicating wide range of variability in these traits. During selection programme the traits showing high values of both phenotypic and genotypic variances may be preferred. The phenotypic and genotypic coefficients of variation are the measures of phenotypic and genotypic variances, respectively. The highest value of genotypic coefficients of variation was noted for stover yield, followed by grain yield, total biomass per plant and earhead weight. The high estimates of genotypic coefficient of variation were also reported by Solanki *et al*. (2002) and Yadav *et al*. (2001) for stover yield, grain yield and total biomass per plant. The moderate estimates of genotypic coefficient of variation were observed for the characters like earhead girth, number of productive tillers per plant, number of leaves per plant, and earhead length, while lowest estimates of genotypic coefficient of variation was recorded for average internode length. The large difference between genotypic coefficient of variation and phenotypic coefficient of variation estimates of harvest index indicated more influence of environmental factors on this trait. In general, phenotypic coefficient of variation was found to be higher than genotypic coefficient of variation for all characters.

Estimate of genotypic coefficient of variation alone does not assess the amount of heritable variation. Genotypic coefficient of variation computed in conjunction with heritability estimates would provide a better picture for selection on the phenotypic performance (Burton, 1952). Heritability was highest for total biomass per plant (92.38), followed by stover yield (88.29), earhead girth (85.54), earhead weight (84.63), grain yield (83.24), number of productive tillers per plant (82.05) and number of leaves per plant (80.84). The estimates of heritability were moderate for test weight and plant height. This indicated that these traits were relatively less influenced by environment. Similar results were also reported by Lakshmana *et al.* (2003), Yadav *et al*. (2001) Manonmani and Fazlullah Khan (2000) and Aryana (1996) for grain yield, stover yield, earhead weight and total biomass per plant, respectively. The lowest heritability was recorded for average internode length (14.93) indicating larger influence of environmental conditions.

High heritability combined with high genetic advance for the traits like stover yield per plant (86.80), grain yield (79.53), total biomass per plant (76.34) earhead weight (72.35) and earhead girth (64.68), indicated that these characters were governed largely through additive effects of genes and improvement in these traits may be achieved

Table 1 : Mean, range and related genetic parameters in F_3 progenies of pearl millet

Characters	Unit	Range		Mean	GCV	PCV	H^2	GA
		Max	Min		(%)	(%)	(%)	(% of mean)
Grain yield/plant	g	97.3	6.62	46.36	42.32	46.38	83.24	79.53
Days to 50% flowering	days	74	50	57.88	7.34	11.15	43.38	9.97
Test weight	g	13.6	4.6	7.43	18.12	22.60	64.31	29.90
Plant height	cm	209.9	112.8	163.2	12.72	18.04	49.69	18.46
Av. internode length	cm	24.88	16.31	20.91	5.44	14.07	14.93	4.35
Av. stem thickness	cm	1.044	0.582	0.75	9.39	16.43	32.61	10.68
Productive tillers/ plant	no.	9.4	2.4	4.95	29.95	33.07	82.05	55.96
No. of leaves/plant	no.	66.66	17.68	38.46	30.16	33.55	80.84	55.87
Earhead length	cm	42.3	17.9	24.67	24.83	27.98	78.76	45.40
Earhead girth	cm	12.71	3.83	7.02	33.91	36.67	85.54	64.68
Earhead weight/plant	g	151.8	9.68	69.77	38.18	41.50	84.63	72.35
Days to maturity	days	108	74	85.27	7.84	12.53	39.11	10.10
Stover yield/plant	g	220	30	90.48	44.84	47.73	88.29	86.80
Total biomass/plant	g	332.6	48	160.2	38.55	40.11	92.38	76.34
Harvest index	%	39.25	10.17	30.15	16.11	30.13	28.58	17.75

through phenotypic selection. High estimates of genetic advance for grain yield and stover yield were also reported by Solanki *et al.* (2002) and Yadav *et al.* (2001). Johnson *et al.* (1955) have also suggested that heritability estimates along with genetic advance shall be more helpful in predicting gain under phenotypic selection than heritability estimates alone. Earhead length showed high heritability with low genetic advance. Such a situation may be caused by non-additive gene action *i.e.* dominance and epistasis. The lowest heritability coupled with lowest genetic advance (4.35) was noted for average internode length which indicated that very little improvement can be achieved by phenotypic selection in this trait. Thus, improvement could be achieved for stover yield per plant, grain yield per plant, earhead weight per plant, total biomass per plant and earhead girth.

