International Journal of Research in Agricultural Sciences
Volume 3, Issue 5, ISSN (Online): 2348 – 3997

Genetic Association in f_2 Populations and their Potential in the Improvement of Grain Yield in Pearl Millet [*Pennisetum Glaucum* (l.) R. Br.]

P. L. Badhe, P. N. Rasal and R. C. Kharat
Department of Agricultural Botany, College of Agriculture, (Mahatma Phule Agriculture University) Dhule -424 001, Maharashtra (India) Email: pramodbadhe61@gmail.com

***Abstract* – The phenotypic correlation and path coefficient were worked out for F_2 generation of three crosses of pearl millet for ten characters. Grain yield plant^{-1} had significant and positive correlations with effective tillers per plant, ear head girth and plant height in all three crosses of F_2 generation. Path analysis revealed that the effective tillers per plant made appreciable positive and direct contribution to grain yield, consistently in all three crosses. Other components which had direct and consistent contribution towards grain yield, but in a small magnitude, in all three crosses were; ear head girth, plant height, days to maturity and Zn content (except cross RHRBI-138 X S/12-30088). The direct contributions of 1000-grain weight were low magnitude to grain yield in cross RHRBI-138 X S/12-30088 revealed its important role in its correlation with grain yield which was reduced to non-significant values in some crosses because of negative indirect effect of other componential characters. It can be concluded that effective tillers per plant, ear head girth, 1000-grain weight, plant height and ear head length are important components of grain yield in all three crosses which should be considered when any breeding program for higher yield in pearl millet is to be planned.**

***Keywords* – Correlation, F_2 Generation, Path Analysis, Pearl Millet.**

I. Introduction

Pearl millet (*Pennisetum glaucum* (L.) R. Br.) is the most drought tolerant warm-season cereal crop predominantly grown as a staple food grain and source of feed and fodder for millions of people living in harsh environments characterized by erratic rainfall and nutrient-poor soil. The grain has higher levels of protein content with balanced amino acids, carbohydrate and fat which are important in the human diet, and its nutritive value is considered to be comparable to rice and wheat. The basic objective of most of the crop improvement programs is to realize a marked improvement in crop yield. But yield is a complex character which is controlled by association of various characters. Before placing strong emphasis on breeding for yield improvement traits, the knowledge on the association between grain yield and yield attributes will enable the breeder in the improvement of yield. The correlation coefficient may also help to identify characters that have little or no importance in the selection programme. The existence of correlation may be attributed to the presence of linkage or pleiotropic effect of genes or physiological and development relationship or environmental effects or in combination of all (Oad *et al*, [10]. The information on association of yield attributes and their direct and indirect effects on grain yield are of paramount significance. Hence, path analysis is of much importance in any plant breeding program. The present research study was conducted to find out the genetic variability among different plant traits, direct and indirect contribution of these parameters towards pearl millet grain yield and to identify better combinations as selection criteria for developing high yielding genotypes.

II. Materials and Methods

The experimental material consisted F_2 generation of three crosses *viz.*, RHRBI-138 X S/12-30074, RHRBI-138 X S/12-30088 and DHLBI-967 X S/12-30088 developed at Bajra Improvement Project, Dhule. The experiment was carried out at Botany section farm, College of Agriculture, Dhule during *Kharif*-2014 in randomized block design with three replications. Among the treatments twenty four rows of F_2 generation of 4.5 m length were grown at 50cm apart between rows and 15 cm within row. All the necessary precautions were taken to maintain uniform plant population in each treatment per replication. All the recommended package of practices was followed along with necessary prophylactic plant protection measures to raise a good crop. Observations were recorded on ten different characters *viz.*, days to flowering, days to maturity, plant height (cm), effective tillers plant^{-1}, ear head length (cm), ear head girth (cm), 1000-seed weight (g), Fe content (ppm), Zn content (ppm) and grain yield plant^{-1} (g) by selecting hundred random plants in segregating F_2 generation of each of the cross in each replication. Simple correlation coefficient and path coefficients were obtained using standard method suggested by Singh and Choudhary [13] and Dewey and Lu [4], respectively.

