Indian Res. J. Genet. & Biotech. 6(3) : 491-500 (2014)

Genetic Variability, Correlation And Path Analysis In Pearl Millet (*Pennisetum Glaucum* (L.) R. Br.)

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(Received : May, 2014 : Revised : June, 2014; Accepted : July 2014)

Abstract

A study was conducted at Agronomy Research Farm, S.K.N. College of Agriculture, Jobner, Jaipur (Rajasthan) during *kharif* season 2012. Range, CV, genotypic, phenotypic and environment variance, genotypic and phenotypic coefficient of variation, heritability, genetic advance, correlation and path analysis were performed for yield and its contributing characters in 55 pearl millet genotypes. Analysis of variance for significant differences was among the all characters. A broad range of variation was observed for biological yield per plant, dry fodder yield per plant, plant height and days to maturity. Phenotypic variance value for most characters was closer than the corresponding genotypic variance value showing little environment effect on the expression of these characters. The estimated value of broad sense heritability was found between 55.46% (productive tillers per plant) and 99.11% (test weight). Heritability values were determined as 83.21%, 82.26%, 55.46%, 97.77%, 93.93%, 98.78%, 84.23%, 96.85%, 69.12%, 99.11%, 91.77% and 85.23%, for days to 50% flowering, days to maturity, productive tillers per plant, plant height, panicle length, panicle girth, biological yield per plant, dry fodder yield per plant, harvest index, test weight, protein content and grain yield per plant, respectively. High heritability coupled with high genetic advance as percent over mean was observed for plant height, panicle length, panicle girth, biological yield per plant, dry fodder yield per plant, test weight, protein content and grain yield per plant suggesting selection for these traits would give good responses. Grain yield per plant showed significant positive genotypic and phenotypic correlation with productive tillers per plant, plant height, panicle length, panicle girth, biological yield per plant, dry fodder yield per plant, harvest index and test weight. Grain yield per plant (0.987, 0.918) had highest positive direct effect on harvest index followed by biological yield per plant (0.606, 1.022). It is suggested that these characters can be considered as selection criteria in improving the grain yield.

Key words : Genetic variability, heritability, genetic advance, correlation and path analysis.

Inroduction

Pearl millet (*Pennisetum glaucum* L.) is the fifth most important cereal crop and the most important millet with more than 55 percent of global millet production, grown in 40 countries predominantly in Asia and Africa, as a staple food grain and source of feed, fodder, fuel and construction material. In India, pearl millet occupies forth position among cereal crops next to rice, wheat, maize and sorghum. Though it is a drought tolerance crop, it faces moisture stress

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Published by Indian Society of Genetics, Biotechnology Research and Development, 5, E Biotech Bhawan, Nikhil Estate, Mugalia Road, Shastripuram, Sikandra, Agra 282007
Onlince management by www.isgbrd.co.in

very often. Hence, breeding for drought tolerance forms an integral part of pearl millet breeding.

Genetic studies provide basic information regarding the genetic properties of the population based on which breeding methods are formulated for further improvement of the crop. These studies are also helpful to know about the nature and extent of variability that can be attributed to different cause's sensitive nature of the crop to environmental influences heritability of the characters and genetic advance that can be realized in practical breeding. Progress in any crop improvement venture depends mainly on the magnitude of genetic variability and heritability present in the source material. The extent of variability is measured by GCV and PCV which provides information about relative amount of variation in different characters. Hence, to have a thorough comprehensive idea it is necessary to have an analytical assessment of yield components. Since heritability is also influenced by environment, the information on heritability alone may not help in pin pointing characters enforcing selection. Nevertheless the heritability estimates in conjunction with the predicted genetic advance will be more reliable (Johnson *et al*., 1955). Heritability gives the information on the magnitude of inheritance of quantitative traits while genetic advance will be helpful in formulating suitable selection procedures.

