Electronic Journal of Plant Breeding, 4(4): 1325-1330 (Dec 2013)
ISSN 0975-928X

Research Note

Components of genetic variance and interrelationship among quantitative traits in CAZRI-bred inbred restorers of pearl millet [*Pennisetum glaucum* (L.) R. Br.]

V.K. Manga
Central Arid Zone Research Institute, Jodhpur 342003, India
Email: vk_manga@yahoo.co.in

(Received: 26 Sep 2013; Accepted: 25 Oct 2013)

Abstract
Genetic variation, heritability, genetic advance and association among various traits were investigated in a set of 47 inbred restorer lines developed under inbred development programme at CAZRI, Jodhpur. Significant genetic variation was indicated by analysis of variance, phenotypic (PCV) and genotypic coefficients of variation (GCV) for days to flowering, plant height, effective tillers per plant, ear length, ear girth, ear head weight, grain yield, dry fodder yield, biomass, panicle harvest index, harvest index and 500 grain weight. High estimates of heritability were obtained for 500 grain weight, grain yield, ear head weight, biomass and plant height. Genetic advance as percent of mean, were found to be high for grain yield, ear head weight and biomass. These traits also recorded high GCV and heritability. This indicated that selection may be effective for these traits. Association study revealed that most of the traits had positive significant correlation with grain yield except for days to flowering which had negative significant correlation with grain yield, suggesting that early varieties tend to yield higher. Days to flowering also had negative significant correlation with ear head girth, ear head weight, panicle harvest index and harvest index, but positive significant association with 500 grain weight, thus late varieties had higher 500 grain weight as compared to early varieties. Ear head weight, dry fodder yield and biomass yield had high values of correlation coefficients with grain yield, while plant height, ear head length, ear head girth, panicle harvest index and harvest index had moderate positive association with grain yield. Consequently, selection of taller genotypes with long ear heads, more ear head girth, early maturity and high panicle harvest index would be the best way to improve grain yield.

Key words: Pearl millet, Genetic variation, heritability, genetic advance and correlation

Pearl millet [*Pennisetum glaucum* (L.) R. Br.] is cultivated mostly in marginal environments of the arid and semi-arid regions generally characterized by low rainfall, high temperatures and sandy soils having low fertility. This crop is primarily cultivated for grain purpose, but also valued for its stover and fodder. The dual purpose nature of pearl millet offers both food and fodder security in the arid and semi-arid tropical regions of the country. India is the largest producer of pearl millet, both in terms of area (9.3 mha) and production (7.97 mt), with an average productivity of 856 kg ha $^{-1}$ and contributes 7.8% to the total food grain area of the country and 3.9 per cent to the total food grain production. Rajasthan constitutes about 50 per cent area and 42 per cent of production of pearl millet in the country.

The discovery of cytoplasmic male sterility by Burton (1958, 1965) has resulted in the development and release of more than hundred commercial hybrids of pearl millet, but number of hybrids suitable for cultivation under harsh climatic conditions of arid zone, remained limited. The pearl millet hybrid breeding programme at CAZRI, Jodhpur has developed over years, a number of inbred restorers (pollinators), adapted to the harsh climatic conditions of this region, to utilize as potential male parents in the hybrid development.

Knowledge about nature and magnitude of genetic variability for various characters in the available breeding material is important for planning a successful breeding programme. Further, heritability in conjunction with genetic advance has a greater role to play in identifying characters amenable to genetic improvement through selection. Keeping this in view, the present study was undertaken to estimate variability, heritability, genetic advance and association among various quantitative traits in a set of inbred restorers of pearl millet at CAZRI, Jodhpur.

The experiment was conducted at the Central Arid Zone Research Institute, Jodhpur (26º 18´ N, 73º 01´ E) during the rainy season (July to September) of 2011. The experiment was planted in the month of July and harvested in October. During the cropping period a precipitation of 305.2 mm was received. The rainfall was well distributed during July and August and continued up to the second week of September, as a result good crop growth was obtained. The weekly maximum mean temperature during the crop growth period was ranged between 31.3 and 38.7 ^{o}C, and weekly mean evaporation was ranged between 3.1 and 10 mm.