III. Results and Discussion

Phenotypic correlations of grain yield with nine agronomic and micronutrient characters were studied in F_2 generation of three crosses *viz*., RHRBI-138 X S/12-30074 (Cross 1), RHRBI-138 X S/12-30088 (Cross 2) and DHLBI-967 X S/12-30088 (Cross 3). The results are presented in Table 1 and data revealed that significant and positive correlations of grain yield plant^{-1} were observed with effective tillers per plant, ear head girth and plant height in all three crosses and 1000-grain weight in cross-2 and Fe and Zn content in cross 3 of F_2 generation. These characters showed positive correlation among themselves uniformity in the F_2 generation indicating that selection for these characters in one cross might bring an improvement in grain yield for other crosses also. Among these association consistent and moderate to high values of correlation coefficient was obtained for association of grain yield with number of effective tillers per plant (0.516 to 0.620), ear head girth (0.263 to 0.275), plant height (0.133 to 0.380) and 1000-grain weight (0.176) in cross-2, for Fe content (0.501) and Zn content (0.922) in cross 3. It is significant to note that none of the characters involved in above association of the three crosses, except Fe content in crosses 1 and 2 respectively, Zn content in cross 2 and 1000-grain weight in cross 3. This corroborates with finding of Govindaraj et.al. [5] for number of productive tillers, panicle girth, and 100-grain weight had high significant positive association with grain yield. Gupta *et al*. [6] reported significant positive correlation between Fe and Zn content in two populations of pearl millet suggesting the possibility of simultaneous effective genetic improvement of both micronutrients and non significant correlation of grain Fe and Zn content with grain yield and 1000 grain weight and there would be no penalty on grain yield while breeding for grains rich in these micronutrients. Rai *et al*. [11] noticed Fe and Zn contents were positively and highly significantly correlated, implying the possibility of simultaneous effective selection for Fe and Zn micronutrients. There were negative correlations between these micronutrients and grain yield, though significant only in the case of Fe content indicating that selection for high Fe and Zn content may be possible without significant compromise on grain yield. Similarly other reported (Abhay *et. al*. [1]; Vinodhana *et al.* [15]; Bhuri Sing et *al.*,[2] and Mohamed *et al*.,[8]) grain yield was significantly and positively correlated with ear girth, effective tillers, panicle thickness, thousand seed weight and plant height. Non-significant correlation was observed between grain yield with days to flowering and days to maturity in all three crosses. Similar types of observation have been also reported by Manga [7] while, Naveen Kumar *et al*. [13] showed negative correlation of zinc content with grain yield.

For the association of grain yield with number of effective tillers per plant the correlation coefficient was more than 0.516 values in all the three crosses of F_2 generation. For this, association would be useful indirectly, as improvement in componential characters through selection could result in improvement of single plant yield as a result of expected correlated response. The r values of grain yield with ear head girth, 1000-grain weight, ear head length and plant height ranged from 0.101 to 0.380 suggesting, these associations were not uniformly higher in all the crosses of F_2 generation for these traits. The magnitude of correlated response of selection would be different in segregating generations. Any attempt to look for increase in r value may not be desirable for all association but for certain association like grain yield with ear head girth and ear head length. The presence of such plasticity in r value may provide more opportunity for better selection response.

In all the crosses of F_2 generation, correlation of effective tillers per plant, ear head girth, 1000-grain weight, ear head length and plant height were mostly significant. However, it was encouraging to note that positive association of 1000-grain weight with ear head girth and ear head length could be obtained through recombination and such recombination's were noticed, as presented elsewhere in all three crosses (except cross 3). The associations of grain yield with days to flowering and days to maturity were non-significant and negative in all the three crosses. Such significant negative correlation is desirable because the breeders are interested in high yield with early flowering and maturity indicating that early flowering and maturity may be combined with higher yields of transgressants.

As regards, Fe and Zn content with association of grain yield was positive significant association of Fe (0.501) and Zn content (0.922) in cross 3 and non-significant negative association of Fe content (-0.018 and -0.029) in cross 1 and 2, respectively and significant negative association of Zn content (-0.114) in cross 2 indicating, that the simultaneous selection for Fe and Zn can be accomplished without compromising on grain yield. There would be no penalty on grain yield while breeding for grains rich in these micronutrients (Gupta *et al*., [6]). Rai *et al*. [11] reported negative correlations between Fe and Zn micronutrients and grain yield. It can be concluded that the improved plant type (grain yield per plant basis) should have high effective tillers per plant, more ear head girth, long ear head and higher 1000-grain weight.