Correlation and path coefficient analysis could be used as an important tool to bring information about appropriate cause and effects relationship between yield and some yield components (Khan *et al.,* 2003).

Path coefficient analysis provides means to quantify the inter-relationship of different yield components and indicate whether the influence is directly reflected in the yield or take some other path ways to produce an effect. Path analysis was used for different crops to determine the direct and indirect effect of yield components (Khaliq *et al.,* 2004; Chaudhary and Joshi, 2005; Yagdi, 2009; Yasin and Singh, 2010). The present investigation was conducted with the objectives to determine the variability of traits, provide information on inter-relationship of yield with some important yield components and to partition the observed genotypic correlations into their direct and indirect effects.

Material and Methods

The field experimental materials for the present investigation comprised selected ten inbred of Pearl Millet [*Pennisetum glaucum* (L.) R. Br.]. The inbred were received from All India Coordinated Pearl Millet Improvement Project, Department of Genetics and Plant Breeding, Rajasthan Agriculture Research Institute, Durgapura, Jaipur. These were 26-30, 31-40, 41-50, RIB-20, 61-70, 71-75, 75-80, 51-60, RIB-135-144 and 101-105 were crossed in a diallel fashion excluding reciprocals during *kharif* season 2011. These ten parents and their 45 F_1's were evaluated in randomized block design with three replications at Agronomy Research Farm, Jobner (Jaipur) during *kharif* season on date 14th July, 2012. Each entry was sown in a two row of 3.0m length with row-to-row and plant-to-plant distances of 50 cm and 15 cm, respectively. The observation were recorded on five randomly selected competitive plants from each replication and genotypes, for the characters namely; days to 50% flowering, days to maturity, productive tillers per plant, plant height, panicle length, panicle girth, biological yield per plant, dry fodder yield per plant, grain yield per plant, harvest index, test weight and protein content while, days to 50% flowering and days to maturity were recorded on plot basis. All the recommended agronomic cultural practices and plant protection measures were followed. Replication wise mean data for each character were subjected for analysis of variance (Panse and Sukhatme, 1985), coefficient of variance (CV) (Burton, 1953), heritability in board sense (Johnson *et al.,* 1955), genetic advance (Johnson *et al.*, 1955), correlation (Searle *et al.*, 1961) and Path analysis (Sewall Wright, 1921 and

Deway and Lu, 1959) were calculated as per statistical method.

Result and Discussion

Genetic Variability, Heritability and Genetic advance

Highly significant differences (P < 0.01) were observed among genotypes for days to 50% flowering, days to maturity, productive tillers per plant, plant height, panicle length, panicle girth, biological yield per plant, dry fodder yield per plant, grain yield per plant, harvest index, test weight and protein content demonstrating the presence of genetic variability among genotypes (Table-1). The variability parameters showing phenotypic variation ($ó^2p$), genotypic variation ($ó^2g$), environment variation ($ó^2e$), phenotypic coefficient of variance (PCV), genotypic coefficient of variance (GCV), heritability in broad sense (h^2b), genetic advance (GA) and genetic advance as percentage (GA%) over the mean along with mean, range, coefficient of variance (CV) are presented in Table- 2. Maximum phenotypic coefficient of variance (PCV) was observed on dry fodder yield per plant (32.45%), biological yield per plant (25.45%), panicle length (24.11%), grain yield per plant (22.28%), harvest index (22.02%), productive tillers per plant (20.31%) and test weight (19.44%) and minimum for days to maturity (5.62%) and days to 50% flowering (6.11%). The genotypic coefficient of variance (GCV) was also maximum for dry fodder yield per plant (31.94%) followed by panicle girth (23.96%), biological yield per plant (23.36%), grain yield per plant (20.56%), test weight (19.35%) and harvest index (18.31%) and minimum for days to maturity (5.09%) and days to 50% flowering (5.57%).