Forty seven inbred restorer lines of pearl millet developed at CAZRI, Jodhpur and having different genetic backgrounds were planted in a randomized complete block design with three replications. Each plot consisted of two rows of four meter length with row spacing of 60 cm and plant to plant spacing of 15 cm. The experiment was conducted in the loamy sand with applied fertilizer of 40 kg nitrogen ha^{-1} (50% basal and rest as top dressing) and 20 kg phosphorous ha^{-1} (basal dose). The standard cultural and agronomic practices were followed. Data were recorded on five random plants for plant height, days to 50% flowering, effective tillers per plant, ear head length (cm), ear head girth (cm), ear head weight (g)/plot, grain yield (g)/plot, dry fodder weight kg/plot and 500 grain weight (g). The above data were used to compute biomass yield, panicle harvest index and harvest index. The data were subjected to analysis of variance according to Steel and Torrie (1980). The phenotypic and genotypic coefficients of variations were computed as suggested by Burton and Davane (1952). The heritability estimates were computed as ratio between estimates of genetic variance and phenotypic variance following formula and procedures as outlined by Singh and Chaudhary (1985). Expected genetic advance was estimated as described by Johnson *et al.* (1955). Correlation coefficients among traits were worked out according to Robinson *et al.* (1951).

In pearl millet improvement programme at CAZRI, Jodhpur, inbred restorer lines were developed by selection from a wide range of germplasm, composites and breeding materials resulting from crosses among promising lines. As indicated in the Table 1, ten inbred restorers were developed from crosses involving inbreds and composites, nine inbreds were directly selected from the germplasm accessions, nine were selected directly from composites, six from top cross pollinators, seven from inter-inbred crosses, five from crosses involving inbreds and germplasm, and one inbred restorer from a cross between composite and germplasm.

This showed substantial use of germplasm/ composites in the development of these inbred restorers. In general it was observed that crosses involving elite inbred lines and composites resulted in better inbred restorers. The utilization of varied breeding material from different sources in the development of these inbred restorers has resulted into a wide range of variability.

Analysis of variance was carried out to partition the variances into its components. It revealed highly significant differences among the mean values for all the traits i.e. days to flowering, plant height, effective tillers per plant, ear head length, ear head girth, ear head weight, grain yield, dry fodder yield, biomass, panicle harvest index, harvest index and 500 grain weight (Table 2).

Mean performance, range, phenotypic (PCV) and genotypic coefficients of variation (GCV), heritability, genetic advance and genetic advance as percent of mean with respect to all traits are given in Table 3. It was observed that the range was wider for the traits, plant height (97 to 238 cm), effective tillers/plant (1.1 to 5.5), ear head weight/plot (214 to 1856 g), grain yield/plot (122 to 1299 g), dry fodder yield/plot (0.238 to 1.863 kg) and biomass/plot (0.393 to 3.048 kg).

A comparison of the phenotypic coefficients of variation and genotypic coefficients of variation revealed that, in general phenotypic coefficients of variation was higher than the genotypic coefficients of variation, indicating the influence of environment. This difference was narrow in the traits, days to flowering, plant height, and 500 grain weight indicating that these traits were least influenced by the environment, and if any selection pressure operated on these traits, it will help to realize the improvement. However, the difference was high in the case of effective tillers/plant, indicating higher influence of environment on this trait.

Besides, a narrow range of difference between PCV and GCV for traits 500 grain weight, plant height, ear head weight/plot, grain yield/plot and biomass/plot, indicated that any selection pressure operated on these characters at early generation, would help to realize improvement. High values of PCV and GCV for grain yield was reported by Lakshmana *et al.* (2003) and Borkhataria *et al.* (2005), and for plant height by Kunjir and Patil (1986).

Total variability present for a character is indicated by the coefficient of variation. However the extent of variability, which could be transferred from parent to offspring would determine response to selection and this is provided by the estimates of heritability. The heritability estimates for various traits ranged from 0.62 to 0.93. High estimates of heritability were obtained for 500 grain wt (0.93), grain yield (0.91), ear head weight (0.91), biomass (0.88), plant height (0.81), effective tillers per plant (0.62), ear head girth (0.63) and panicle harvest index (0.65). These results are similar to findings of Dang *et al*. 1985 and Kunjir and Patil (1986). They also reported high heritability for 1000 grain weight in pearl millet. Lakshmana *et al.* (2009) also reported high heritability for grain yield, ear head weight, and 1000 grain weight.

Genetic advance as percent of mean was found to be high for grain yield, ear head weight and biomass. These traits also recorded high GCV and heritability. This indicated the selection could be effective for these traits. Similar observations were reported by earlier workers *viz*., Solanki *et al.* (2002), Lakshmana *et al.* (2003, 2009), and Varu *et al*. (2005) for grain yield per plant. The study revealed that the studied restorer lines possessed significant genetic variability. Hence, these lines can be exploited further through selection.

Associations among grain yield and its component traits were also worked out and estimates of correlation coefficients are given in Table 4. It revealed that all traits had positive significant correlation with grain yield except for days to flowering which had negative significant correlation with grain yield, suggesting that early varieties tend to yield higher. This is particularly true for arid areas where pearl millet crop invariably matures under terminal moisture stress conditions. Negative association between grain yield and days to flowering has earlier been reported by Akromah et al. (2008), Varu et al. (2005), Manga (2002) and Dubey and Manga (2005).

