STUDIES ON GENETIC VARIABILITY AND TRAIT ASSOCIATION FOR GRAIN YIELD AND ITS COMPONENTS IN PEARL MILLET [*PENNISETUM GLAUCUM* (L.) R. BR.]

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SUMMARY

The present study was undertaken to determine genetic variability present in relation to grain yield and its components with the objective to study their association contributing to grain yield in pearl millet. A set of 24 pearl millet genotypes (7 hybrids and 17 parental lines) was evaluated in randomized block design (RBD) with three replications at Hisar under irrigated conditions during **kharif** 2011 season. Observations were recorded on 12 yield and yield contributing traits. Considerable amount of variation was found in material under study. Wide range, high coefficients of variation, heritability and genetic advance as per cent of mean were recorded for grain yield/plant, dry fodder weight/plant, fresh fodder weight/plant, productive tillers/plant, plant height and number of nodes/plant. Grain yield was found positively and highly significantly correlated with all the traits under study. Path analysis revealed that productive tillers/plant had highest positive direct effect followed by plant height, spike length and nodes/plant. These desirable correlations showed that productive tillers/plant, plant height, spike length, nodes/plant and fresh fodder weight were the major yield components in pearl millet and therefore can be used as selection criteria for yield improvement of pearl millet.

Key words : Variability, heritability, genetic advance, association, yield components, pearl millet

Pearl millet [*Pennisetum glaucum* (L.) R. Br.] is extensively cultivated for grain as well as fodder in the dry areas of north-western and southern India and along with periphery of the Sahara. It is the fourth most important staple food after rice, wheat and maize in India. To sustain food wealth and cattle production, pearl millet varieties need to be improved for grain and fodder yield with better quality. Genetic variability for grain yield and its contributing components and understanding their inter-relationship is essential to develop high yielding varieties of pearl millet.

The characters should be highly heritable as progress due to selection depends on heritability, selection intensity and genetic advance of the character (Abuali *et al.*, 2012). Heritability and genetic advance estimates for different targeted traits help the breeder to apply appropriate breeding methodology in the crop improvement programme. The components which have high heritability and positive correlation with yield can be used in the indirect selection for yield and act as an alternate mode of selection for yield improvement. When the indirect association becomes complex, path coefficient analysis is the most effective mean to find out direct and indirect causes of association among the different variables. Hence, the knowledge of direct and indirect effect of different components on yield is of prime importance in selection of high yielding genotypes (Izge *et al*., 2006). Keeping the above facts in view, the present investigation was undertaken by involving some released hybrids and their parental lines.

MATERIALS AND METHODS

The present investigation was carried out at Research Farm of the Department of Genetics & Plant Breeding, CCS Haryana Agricultural University, Hisar (29^0

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TABLE 1
List of pearl millet hybrids and their parents studied

S. No.	Hybrids	Year of release	Female parent	Male parent	Maintainer
1.	HHB 94	2000	ICMA 89111	G 73-107	ICMB 89111
2.	HHB 117	2004	HMS 7A	H 77/ 29-2	HMS 7B
3.	HHB 67 Imp.	2005	ICMA 843-22	H 77/833-2-202	ICMB 843-22
4.	HHB 197	2007	ICMA 97111	HBL 11	ICMB 97111
5.	HHB 216	2010	HMS 37A	HTP 3/13	HMS 37B
6.	HHB 223	2010	ICMA 94555	HBL 11	ICMB 94555
7.	HHB 226	2010	ICMA 843-22	HBL 11	ICMB 843-22

N, 75^0E and an altitude of 215.2 m) during the **kharif** 2011 season. The seed material for the present study consisted of 24 genotypes (7 hybrids, 6 CMS lines, 6 B lines and 5 restorers) of pearl millet and described in Table 1. The 24 pearl millet genotypes were evaluated in randomized block design (RBD) with three replications at Hisar under irrigated conditions. The plot size was one row of 4 m length for each entry per replication with row to row distance of 50 cm and plant to plant distance of 10-12 cm. Standard agronomic practices were followed to raise a good crop. The observations were recorded on five representative random plants in each replication for number of nodes, number of productive tillers, leaf length (cm), leaf width (cm), plant height (cm), spike length (cm), spike girth (mm), stem thickness (cm), 1000-grain weight (g), fresh fodder weight (g), dry fodder weight (g) and grain yield/plant (g).