The higher PCV and GCV values for most of the characters could be evidence for the existence of a wide range of variation for such characters. In general, the PCV values for most characters were closer than the corresponding GCV values showing little environment effect on the expression of these characters. Similar results were also observed by Galeta *et al*., 2005 and Ventriventhan and Nirmalakumari, 2007. Selection on a phenotypic basis may be effective for the genetic improvement of such traits. Days to 50% flowering and days to maturity were showed low PCV and GCV values implying the difficulty of improving these traits through simple selection. However, contradicting results were obtained from the works of Tazeen *et al*., 2009.

High heritability values were exhibited for test weight (99.11%), panicle girth (98.78%), plant height (97.77%), dry fodder yield per plant (96.85%), panicle length (93.93%), protein content (91.78%), grain yield per plant (85.23%), biological yield per plant (84.23%), days to 50% flowering (83.21%) and days to maturity (82.26%) showed that these characters were governed by additive genes. The high heritability magnitude indicates the reliability with which the high chance of the genotype to be recognized by its phenotypic expression. Moderate heritability value were observed for harvest index (69.12%) and productive tillers per plant (55.46%) suggesting selection for these characters would not be effective due to predominant effects of non additive genes in this population.

Maximum expected genetic advance as percentage of mean was observed on dry fodder yield per plant (64.75%) followed by panicle girth (49.06%), biological yield per plant (44.16%), test weight (39.69%) and grain yield per plant (39.11%) indicating the presence of additive gene effects; while the same was minimum for days to 50% flowering (10.47%) and days to maturity (9.52%). Similar results were found in other findings (Galeta *et al*., 2005; Meena Kumari and Nagarajan, 2008 and Bhoite *et al*., 2008).

High heritability coupled with high genetic advance percentage over mean was recorded on for test weight, panicle girth, plant height, dry fodder yield per plant, panicle length, protein content, grain yield per plant and biological yield per plant indicating selection for these characters would be more effective.

Phenotypic and genotypic correlation coefficient of grain yield per plant with other characters is presented in Table 3&4. Grain yield per plant showed significant positive phenotypic and genotypic correlation with productive tillers per plant (0.222, 0.342), plant height (0.307, 0.342), panicle length (0.258, 0.311), panicle girth (0.307, 0.335), biological yield per plant (0.545, 0.609), dry fodder yield per plant (0.404, 0.442), harvest index (0.398, 0.353) and test weight (0.154, 0.162) and negative significant with days to 50% flowering (-0.168,-0.177), days to maturity (-0.177,-0.225). Similar results were observed by (Bello *et al*., 2001; Ezeaku and Mohammed, 2006 and Yogdi and Sozen, 2009). The negative association of grain yield per plant with days to 50% flowering and days to maturity suggested that early initiation of panicle and maturity genotypes would give high grain yield.

The genotypic correlation coefficient value for most of the characters were higher in magnitude than the corresponding phenotypic values showing the existence of inherent association among the traits.

The path coefficient analysis was done with twelve characters using estimates of direct and indirect effects of eleven characters on grain yield based on phenotypic and genotypic correlation coefficient (Table-5&6). High and positive phenotypic and genotypic direct effects on grain yield per plant were exhibited by harvest index (0.918, 0.987) followed by biological yield per plant (1.022, 0.606), plant height (0.116, 0.212), protein content (0.014, 0.054) and panicle length (0.007, 0.030) which supports the findings by Izge *et al*., 2004. Hence, these traits should be considered in further selection procedures for higher grain yield. Grain yield per plant showed indirect effect on harvest index, biological yield per plant through plant height and panicle length. Days to 50% flowering, days to maturity, productive tillers per plant, panicle girth and test weight had negative phenotypic and genotypic direct effect on grain yield per plant. Similar results were found (Izge, *et al*., 2004 and Mohammed, 2006).

Residual effect was P = 0.072, G=0.053 showing the variability in the grain yield in pearl millet was contributed by the characters studied in path analysis.