Days to flowering also had negative significant correlation with ear head girth, ear head weight, panicle harvest index and harvest index, but it had positive significant association with 500 grain weight, thus late varieties had higher 500 grain weight as compared to early varieties. Ear head weight, dry fodder yield and biomass yield had high values of correlation coefficients, while plant height, ear head length, ear head girth, panicle harvest index and harvest index had moderate positive association with grain yield. Consequently, selection of taller plants with long ear heads, having more ear girth, early maturity and high panicle harvest index would be the best way to improve grain yield. Selection for higher panicle harvest index, an indicator of terminal drought tolerance, will not only improve grain yield due to high positive association with grain yield, but also stability of grain yield in the arid regions, where pearl millet crop frequently faces terminal drought.

The above results clearly indicate the existence of adequate genetic variability in the studied material for most of the traits studied. This would allow selection for the traits having high heritability like, plant height, days to flowering, ear head length, grain yield/plot and dry fodder yield/plot. Association study revealed significant positive association of ear head weight, biomass, dry fodder yield, plant height, ear head length and panicle harvest index with grain yield. Consequently selection for taller plants having higher biomass, early maturity, long and thicker ear heads and higher panicle harvest index would form ideal selection indices for improving grain yield.

References

Akromah, R., Afribeh, D. and Abdulai, M. S. 2008. Genetic variation and trait correlations in a bird resistant pearl millet landrace population. *African J. Biotech.*, 7:1847-1850.

Borkhataria, P. R., Bhatiya, V. J., Pandya, H. M. and Value, M. G. 2005. Variability and correlation studies in pearl millet. *National J. Pl. Improv.,* 7: 21-23.

Burton, G. W. and Davane, E. M. 1952. Estimating heritability in tall fescue (*Festuca arundiancea* L.) from replicated clonal material. *Agronomy Journal.*, 45:478-481.

Burton, G. W. 1958. Cytoplasmic male sterility in pearl millet [*Pennisetum gluaucum* (L.)R.Br.] *Agron. J.*, 50:230.

Burton, G. W. 1965. Pearl millet Tift 23A1 released. *Crops and Soils.*, 17:19.

Dang, J. K., Thakur, D. P. and Das, S. 1985. Genetics of grain yield and some plant characters in pearl millet. *Crop Improv.* 12: 39-41.

Dubey, L. K. and Manga, V. K. 2005. Variance components and association between grain yield and its components in pearl millet. *Ann. Arid Zone.*, 44:17-22.

Johnson, H. W., Robinson, H. F. and Comstock, L. E. 1955. Genotypic and phenotypic correlation in soybean and their implications in selection. *Agron. J.*., 47: 177-483.

Kunjir, A. N. and Patil, R. B. 1986. Variability and correlation studies in pearl millet. *J. Maharashtra Agric. Univ.*,11:273-275.

Lakshmana, D., Surendra, P. and Gurumurthy, R. 2003. Combining ability studies in pearl millet. *Res. on Crops.*, 4: 358-362.

Lakshmana, D., Birdar, B. D. and Ravikumar, L. R. 2009. Genetic variability studies for quantitative traits in a pool of restorers and maintainers lines of pearl millet (*Pennisetum glaucum* (L.). *Karnataka J. Agric. Sci.*, 22: 881-882.

Manga, V. K. 2002. Character association and path analysis under stress and non-stress conditions in pearl millet. *Ann. Arid Zone.*, 41: 31-36.

Robinson, H. F., Comstock, R. E. and Harvery, P. H. 1951. Genotypic and phenotypic correlation in corn and their implication in selection. *Agron. J.*, 43: 262-267.

Singh, R. K. and Chaudhary, B. D. 1985. *Biometrical Methods in Quantitative Genetic Analysis*., p. 38-54. Kalyani Puhlishers, New Delhi.

Solanki, Y. P. S., Khairwal, I. S. and Bidinger, F. R. 2002. Genetic variability in some productivity traits of pearl millet composites. *Forage Res.*, 27: 273-275.

Steel, R. G. D. and Torrie, J. H. 1980. *Principles and Procedures of Statistics*. A Biometrical Approach, McGraw Hill. Co., New York.

Varu, D. K., Valu, M. G., Doshi, K. M. and Dangaria, C. J. 2005. Variability and character association of grain yield in pearl millet [*Pennisetum glaucum* (L.)R. Br.] *Agric. Sci. Digest.*, 25:231-232.