The experimental data were subjected to the analysis of variance as suggested by Panse and Sukhatme (1967). Heritability, genetic advance, coefficient of variance and correlation coefficient were worked out as per the method given by Al-Jibouri *et al.* (1958). Path coefficient analysis was done by using correlation coefficients as suggested by Dewey and Lu (1959) and was carried out by taking grain yield/plant as dependent variable and other observed traits as independent variables.

RESULTS AND DISCUSSION

Mean sum of squares due to genotypes was highly significant for all the traits indicating sufficient amount of genetic variation among the genotypes under study. Wide range of variation observed for these characters (Table 2) would offer scope of selection for development of desirable genotypes.

In this study, the genetic constants for the characters revealed that the magnitude of phenotypic coefficient of variation (PCV) was higher than the genotypic coefficient of variation (GCV) denoting environmental factors influencing their expressions to some degree or other. Narrow difference between PCV

TABLE 2
Mean, range, PCV & GCV, heritability (h^2) and GA for grain yield components in pearl millet

Character	Mean	Range	PCV	GCV	h^2 (bs)	GA (% of mean)
No. of nodes/plant	8.04	5.00-11.30	19.50	18.52	0.90	36.21
Spike length (cm)	19.87	12.00-25.70	14.34	13.41	0.87	25.84
Spike girth (mm)	23.57	14.00-32.80	16.88	16.20	0.92	32.02
Plant height (cm)	187.06	123.30-291.0	23.41	22.50	0.92	44.57
Stem thickness (cm)	0.80	0.56-0.97	8.53	4.25	0.25	4.36
No. of productive tillers	4.05	1.90-6.30	31.19	30.45	0.95	61.24
Leaf length (cm)	66.92	49.00-82.00	11.32	10.01	0.78	18.22
Leaf width (cm)	3.67	2.30-5.50	18.21	17.02	0.87	32.76
1000-grain weight (g)	8.87	5.47-12.15	19.07	18.42	0.93	36.68
Fresh fodder weight/plant (g)	338.31	165.0-652.66	33.14	32.57	0.97	65.95
Dry fodder weight/plant (g)	209.56	83.33-346.66	33.10	32.19	0.95	64.50
Grain yield/plant (g)	33.68	11.00-64.66	49.62	49.02	0.98	99.74

PCV–Phenotypic coefficient of variance, GCV–Genotypic coefficient of variance and GA–Genetic advance.

and GCV suggested their relative resistance to environmental alteration. It was observed that PCV and GCV were higher for grain yield/plant, dry fodder weight/plant, number of nodes/plant, fresh fodder weight/plant, plant height, number of productive tillers/plant and 1000-grain weight indicating the possibility of improving these characters through phenotypic selection for the development of high yielding potential hybrids. High amount of GCV and PCV suggested greater scope of selection of superior genotypes for these traits.

The determination of heritable portions is not based on only the estimation of PCV and GCV, it also depends on heritability and genetic advance (Govindaraj *et al.,* 2010). The traits number of nodes/plant, spike girth and 1000-grain weight exhibited high heritability along with the moderate genetic advance as per cent of mean which indicated that the existence of both additive and non-additive genes in equal proportion and similar findings were also reported by Vidyadhar *et al*. (2006). Whereas grain yield/plant, dry fodder weight/plant, fresh fodder weight/plant, plant height and number of productive tillers/plant showed high heritability (h^2) with high genetic advance indicating the predominance of additive gene action and greater response to phenotypic selection and conforming to the earlier findings by Sumathi *et al.* (2010).

In the present study, the grain yield/plant had significant positive correlation with all yield components. Significant and positive correlations between yield and other yield variables are quite desirable in plant breeding, because these facilitate the selection process (Vinodhana *et al.,* 2013). The phenotypic correlation coefficients of plant height, fresh fodder weight and nodes/plant of 0.880, 0.869 and 0.851, respectively, with grain yield/plant were among the highest values obtained in this study. The correlation coefficients for most of the pairs of characters were found significant and positive (Table 3).