Conclusion

The present study illustrated the existence of wide ranges of variations for most of the trait among the pearl millet genotypes and opportunities of the genetic gain through selection or hybridization. Phenotypic and genotypic correlation analysis showed the positive correlation of grain yield with important agro-morphology characters. Hence, improving one or more of these traits could result in high grain yield for pearl millet. Grain yield per plant, harvest index, biological yield per plant, plant height and panicle length had positive phenotypic and genotypic direct effect and correlation with grain yield suggesting the possibility of improving grain yield through direct selection of these traits.

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Table1. Analysis of Variance for Pearl Millet in Medium Late Sown Condition of Semi Arid Region of Rajasthan

Source of variance	d.f.	Days to 50% flowering	Days to maturity	Productive tillers per Plant	plant height (cm)	Panicle length (cm)	Panicle girth (cm)	Biological yield per plant (g)	Dry fodder yield per plant (g)	Grain yield per plant (g)	Harvest index (%)	Test weight (g)	Protein content (%)
Replication	2	2.81	10.48	0.10	11.10	0.86	0.01	270.32	58.05	3.16	0.04	0.06	0.42
Treatment	54	29.24**	55.82**	0.22**	1297.12**	28.35**	6.05**	2081.98**	2132.76**	20.97**	15.96**	7.08**	5.76**
Error	108	1.84	3.74	0.05	9.78	0.32	0.02	122.31	22.82	1.15	2.07	0.02	0.17
S.Em±		0.78	1.12	0.13	1.81	0.33	0.09	6.39	2.76	0.62	0.83	0.08	0.24
C.D. at 5%		2.2	3.13	0.35	5.06	0.92	0.25	17.90	7.73	1.73	2.33	0.08	0.24

** And * significant at 1% and 5% level, respectively

Table 2. Estimation of parameters of Mean, range, Coefficient of Variability, Heritability and Genetic advance for different character in pearl millet

Parameters/ Characters	d.f.	Days to 50% flowering	Days to maturity	Productive tillers per Plant	plant height (cm)	Panicle length (cm)	Panicle girth (cm)	Biological yield per plant (g)	Dry fodder yield per plant (g)	Grain yield per plant (g)	Harvest index (%)	Test weight (g)	Protein content (%)
Mean		54.261	81.806	1.601	170.34	18.295	5.912	109.43	83.033	12.499	11.752	7.926	11.377
Range		47-60	73.67-91.33	1.0-2.33	108.33-216	11.77-24.54	3.5-9.39	46.88-196.47	30.47-168.33	6.39-18.73	7.16-18.09	5.75-11.68	8.32-13.34
C.V.%		2.5	2.37	13.55	1.84	3.1	2.66	10.11	5.75	8.56	12.24	1.84	3.59
Variance	**^{2}g**	**8.81**	**15.11**	**0.04**	428.67	9.16	2.01	603.88	691.57	5.93	5.31	2.34	1.78
	σ^2p	9.42	16.36	0.06	431.93	9.27	2.01	644.65	699.18	6.32	5.99	2.35	1.84
	σ^2e	0.61	1.25	0.02	3.25	0.11	0.01	40.77	7.61	0.38	0.69	0.01	0.06
Coefficient of variance	**GCV**	5.57	5.093	15.122	12.161	16.245	23.96	23.356	31.939	20.564	18.309	19.352	12.007
	PCV	6.106	5.616	20.305	12.299	16.762	24.107	25.449	32.453	22.276	22.023	19.439	12.533
Heritability (H)%		83.209	82.258	55.462	97.772	93.928	98.787	84.229	96.857	85.226	69.115	99.107	91.778
Genetic advance		5.679	7.784	0.371	42.195	5.934	2.901	48.32	53.766	4.888	3.685	3.146	2.696
G.A. over mean %		10.466	9.516	23.199	24.771	32.434	49.058	44.156	64.753	39.108	31.356	39.686	23.695

Table 3. Genotypic (G) correlation coefficient among yield and its component under study in pearl millet

