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Genetic component analysis of grain yield and iron and zinc content in pearl millet (*Pennisetum glaucum*) under varying environmental conditions

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ABSTRACT

Genetic analysis of pearl millet [Pennisetum glaucum (L.) R. Br.] was studied at Rajasthan Agricultural Research Institute (RARI), Durgarura, Jaipur (Rajasthan), India, during Kharif-2015 in diallel fashion excluding reciprocals for grain yield and iron and zinc content using ten diverse inbreds. Genetic components analysis revealed those additive-dominance models were fitted for all the characters in all the environments. Both additive (D) and dominance (H_1 and H_2) components were significant for both the characters with seed yield. However, relative magnitude of dominance component (H1 and H2) was higher than additive component for all the characters indicated preponderance of dominant gene action. The ratio of mean degree of dominance as measured by $(H_1/D)^{½}$ was more than unity in all the environments indicating over dominance. The value of ($H_2/4H_1$) was less than 0.25 indicating asymmetric distribution of positive and negative alleles. The ratio of dominant to recessive alleles was more than unity in all the environments indicating accumulating of dominant genes. Narrow sense heritability estimates were of low to high magnitude for different traits. Heritability estimates (ns) were high 0.303 in E_2 and 0.528 in E_3 for Fe content and 0.116 in E_1 and 0.117 in E_3 for grain yield per plant. This is suggesting that selection for these traits would lead to rapid genetic improvement. The preponderance of non-additive gene effects of grain yield and its component traits in parents indicated that, heterosis breeding would be practically feasible in pearl millet crop.

Key words: Pearl millet, gene action, additive, non-additive variance, heritability

INTRODUCTION

Pearl millet [*Pennisetum glaucum* (L.) R. Br.] is a diploid species having 2n=14 chromosomes, belongs to the family Poaceae (Gramineae). It is an important cereal crop in arid and semi arid region of the world. It is a most drought tolerant of all cultivated food grain crops, is widely cultivated across the arid and semi-arid tropics of Africa and Asia. In India, Rajasthan is having the largest area and production in the country with low productivity. Pearl millet is largely cultivated under rain fed condition. Total genetic variance were partitioned in the three parts; additive (arising from average effect of genes), dominance (arising from allelic interactions) and epistatic part (arising from non-allelic interactions). Parmar *et al.* (2013) reported non- additive gene action in pearl millet for grain yield and its related characters. The genotype x environment effect in pearl millet varied in nature and magnitude of gene action affecting traits of productivity and efficiency of selection in segregating population. Morphological traits are also important for harnessing the potential yield. Estimates of additive and dominance genetic variance help to choose the most effective breeding procedure to be followed for a crop species. These components of variance do explain the genetic architecture of the population at hand and help to draw up the breeding strategies on the basis of expected performance of progenies. Therefore, the present study was undertaken to elucidate the nature and magnitude of gene action involved in inheritance of grain yield and its components in pearl millet.

MATERIALS AND METHODS

Ten genetically diverse inbreds of pearl millet *viz*., J-2340, MIR-525-2, RIB-192, RIB-494, RIB-3135-18, RIB 57, RIB-335/74, HBL-11, H-77/833-2-202 and G-77/107 were crossed in all possible combinations excluding reciprocals during summer 2015 at ICRISAT, Hyderabad to generate a diallel set. Ten parents' along with their 45 F_1's were evaluated for grain yield and 13 yield components in a randomized block design with three replications at Rajasthan Agricultural Research Institute, Durgarura, Jaipur (Rajasthan), India, during *Kharif*-2015. Each

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entry was sown in two rows of 4.0 m length having 50 x 15 cm crop geometry. All the recommended cultural practices were adopted to raise good crop of pearl millet. The observation were recorded on ten randomly selected plants from each replication and environment grain yield per plant, Fe content and Zn content while. The mean values were used for the analysis of genetic components of variation according to Hayman (1954a).

RESULTS AND DISCUSSION

The estimates of genetic parameters, their ratio and narrow sense heritability for grain yield and its components are presented (Table 1). The estimates of components of genetic variance exhibited that both additive (D) and dominance (H_1 and H_2) were highly significant for both the characters except seed yield per plant in all the environments (Table 2). This clearly indicated that both additive and non- additive components were operative for inheritance of these characters except, grain yield per plant in all the environments where, only non-additive component was operative. The H_1 component was greater than D for all the characters. These results suggested that although, additive and dominance gene action existed to this character in material used. The estimates of dominance genes effects, corrected for gene distribution (H_2), were significant and therefore, agreed with H_1 estimates obtained. The results were in conformity with the findings of Shanmuganathana and Gopalan (2006), Kumar (2007) and Bhadalia *et al.* (2012).

Table 1: Regression coefficient of Wr on Vr with their standard error, deviation from zero, unity and t^2 value for different characters in F_1 generation in E_1, E_2 and E_3 environments

S. No.	Characters	Env.	b	SE(b)	(b-0)/SE(b)	(1-b)/SE(b)	t^2 value
1	Grain yield per plant	E_1	-0.065	0.134	0.490	7.948**	10.206
		E_2	-0.102	0.145	0.70	7.600**	8.075
		E_3	-0.022	0.84	0.26	12.167**	31.471
2	Fe content	E_1	0.198	0.181	-1.090	4.431**	3.726
		E2	0.397	0.223	-1.78	2.704*	1.0
		E_3	0.563	0.259	-2.17	1.687*	0.079
3	Zn content	E_1	0.635	0.168	-3.78	2.173	1.239
		E2	0.015	0.200	-0.08	5.075**	2.888
		E_3	0.042	0.203	-0.021	4.719**	2.734