Table 1. Genetic base of pearl millet inbred restorers bred at CAZRI, Jodhpur

Genetic base	No. of inbred lines	Remarks
Germplasm	9	Selection and inbreeding from germplasm
Composite	9	Selection and inbreeding from a composite or open pollinated variety
Selection from top cross pollinator	6	Selection and inbreeding from top cross pollinator
Elite line x elite line	7	Crosses among restorer inbreds
Composite x germplasm	1	Composite x selection from germplasm
Elite line x composite	10	Selection and inbreeding from crosses of inbred x composite
Elite line x germplasm	5	Selection and inbreeding from cross of inbred x germplasm

Table 2. Analysis of variance for various characters in inbred restorers of pearl

Source of variation	Replication	Genotypes	Error
	2	46	138
DF	5.36	72.26**	4.92
PHT	605.3**	2561.2**	144.4
ET	0.079	3.139**	0.413
EL	2.28	30.41**	2.89
EG	0.11	0.49**	0.06
EHW	11025	626952**	16111
GY	8547	334793**	8169
DFY	0.03	0.664**	0.037
BM	0.062	1.847**	0.061
PHI	0.008	0.033**	0.004
HI	0.002	0.019**	0.002
500 GW	0.131*	2.237**	0.042

*P=0.05; **P=0.01

DF-Days to flower; PHT-Plant height; ET-Effective tillers/plant; EL-Ear head length; EG-Ear head girth; EHW-ear head weight;DFY-Dry fodder yield/plot; BM-Biomass; PHI-Panicle harvest index; HI-Harvest index; 500 GW-500 grain weight.; GY-Grain yield

Table 3. Mean, range, and other variability parameters for 12 different characters in pearl millet

Character	Mean	Range	PCV	GCV	h^2(bs)	GA	GAM
Days to flowering	53	45-61	8.88	7.81	0.77	7.43	14.16
Plant height (cm)	153	97-208	17.85	16.03	0.81	45.49	29.67
Effective tiller/plant	2.7	1.1-5.5	38.87	30.67	0.62	1.34	49.85
Ear head length (cm)	19.8	13.8-26.5	15.76	13.22	0.70	4.53	22.84
Ear head girth (cm)	2.1	1.4-2.9	19.48	15.44	0.63	0.54	25.23
Ear head weight/plot (g)	709	214-1856	57.99	55.16	0.91	765.60	108.06
Grain yield/plot (g)	448	122-1299	66.92	63.80	0.91	561.25	125.31
Dry fodder yield/plot (kg)	0.820	0.238-1.863	53.64	48.28	0.81	0.73	89.53
Biomass/plot (kg)	1.268	0.393-3.048	56.19	52.69	0.88	1.29	101.77
Panicle harvest Index	0.61	0.37-0.78	17.28	13.95	0.65	1.14	23.20
Harvest Index	0.34	0.17-0.47	23.02	18.99	0.68	0.11	32.26
500 grain wt (g)	3.46	2.15-5.05	22.19	21.38	0.93	1.47	42.44

GA- Genetic advance

Electronic Journal of Plant Breeding, 4(4): 1325-1330 (Dec 2013)
ISSN 0975-928X

Table 4. Association among traits in inbred restorers of pearl millet

	DF	PHT	ET	EL	EG	EHW	DFY	BM	PHI	HI	500 GW	GY
DF	1.000	0.085	0.093	-0.102	-0.147*	-0.174*	-0.041	-0.111	-0.144*	0.309**	0.162**	0.202**
PHT		1.000	0.043	0.541**	0.493**	0.502**	0.612**	0.589**	0.242**	-0.039	0.308**	0.502**
ET			1.000	0.067	0.059	0.391**	0.299**	0.342**	0.077	0.179*	0.153*	0.372**
EL				1.000	0.364**	0.521**	0.486**	0.519**	0.254**	0.166*	0.214**	0.523**
EG					1.000	0.474**	0.489**	0.502**	0.206**	0.123	0.204**	0.476**
EHW						1.000	0.838**	0.925**	0.387**	0.466**	0.384**	0.971**
DFY							1.000	0.975**	0.465**	0.025	0.369**	0.852**
BM								1.000	0.524*	0.220**	0.372**	0.946**
PHI									1.000	0.366**	0.075	0.566**
HI										1.000	-0.018	0.489**
500 GW											1.000	0.343**
GY												1.000

*Significant at P=0.05; ** Significant at P=0.01
DF-Days to flower; PHT-Plant height; ET-Effective tillers/plant; EL-Ear head length; EG-Ear head girth; EHW-Ear head wt
DFY-Dry fodder yield/plot; BM-Biomass; PHI-Panicle harvest index; HI-Harvest index
500 GW-500 grain wt.; GY-Grain yield