As simple correlation does not provide the true contribution of the characters towards the grain yield, these correlations were partitioned into direct and indirect effects through path coefficient analysis. The estimates of path coefficient analysis are furnished for grain yield and yield component characters in Table 2. Partitioning of phenotypic correlations of grain yield into direct and indirect contribution through other variables shows that effective tillers per plant made appreciable positive and direct contribution to grain yield, consistently in all three crosses. The other components which had direct and consistent contribution towards grain yield, but in a small magnitude, in all three crosses were; ear head girth, plant height, days to maturity and ear head length in (cross 3), Zn content (except cross 2). The direct contributions of 1000-grain weight were low magnitude to grain yield in (cross 2) revealed its important role in its correlation with grain yield which was reduced to non-significant values in some crosses because of negative indirect effect of other componential characters.

The indirect contribution of the different component of grain yield, ear head length contributed through ear head girth to its correlation with grain yield/plant. Though 1000-grain weight had direct effect in smaller magnitude, its small associations with grain yield contributed indirectly through ear head girth and ear head length in all three crosses. The importance of effective tillers per plant, ear head length, ear head girth, 1000-grain weight and plant height as component of grain yield was noticed by different workers *viz;* Salunke *et al*. [12]; Vagadiya *et al*. [14]; Chaudhary *et al*. [3]; Abhay *et. al*. [1] and Bhuri Sing et *al*[2].

IV. Conclusion

In general, it can be inferred that effective tillers per plant, ear head girth, 1000-grain weight, plant height and ear head length are important components of grain yield in all three crosses of pearl millet. Of these characters, direct contributions of effective tillers per plant, ear head girth and indirect contribution of 1000-grain weight on grain yield were always remarkable.

References

[1] Abhay B., Yadav I.S. and Arya R.K. 2013. Studies on variability, correlation and path analysis in Pearl millet *Forage res.*, 39 (3): 134-139.

[2] Bhuri Singh, Upadhyay P.K. and Sharma K.C.. 2014. Genetic variability, correlation and path analysis in Pearl millet (*Pennisetum Glaucum* (L.) R. Br.). *Indian Res. J. Genet. & Biotech*. 6(3): 491-500.

[3] Chaudhary, V.P., Dhedhi, K.K., Joshi, H.J. and Sorathiya, J.S. 2012. Character association and path analysis in Pearl millet (*Pennisetum glaucum* (L.) R. Br.). *Asian J. Bio. Sci.*, 7 (1): 98 – 100.

[4] Dewey, D.R. and Lu K. H., 1959. Correlation and path analysis of crested wheat grass seed production., *Agron. J.*, 51:515-518.

[5] Govindaraj, M. Selvi, B. and Rajarathinam, S. 2009. Correlation studies for grain yield components and nutritional quality traits in Pearl Millet *(Pennisetum glaucum (L.) R. Br.)* Germplasm. *World J. of Agri. Sci.* 5 (6): 686-689.

[6] Gupta S.K, Velu G., Rai K.N. and Sumalini K. 2009. Association of grain iron and zinc content with grain yield and other traits in pearl millet (*Pennisetum glaucum* (L.) R. Br.). *Crop Improv*. 36 (2): 4-7.

[7] Manga, V.K. 2013. Genetic variance and interrelationship among quantitative traits in CAZRI-bred inbred restorers of Pearl millet (*Pennisetum glaucum* (L.) R. Br.) Central Arid Zone Research Institute, Jodhpur 342003, *Electronic Journal of Plant Breeding*, 4(4): 1325-1330.

[8] Mohamed I. Ismail, Elgailani Abdalla, Khalid A. Osman , Adam M. Ali. 2014. Genetic variation among Pearl millet genotypes for yield and its components in semi-arid zone Sudan. *Intl J. Agric. and Crop Sci.* 7: 822-826.

[9] Naveen Kumar Gande, Rakhi Soman, Pavan J Kundur, Rajeswari Amabti and Berhanu Dagnaw. 2013. Evaluation of recombinant inbred lines of rice [*Oryza sativa* (L.)] for grain zinc content, yield related traits and identification of transgressants lines grown under aerobic conditions. *Asian J. Exp. Biol. Sci.* Vol.4(4):567-574.