**and **=Significant at 5% and 1% level of significance, respectively*

Further, the ratio of $H_2/4H_1$ was less to 0.25 for all the characters indicating asymmetric distribution of positive and negative alleles. The ratio of $(4DH_1)^{1/2}$+F / $(4DH_1)^{1/2}$ - F indicated the type of alleles which were more frequent. In the present study this ratio was positive and more than unity for all the traits indicated that the parents carried more dominant alleles than recessive one. This was further supported by positive value of “F” in all the cases. The value of ($H_2/4H_1$) was 0.224 (E_1), 0.229 (E_2) and 0.0(E_3) indicating asymmetric distribution of positive and negative alleles. The ratio of dominant to recessive alleles was more than unity in all the environments indicating accumulating of dominant genes. h^2 /H_2 ratio was 1.916(E_1), 2.304 (E_2) and 1.27 (E_3), respectively suggested that two or more groups of genes might be operating in the in heritance of this trait and expressive dominance. The heritability in narrow sense was 0.117 (E_1), 0.116 (E_2) and 0.0 (E_3), respectively for grain yield, 0.224 (E_1), 0.188 (E_2) and 0.216 (E_3) indicating asymmetric distribution of positive and negative alleles. The ratio of dominant to recessive alleles was more than unity in all the environments indicating accumulating of dominant genes. h^2/H_2 ratio was 0.290 (E_1), 0.004 (E_2) and 0.030 (E_3), respectively suggested that at least one group of genes might be operating in the in heritance of this trait and expressive dominance. The heritability in narrow sense was 0.364 (E_1), 0.303 (E_2) and 0.528 (E_3), respectively for iron content and 0.204 (E_1), 0.187 (E_2) and 0.202 (E_3) indicating asymmetric distribution of positive and negative alleles. The ratio of dominant to recessive alleles was more than unity in all the environments indicating accumulating of dominant genes. h^2/H_2 ratio was 0.335(E_1), 0.382 (E_2) and 0.099 (E_3), respectively suggested that at least one group of genes might be operating in the in heritance of this trait and expressive dominance. The heritability in narrow sense was 0.079 (E_1), 0.213 (E_2) and 0.287 (E_3), respectively for zinc content. Narrow sense heritability estimates obtained in component analysis ranged from low to high for different traits. This was 0.117 in E_1 for grain yield per plant, 0.364 E_1 for Fe content, 0.079 in E_1 and 0.287 in E_3 for Zn content. The lower values of heritability clearly indicated that it was much influenced by environment. Graphical analysis was carried out as given by Hayman (1954). Suggesting that selection based on these attributes would lead to rapid improvement. Major part of phenotypic variability was due to addictiveness and possibility of fixing these traits by simple selection. The results was corroborate with the findings of Lakshmana *et al.* (2009), Vagadiya *et al.*, (2010) and Rai *et al* (2013).

Table 2: Estimates of components of genetic variance for characters in E_1, E_2 and E_3 environments

Components	Grain Yield			Fe Content			Zn Content		
	E_1	E_2	E_3	E_1	E_2	E_3	E_1	E_2	E_3
D ±SE	5.19 ±16.75	1.59± 5.70	1.45± 4.97	27.50± 14.46	56.94± 19.57	46.93± 16.64	24.38± 7.18	34.04± 18.36	24.77± 11.22
H1±SE	176.73± 35.67	80.21± 12.14	50.76± 10.59	167.56.15± 30.78	228.15± 41.66	177.24± 35.43	147.12± 15.28	204.86± 39.10	165.64± 23.9
H2±SE	158.38± 30.61	73.43± 10.31	42.51± 9.01	150.21± 26.16	171.55± 35.41	153.17± 30.11	126.99± 12.991	152.86± 33.23	133.53± 20.31
h^2±SE	311.13± 20.29	169.18± 6.91	54.15± 6.03	43.59± 17.51	0.73± 23.70	4.62± 20.15	42.57± 8.69	58.42± 22.24	13.21± 13.59
F±SE	11.68± 38.66	3.01± 13.15	3.77± 11.48	1.95± 33.37	76.32± 45.16	-14.53± 38.40	39.02± 16.56	65.33± 42.38	30.01± 25.90
E±SE	5.11± 5.05	2.10± 1.71	1.42± 1.50	0.003± 4.36	0.003± 5.90	0.004± 5.01	0.041± 2.16	0.01± 5.53	0.01± 3.38
$(H_1/D)1/2$	5.83	7.097	5.91	2.468	2.002	1.94	2.45	2.453	2.586
$H_2/4H_1$	0.224	0.229	0.0	0.224	0.188	0.216	0.214	0.187	0.202
$(4DH_1)1/2+F/(4DH_1)1/2-F$	1.477	1.307	0.0	1.029	2.007	0.852	1.966	2.285	1.612
h^2/H_2	1.964	2.304	1.27	0.290	0.004	0.030	0.335	0.382	0.099
Heritability in narrow sense	0.117	0.116	0.0	0.364	0.303	0.528	0.079	0.213	0.287

The results revealed that partial, complete and over-dominance for different characters was seen in all the three environments. The scattering of parental array points indicated the existence of high genetic diversity among the parents for most of the characters studied. On over all basis, the parents RIB-57, RIB-192 and RIB-335-74 possessed more dominant genes while, J-2340 and H-77/833-2-202 possessed more recessive genes for grain yield and related traits under all the environments.

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