Characters	Days to 50% flowering	Days to maturity	Productive tillers per Plant	plant height (cm)	Panicle length (cm)	Panicle girth (cm)	Biological yield per plant (g)	Dry fodder yield per plant (g)	Harvest index (%)	Test weight (g)	Protein content (%)	Grain yieldper plant (g)
Days to 50% flowering		0.407**	0.129NS	-0.018NS	0.057NS	-0.189*-	0.015NS	0.026NS	-0.150NS	-0.007NS	-0.081NS	-0.177*
Days to maturity			-0.230**	-0.107NS	-0.022NS	-0.370**	-0.139NS	-0.065NS	-0.055NS	-0.242**	-0.214**	-0.225**
Productive tillers perplan				0.328**	0.268**	0.112NS	0.475**	0.461**	-0.163*	0.433**	0.232**	0.342**
Plant height (cm)					0.443**	0.375**	0.689**	0.650**	-0.508**	0.339**	-0.047NS	0.342**
Panicle length (cm)						0.294**	0.431**	0.373**	-0.181*	0.191*	-0.026NS	0.311**
Panicle girth (cm)							0.501**	0.493**	-0.205**	0.402**	0.214**	0.335**
Biological yield per plant (g)								0.991**	-0.496**	0.397**	0.279**	0.609**
Dry fodder yield per plant (g)									-0.648**	0.392**	0.254**	0.442**
Harvest index (%)										-0.260**	-0.173*	0.353**
Test weight (g)											0.207**	0.162*
Protein content (%)												0.122NS
Grain yield per plant (g)												

** And * significant at 1% and 5% level, respectively

Table 4. Genotypic (G) correlation coefficient among yield and its component under study in pearl millet

Characters	Days to 50% flowering	Days to maturity	Productive tillers per Plant	plant height (cm)	Panicle length (cm)	Panicle girth (cm)	Biological yield per plant (g)	Dry fodder yield per plant (g)	Harvest index (%)	Test weight (g)	Protein content (%)	Grain yieldper plant (g)
Days to 50% flowering		0.334**	0.114NS	-0.014NS	0.050NS	-0.171*	0.010NS	0.023NS	-0.153*	-0.003NS	-0.082NS	-0.168*
Days to maturity			-0.189*	-0.097NS	-0.041NS	-0.327**	-0.132NS	-0.046NS	-0.016NS	-0.218**	-0.192*	-0.177*
Productive tillers perplan				0.227**	0.194*	0.082NS	0.344**	0.337**	-0.117NS	0.318**	0.175*	0.222**
Plant height (cm)					0.422**	0.368**	0.625**	0.630**	-0.421**	0.335**	-0.042NS	0.307**
Panicle length (cm)						0.278**	0.383**	0.345**	-0.164*	0.184*	-0.029NS	0.258**
Panicle girth (cm)							0.461**	0.486**	-0.177*	0.399**	0.203**	0.307**
Biological yield per plant (g)								0.891**	-0.511**	0.362**	0.237**	0.545**
Dry fodder yield per plant (g)									-0.532**	0.384**	0.235**	0.404**
Harvest index (%)										-0.209**	-0.132NS	0.398**
Test weight (g)											0.198*	0.154*
Protein content (%)												0.108NS
Grain yield per plant (g)												

** And * significant at 1% and 5% level, respectively

Table 5. Genotypic (G) path coefficient analysis showing direct and indirect effect of eleven components on grain yield per plant in pearl millet