[10] Oad F. C., Samo M. A., Hassan Z. U., Pompe S. C. and Oad N. L. 2002. Correlation and path analysis of Quantitative Characters of Rice Raton Cultivars and Advance Lines., *Int. J. Agri. Biol*. 4(2): 204-207.

[11] Rai, K. N., Govindaraj M. and Rao A. S. 2012. Genetic enhancement of grain iron and zinc content in pearl millet. Quality Assurance and Safety of Crops & Foods., 4, (3): 119-125.

[12] Salunke, P K., Dumbre A .D. and Rajput S. D. 2006. Correlation and Path Analysis in Germplasm of Pearl Millet *(Pennisetum glaucum* (L.). *J. Maharashtra agric. Univ., 31 (1):*16-18.

[13] Singh, P. K. and Choudhary, B. D. 1977. Biometrical Methods in Quantitative Genetic Analysis. Kalyani Publishers, New Delhi., pp.39-68.

[14] Vagadiya, K.J., Dhedhi, K.K., Joshi, H.J., Bhadelia A.S. and H.B. vekariya A.S. 2010. Correlation and path co efficient analysis in pearl millet (*Pennisetum glaucum* (L) R.Br.), *Intl. J. Plant Sci.*, 5(2): 606-608.

[15] Vinodhana, N. P. Sumathi and M. Sathya. 2013. Genetic variability and inter-relationship among morpho-economic traits of Pearl millet (*Pennisetum glaucum* (L.) R. Br.) and their implications in selection. *International J. of Plant, Animal and Environmental Science*, 3(2):145-149.

Table 1: Simple phenotypic correlations for various characters in three crosses of Pearl millet

Character	Cross No.	Days to 50% flowering	Days to maturity	Plant height	Effective tillers plant^{-1}	Ear head length	Ear head girth	1000- grain weight	Fe content	Zn content	Grain yield plant^{-1}
Days to 50% flowering	1	**1.000**	0.767**	-0.021	-0.023	0.029	-0.014	-0.114*	0.058	-0.071	0.023
	2	**1.000**	0.953**	-0.028	-0.014	0.085	0.045	0.053	0.011	0.017	0.008
	3	**1.000**	0.753**	0.089	0.046	0.064	0.113*	-0.150**	0.064	0.055	0.083
Days to maturity	1		**1.000**	0.007	-0.027	-0.012	0.007	-0.040	-0.009	-0.092	0.024
	2		**1.000**	-0.011	0.021	0.101	0.049	0.014	0.006	-0.042	0.035
	3		**1.000**	0.057	0.031	0.113*	0.144*	-0.039	0.075	0.037	0.065
Plant height	1			**1.000**	0.057	0.295**	0.209**	0.014	-0.098	-0.128*	0.152**
	2			**1.000**	0.146*	0.122*	0.061	0.059	-0.012	0.067	0.133*
	3			**1.000**	0.177**	0.009	0.297**	-0.007	0.067	0.094	0.380**
Effective tillers/plant^{-1}	1				**1.000**	0.026	0.117*	0.106	-0.080	-0.014	0.604**
	2				**1.000**	0.057	0.001	0.084	0.068	-0.043	0.620**
	3				**1.000**	-0.082	0.003	-0.017	0.292**	0.299**	0.516**
Ear head length	1					**1.000**	0.190**	0.105	0.018	0.037	0.071
	2					**1.000**	0.318**	0.023	0.013	-0.077	0.008
	3					**1.000**	0.068	-0.051	0.003	0.006	0.089
Ear head girth	1						**1.000**	0.093	-0.114*	-0.094	0.275**
	2						**1.000**	0.017	-0.028	-0.054	0.101
	3						**1.000**	-0.004	0.012	0.009	0.263**
1000-grain weight	1							**1.000**	-0.213**	-0.037	0.048
	2							**1.000**	0.153**	-0.017	0.176**
	3							**1.000**	-0.054	-0.028	-0.030
Fe content	1								**1.000**	0.612**	-0.018
	2								**1.000**	0.306**	-0.029
	3								**1.000**	0.922**	0.501**
Zn content	1									**1.000**	0.055
	2									**1.000**	-0.114*
	3									**1.000**	0.922**

*, ** Significant at 5% and 1% level, respectively,

Note: Cross: 1= RHRBI-138 X S/12-30074, Cross 2 = RHRBI-138 X S/12-30088 and Cross 3= DHLBI-967 X S/12-30088.