Direct and indirect effects are given in Table 4. The number of productive tillers/plant had the highest direct effect on grain yield/plant, followed by plant height and spike length. Similar results were reported by Muhammad *et al*. (2003) in pearl millet. Number of nodes/plant had the highest indirect effect (0.235) towards grain yield/plant through productive tillers/plant followed by plant height (0.220) through productive tillers/plant. Though leaf length had negative direct effect but this was compensated by indirect positive effects through spike length, spike girth and fresh fodder weight.

Number of productive tillers/plant, plant height, fresh fodder weight/plant and number of nodes appeared to be the prominent characters when selecting for total grain yield in pearl millet, because of their highly significant phenotypic correlations with grain yield/plant. These characters also had the highest direct effects on total grain yield and high indirect effects through most of the other characters. This investigation, therefore, suggests that number of productive tillers/plant, plant height, fresh fodder weight/plant and number of nodes

TABLE 3
Phenotypic correlation coefficients among grain yield and its components in pearl millet

Characters	SL	SG	PH	ST	PT/P	LL	LW	GW	FFW	DFW	GY
N/P	0.596**	0.272*	0.876**	0.222	0.850**	0.181	0.129	0.610**	0.824**	0.788**	0.851**
SL		0.443**	0.674**	0.417**	0.559**	0.492**	0.224	0.562**	0.617**	0.671**	0.729**
SG			0.320**	0.437**	0.327**	0.582**	0.205	0.638**	0.408**	0.487**	0.473**
PH				0.231**	0.797**	0.259*	0.244*	0.593**	0.884**	0.849**	0.880**
ST					0.142	0.478**	0.357**	0.442**	0.343**	0.423**	0.350**
PT/P						0.196	0.005	0.637**	0.763**	0.724**	0.822**
LL							0.489**	0.426**	0.364**	0.437**	0.370**
LW								0.263*	0.423**	0.394**	0.315**
GW									0.754**	0.795**	0.706**
FFW										0.960**	0.869**
DFW											0.849**

N/P–Number of nodes/plant, SL–Spike length, SG–Spike girth, PH–Plant height, ST–Stem thickness, PT/P–Number of productive tillers/plant, LL–Leaf length, LW–Leaf width, GW–1000-grain weight, FFW–Fresh fodder weight/plant, DFW–Dry fodder weight/plant and GY–Grain yield/plant.

*,**Significant at P=0.05 and P=0.01 levels, respectively.

TABLE 4
Phenotypic direct (main diagonals) and indirect path coefficients

Characters	N/P	SL	SG	PH	ST	PT/P	LL	LW	GW	FFW	DFW	GY
N/P	**0.184**	0.113	0.037	0.202	0.008	0.235	-0.011	0.019	0.010	0.132	-0.079	0.851**
SL	0.110	**0.190**	0.061	0.156	0.014	0.155	-0.030	0.033	0.009	0.099	-0.067	0.729**
SG	0.050	0.084	**0.137**	0.074	0.015	0.090	-0.036	0.030	0.011	0.066	-0.049	0.473**
PH	0.162	0.128	0.044	**0.231**	0.008	0.220	-0.016	0.036	0.010	0.142	-0.085	0.880**
ST	0.041	0.079	0.060	0.053	**0.034**	0.039	-0.029	0.053	0.007	0.055	-0.042	0.350**
PT/P	0.157	0.106	0.045	0.184	0.005	**0.277**	-0.012	0.001	0.011	0.123	-0.073	0.822**
LL	0.033	0.094	0.080	0.060	0.016	0.054	**-0.061**	0.072	0.007	0.059	-0.044	0.370**
LW	0.024	0.043	0.028	0.056	0.012	0.001	-0.030	**0.148**	0.004	0.068	-0.040	0.315**
GW	0.112	0.107	0.087	0.137	0.015	0.176	-0.026	0.039	**0.017**	0.121	-0.080	0.706**
FFW	0.152	0.117	0.056	0.204	0.012	0.211	-0.022	0.063	0.013	**0.161**	-0.096	0.869**
DFW	0.145	0.128	0.067	0.196	0.014	0.200	-0.027	0.058	0.013	0.154	**-0.100**	0.849**

Character details are given in Table 3. **Significant at P=0.01 level.

should be given maximum consideration as selection indices for grain yield improvement in pearl millet.

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