Characters	Direct Effect	Days to 50% Flowring	Days to maturity	Productive tillers per Plant	plant height (cm)	Panicle length (cm)	Panicle girth (cm)	Biological yield per plant (g)	Dry fodder yield per plant (g)	Harvest index (%)	Test weight (g)	Protein content (%)
Days to 50% flowering	-0.003	-0.003	-0.026	-0.006	-0.004	0.002	0.011	-0.009	0.010	-0.148	0.000	-0.004
Days to maturity	-0.065	-0.001	-0.065	0.010	-0.023	-0.001	0.021	-0.084	-0.024	-0.054	0.008	-0.011
Productive tillers perplan	-0.043	0.000	0.015	-0.043	0.070	0.008	-0.006	0.288	0.173	-0.160	-0.014	0.012
Plant height (cm)	0.212	0.000	0.007	-0.014	0.212	0.013	-0.021	0.418	0.243	-0.502	-0.011	-0.003
Panicle length (cm)	0.030	0.000	0.001	-0.012	0.094	0.030	-0.017	0.261	0.140	-0.179	-0.006	-0.001
Panicle girth (cm)	-0.057	0.001	0.024	-0.005	0.079	0.009	-0.057	0.304	0.185	-0.203	-0.013	0.011
Biological yield per plant (g)	0.606	0.000	0.009	-0.020	0.146	0.013	-0.029	0.606	0.371	-0.489	-0.013	0.015
Dry fodder yield per plant (g)	0.374	0.000	0.004	-0.020	0.138	0.011	-0.028	0.601	0.374	-0.639	-0.013	0.014
Harvest index (%)	0.987	0.000	0.004	0.007	-0.108	-0.005	0.012	-0.301	-0.242	0.987	0.008	-0.009
Test weight (g)	-0.032	0.000	0.016	-0.019	0.072	0.006	-0.023	0.241	0.147	-0.257	-0.032	0.011
Protein content (%)	0.054	0.000	0.014	-0.010	-0.010	-0.001	-0.012	0.169	0.095	-0.170	-0.007	0.054

Residual are 0.053

Table 6. Phenotypic (P) path coefficient analysis showing direct and indirect effect of eleven components on grain yield per plant in pearl millet

Characters	Direct Effect	Days to 50% Flowring	Days to maturity	Productive tillers per Plant	plant height (cm)	Panicle length (cm)	Panicle girth (cm)	Biological yield per plant (g)	Dry fodder yield per plant (g)	Harvest index (%)	Test weight (g)	Protein content (%)
Days to 50% flowering	-0.027	-0.027	-0.007	-0.002	-0.002	0.000	0.002	0.010	-0.002	-0.140	0.000	-0.001
Days to maturity	-0.020	-0.009	-0.020	0.003	-0.011	0.000	0.003	-0.135	0.003	-0.015	0.007	-0.003
Productive tillers perplan	-0.017	-0.003	0.004	-0.017	0.026	0.001	-0.001	0.351	-0.025	-0.107	-0.010	0.003
Plant height (cm)	0.116	0.000	0.002	-0.004	0.116	0.003	-0.003	0.639	-0.047	-0.386	-0.011	-0.001
Panicle length (cm)	0.007	-0.001	0.001	-0.003	0.049	0.007	-0.003	0.391	-0.026	-0.150	-0.006	0.000
Panicle girth (cm)	-0.009	0.005	0.007	-0.001	0.043	0.002	-0.009	0.471	-0.037	-0.162	-0.013	0.003
Biological yield per plant (g)	1.022	0.000	0.003	-0.006	0.072	0.003	-0.004	1.022	-0.067	-0.469	-0.012	0.003
Dry fodder yield per plant (g)	-0.075	-0.001	0.001	-0.006	0.073	0.003	-0.005	0.911	-0.075	-0.488	-0.013	0.003
Harvest index (%)	0.918	0.004	0.000	0.002	-0.049	-0.001	0.002	-0.522	0.040	0.918	0.007	-0.002
Test weight (g)	-0.033	0.000	0.004	-0.005	0.039	0.001	-0.004	0.370	-0.029	-0.192	-0.033	0.003
Protein content (%)	0.014	0.002	0.004	-0.003	-0.005	0.000	-0.002	0.242	-0.018	-0.121	-0.007	0.014

Residual are 0.072

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