Grain yield showed high and positive association with earhead weight, average internode length, total biomass per plant, stover yield, no. of leaves per plant and no. of productive tillers per plant (Table 2). Grain yield was also significantly and positively associated with plant height, harvest index and average stem thickness but on lower magnitude. Various workers, Kumar *et al.* (2002), Anarase and Ugale (2001), Harer and Karad (1998) and Latha and Shanmugasundaram (1997) also reported positive association of grain yield with plant height, no. of productive tillers per plant and stover yield, while Yadav *et al.* (2001) observed positive association of grain yield with total biomass per plant and harvest index. Positive association of grain yield with earhead weight was also reported by Karthigeyan *et al.* (1995). The traits, no. of productive tillers per plant, no. of leaves per plant, earhead weight per plant, stover yield and total biomass per plant had positive correlation with each other. The characters pair average internode length and average stem thickness was positively correlated with each other. Under such situation selection for increase manifestation of one character would eventually lead to higher phenotypic expression of other traits and *vice- versa.*

Path coefficient analysis was done to determine the direct and indirect effects of association between independent and dependent variables (Table 3), which indicated that stover yield, earhead weight and no. of productive tillers per plant had high correlation with grain yield also exhibited very high direct as well as indirect effects. High positive direct effect of earhead weight per plant was also reported by Karthigeyan *et al.* (1995), while Kumar *et al.* (2002) and Anarase and Ugale (2001) revealed high direct effect of stover yield per plant on grain yield. The traits total biomass per plant and no. of productive tillers per plant were positive

Table 2 : Genotypic correlation between grain yield and its component characters

Characters	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}	X_{13}	X_{14}	X_{15}
X_1	0.049	0.149	0.346**	0.741**	0.329**	0.608**	0.631**	0.248	0.194	1.019**	0.0801	0.687**	0.890**	0.379**
X_2	1	0.178	0.779**	0.277*	0.901**	0.026	0.304*	0.352**	0.108	0.0243	1.524**	0.662**	0.445**	1.012**
X_3		1	0.020	0.332**	0.412*	0.300*	0.354**	0.410**	0.654**	0.0768	0.199	0.023	0.048	0.119
X_4			1	0.556**	0.932**	0.070	0.281*	0.785**	0.118	0.348**	0.750**	0.719**	0.622**	0.580**
X_5				1	0.789**	0.16	0.257*	1.018**	0.053	0.816**	0.226	0.583**	0.734**	0.245
X_6					1	0.236	0.0015	0.401**	0.584**	0.334**	0.909**	0.764**	0.646**	0.679**
X_7						1	0.933**	0.215	0.351**	0.655**	0.096	0.396**	0.542**	0.310*
X_8							1	0.382**	0.302*	0.667**	0.377**	0.623**	0.697**	0.010
X_9								1	0.439**	0.329**	0.402**	0.421**	0.418**	0.227
X_{10}									1	0.141	0.0421	0.273*	0.240	0.126
X_{11}										1	0.140	0.676**	0.875**	0.560**
X_{12}											1	0.715**	0.530**	1.10**
X_{13}												1	0.948**	0.463**
X_{14}													1	0.0624