Table 2. Direct and indirect effects of nine different characters on grain yield in three crosses of pearl millet

Character	Cross No.	Days to 50% flowering	Days to maturity	Plant height	Effective tillers plant^{-1}	Ear head length	Ear head girth	1000-grain weight	Fe content	Zn content	Total phenotypic correlation with grain yield plant^{-1}
Days to 50% flowering	1	**0.028**	0.019	-0.002	-0.013	-0.003	-0.002	0.002	-0.007	-0.007	0.023
	2	**-0.060**	0.075	-0.001	-0.008	-0.006	0.005	0.007	-0.007	-0.001	0.008
	3	**-0.117**	0.122	0.012	0.013	0.004	0.023	0.011	-0.155	0.168	0.083
Days to maturity	1	0.022	**0.025**	0.006	-0.016	0.001	0.001	0.001	0.001	-0.009	0.024
	2	-0.058	**0.079**	-0.004	0.013	-0.007	0.005	0.001	-0.004	0.002	0.035
	3	-0.088	**0.161**	0.008	0.009	0.008	0.029	0.002	-0.181	0.115	0.065
Plant height	1	-0.006	0.001	**0.093**	0.033	-0.003	0.042	-0.003	0.001	-0.013	0.152**
	2	0.001	-0.009	**0.041**	0.088	-0.009	0.007	0.007	0.008	-0.004	0.133*
	3	-0.010	0.009	**0.143**	0.051	0.007	0.061	0.005	-0.163	0.288	0.380**
Effective tillers/plant^{-1}	1	-0.006	-0.006	0.053	**0.580**	-0.003	0.023	-0.002	0.001	-0.001	0.604**
	2	0.008	0.001	0.006	**0.606**	-0.004	0.001	0.014	-0.004	0.002	0.620**
	3	-0.005	0.005	0.025	**0.289**	-0.006	0.006	0.001	-0.708	0.914	0.516**
Ear head length	1	0.001	-0.003	0.027	0.015	**-0.010**	0.038	-0.002	-0.002	0.003	0.071
	2	-0.005	0.008	0.005	0.034	**-0.077**	0.036	0.002	-0.008	0.005	0.008
	3	-0.007	0.018	0.001	-0.023	**0.074**	0.014	0.003	-0.009	0.018	0.089
Ear head girth	1	-0.007	0.001	0.019	0.068	-0.002	**0.201**	-0.002	0.001	-0.009	0.275**
	2	-0.002	0.003	0.002	0.009	-0.024	**0.114**	-0.002	0.001	0.003	0.101
	3	-0.013	0.023	0.042	0.009	0.005	**0.205**	0.003	-0.029	0.028	0.263**
1000-grain weight	1	-0.003	-0.001	0.001	0.061	-0.001	0.018	**-0.026**	0.002	-0.003	0.048
	2	-0.003	0.001	0.002	0.050	-0.001	-0.001	**0.134**	-0.010	0.001	0.176**
	3	0.017	-0.006	-0.001	-0.005	-0.003	-0.009	**-0.073**	-0.013	-0.087	-0.030
Fe content	1	0.001	-0.002	-0.009	-0.046	-0.002	-0.022	0.005	**-0.011**	0.064	-0.018
	2	-0.006	0.004	-0.005	0.041	-0.001	-0.003	0.020	**-0.066**	-0.019	-0.029
	3	-0.007	0.012	0.009	0.084	0.002	0.002	0.004	**-2.418**	2.814	0.501**
Zn content	1	-0.003	-0.002	-0.012	-0.008	-0.004	-0.019	0.009	-0.007	**0.105**	0.055
	2	-0.001	-0.003	0.002	-0.026	0.006	-0.006	-0.002	-0.020	**-0.063**	-0.114*
	3	-0.006	0.006	0.013	0.086	0.004	0.001	0.002	-2.231	**3.050**	0.922**

*, ** Significant at 5% and 1% level, respectively. **Bold** figures denote direct effects.
Residual effects = 0.757, 0.756 and 0.685 in Cross 1, 2 and 3, respectively.
Note: Cross: 1= RHRBI-138 X S/12-30074, Cross 2 = RHRBI-138 X S/12-30088 and Cross 3= DHLBI-967 X S/12-30088.