Note: * and ** indicate significance of values at P 0.05 and 0.01, respectively

X_1 Grain yield/ plant, X_2 Days to 50% flowering, X^3 Test weight (1000 grain wt.), X_4 Plant height, X_5 Av. internode length , X_6 Av. stem thickness, X_7 No. of productive tillers/plant, X_8 No. of leaves/plant, X_9 Earhead length, X_{10} Earhead girth, X_{11} Earhead weight/plant, X_{12} Days to maturity, X_{13} Stover yield/plant, X_{14} Total biomass/plant, X_{15} Harvest index

Table 3 : Direct (diagonal) and indirect effects of yield components on grain yield in pearl millet

Characters	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}	X_{13}	X_{14}	X_{15}	Genotypic correlation with grain yield/ plant
X_2	0.180	0.038	0.997	0.199	0.431	0.099	1.172	0.064	0.009	0.085	0.371	2.562	2.674	0.225	0.049
X_3	0.032	0.210	0.026	0.239	0.197	1.147	1.364	0.074	0.055	0.267	0.048	0.089	0.289	0.027	0.149
X_4	0.140	0.004	1.279	0.399	0.445	0.269	1.082	0.143	0.010	1.211	0.183	2.781	3.735	0.129	0.346**
X_5	0.050	0.070	0.711	0.718	0.377	0.611	0.990	0.185	0.004	2.840	0.055	2.256	4.412	0.055	0.741**
X_6	0.162	0.087	1.192	0.567	0.478	0.902	0.006	0.073	0.049	1.165	0.221	2.957	3.881	0.151	0.329**
X_7	0.005	0.063	0.090	0.115	0.113	3.816	3.587	0.039	0.030	2.279	0.024	1.533	3.258	0.069	0.608**
X_8	0.055	0.074	0.360	0.185	0.001	3.561	3.844	0.070	0.026	2.324	0.092	2.411	4.187	0.002	0.603**
X_9	0.063	0.085	1.004	0.732	0.192	0.824	1.468	0.182	0.037	1.148	0.098	1.628	2.513	0.051	0.248
X_{10}	0.020	0.137	0.151	0.038	0.279	1.341	1.162	0.080	0.084	0.493	0.010	1.057	1.444	0.028	0.194
X_{11}	0.004	0.016	0.445	0.586	0.160	2.500	2.567	0.060	0.012	3.479	0.034	2.615	5.254	0.125	1.019**
X_{12}	0.275	0.042	0.960	0.162	0.434	0.369	1.449	0.073	0.004	0.489	0.243	2.767	3.185	0.246	0.080
X_{13}	0.119	0.005	0.920	0.419	0.365	1.513	2.397	0.077	0.023	2.352	0.174	3.867	5.692	0.103	0.687**
X_{14}	0.080	0.010	0.796	0.528	0.309	2.071	2.681	0.076	0.020	3.045	0.129	3.667	6.003	0.014	0.891**
X_{15}	0.182	0.025	0.743	0.176	0.325	1.186	0.039	0.041	0.011	1.951	0.269	1.791	0.375	0.222	0.379**

Residual effect 0.0081

Note: X_2 Days to 50% flowering, X_3 Test weight (1000 grain wt.), X_4 Plant height, X_5 Av. Internode length , X_6 Av. stem thickness, X_7 No. of productive tillers/plant, X_8 No. of leaves/plant, X_9 Earhead length, X_{10} Earhead girth, X_{11} Earhead weight/plant, X_{12} Days to maturity, X_{13} Stover yield/plant, X_{14} Total biomass/plant, X_{15} Harvest index

correlated with grain yield but exhibited high negative direct effects. The high positive correlation of these traits was due to high positive indirect effects of these traits via no. of leaves per plant, earhead weight and stover yield. The character average internode length having positive correlation with grain yield exhibited high indirect effects via no. of leaves per plant, earhead weight and stover yield per plant. The residual effect of path analysis was negligible (-0.0081), which indicated that all possible yield contributing characters have been included in the present investigation.

Thus, the above study revealed that the stover yield, earhead weight, no. of leaves per plant and average internode length are the most important traits which affected grain yield and should be given maximum emphasis during selection for the improvement of grain yield in F_3 progenies of pearl millet.

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