GENETIC COMPONENTS ANALYSIS IN PEARL MILLET FOR FE AND ZN CONTENT, GRAIN YIELD AND ITS ATTRIBUTES OVER ENVIRONMENTS

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ABSTRACT

In a study of 36 hybrids derived from 9 × 9 Half diallel without reciprocals, both additive and dominance components were important with the predominance of dominance effects for almost all the studied characters including Fe and Zn content. The distribution of genes with positive and negative effects ($H_2/4H_1$) in the parents was observed nearly symmetrical for grain yield per plant and all the characters studied, indicating considerable degree of gene symmetry over all the loci for the studied traits. The ratio of h^2/H_2, estimating the number of gene groups indicated that there was one group of genes responsible for controlling all the traits studied. The low estimates of narrow sense heritability was depicted for most of the traits in individual environments indicated that the characters studied were much influenced by the environments. Since majority of the traits exhibited very low narrow sense heritability and preponderance of dominant effects, suitable hybridization programme may be adopted to bring desirable genetic improvement in all the traits.

KEY WORDS: Additive gene action, Genetic components, Heritability, Non-additive gene action, Over dominance

INTRODUCTION

Pearl millet (*Pennisetum glaucum* (L.) R. Br.) is a stable diet for the vast majority of poor farmers and also forms an important fodder crop for livestock population in arid and semi-arid regions of the country. Fisher (1918) was the first to recognize the importance of biometrical techniques to study the genetics of quantitative characters. Later on Fisher et al. (1932) partitioned total genetic variance in the three parts; additive (arising from average effect of genes), dominance (arising from allelic interactions) and epistatic part (arising from non-allelic interactions). Yadav *et al.* (2012) and Parmar *et al.* (2013) were 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

The crossing programme was executed at Instructional Farm, Junagadh Agricultural University, Junagadh for development of 36 hybrids from nine restorers inbreds using half - diallel mating during summer 2017. The genetically uniform experimental materials was evaluated during *kharif* 2017 comprising 9 parents and 36 hybrids at *Sagadividi* Farm, Department of Seed Science and Technology, College of Agriculture, Junagadh Agricultural University, Junagadh in a Randomized Block Design with three replications in three different environments, which were created by three sowing dates like early (3th July), timely (18th July) and late sowing (3thAugust) and were designated as environment 1 (E_1); environment 2 (E_2); and environment 3 (E_3). Each entry was accommodated in single row plot of 5.0 meter length with row to row and plant to plant distances of 60 and 15 cm, respectively. All the recommended agronomical practices and plant protection measures were followed for raising a normal crop.

All the recommended cultural practices were followed before and after sowing. Data were recorded on 5 randomly selected plants in each treatment and replication for recording aal the characters studied including grain yield per plant, except days to 50 per cent flowering and days to maturity, which were recorded on plot basis. The genetic components of variance were calculated for sixteen different characters including grain yield per plant for individual environments as per the methods suggested by Hayman (1954) as well as Jinks (1954) as described in details by Mather and Jinks (1982) and Singh and Chaudhary (1985).

RESULTS AND DISCUSSION

The genetic components of variance were calculated for sixteen different characters including grain yield per plant for individual environments and are presented in Table 1-6. The additive (D) was significant for days to 50 per cent flowering, days to maturity, number of nodes on main stem, plant height, ear head girth, green ear head weight, dry ear head weight and total biomass per plant revealing importance of both additive as well as non-additive genetic variances in the expression of these traits in all the environments, while it was significant for harvest index in E_2 environment. The additive components (D) was non-significant for number of effective tillers per plant, ear head length, grain yield per plant, test weight, Fe contain, Zn contain in all the environments; for plant height in E_1; and for total biomass per plant in E_3. However, Dominant components (H_1 and H_2) were significant in all the traits studied in all three environments, which indicated importance of non-additive genetic effect in the expression of all the traits studied in all individual environments. The results were in conformity with finding obtained by Shanmuganathan and Gopalan (2006), Bhadalia *et al*. (2012), Singh *et al.* (2015), Singh *et al.* (2017) and Rajesh *et al.* (2018).

The average degree of dominance $(H_1/D)^{1/2}$ indicated over dominance type of gene action all three individual environments for all the traits except for ear head girth in E_3 and panicle index in E_1 and E_2 environments, Thus, it was evident that characters under studied are controlled by non-additive gene action. The results are in conformity with the results of Bhadalia *et al.*

(2012), Singh *et al.* (2015) and Rajesh *et al.* (2018).

The distribution of genes with positive and negative effects ($H_2/4H_1$) in the parents was observed nearly symmetrical for grain yield per plant and all the characters studied, indicating considerable degree of gene symmetry over all the loci for the studied traits. Symmetrical distribution of positive and negative genes was reported for different traits by the average degree of dominance $(H_1/D)^{1/2}$ 0.5 was found to be in the range of over dominance for all the characters studied except number of effective tillers per plant. Similar results were reported earlier by Singh *et al.* (2015) and Rajesh *et al.* (2018).

The estimates of K_D/K_R ratio was more than unity indicated the excess of dominant alleles in parents for all the characters studied except number of days to flowering, days to maturity, number of node on main stem, plant height, ear head length, green ear head weight in E_1; ear head girth and dry ear head weight in E_1 and E_2; and number of effective tillers per plant, grain yield per plant and test weight in all the three environments indicated the excess of recessive alleles in parents. The results obtained in present studies are in agreement with those of Bhadalia *et al.* (2012) and Singh *et al.* (2015).

Knowledge of number of gene groups which exhibit dominance and are responsible for particular trait is important for the genetic progress through selection. In the present investigation, the ratio of h^2/H_2, estimating the number of gene groups indicated that there was one group of genes responsible for controlling all the traits studied. Bhadalia *et al.* (2012), also obtained similar type of results. The estimates of effective factors obtained are likely under estimates of the actual number of genes affecting the traits due to linkage of genes, epistasis and partial dominance at some loci (Jinks, 1954).

According to Robinson (1966), heritability estimates in cultivated plants can be placed in following categories: low (5 to 10 per cent), medium (10 to 30 per cent) and high (30 to 60 per cent). Looking into account this classification for present study, it was observed that low estimates of narrow sense heritability were depicted for all the characters, indicating comparatively more role of dominance gene effects in the expression of grain yield and its attributes. Similar results were also reported earlier by Shanmuganathan and Gopalan (2006), Govindaraj *et al.* (2010), Bhadalia *et al.* (2012), Singh *et al.* (2017) and Rajesh *et al.* (2018). The lower value of heritability clearly indicated that the characters studied were much influenced by the environments.

CONCLUSION

The results revealed importance of non-additive genetic effect in the expression of all the traits studied in all individual environments. The distribution of genes with positive and negative effects ($H_2/4H_1$) in the parents was observed nearly symmetrical for grain yield per plant and all the characters studied, indicating considerable degree of gene symmetry over all the loci for the studied traits. The ratio of h^2/H_2, estimating the number of gene groups indicated that there was one group of genes responsible for controlling all the traits studied. The low estimates of narrow sense heritability was depicted for most of the traits in individual environments indicated that the characters studied were much influenced by the environments.

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Table 1: Estimates of genetic components of variances for days to 50 per cent flowering, days to maturity and number of nodes on main stem in individual environments in pearl millet

Parameters	Days to 50 per cent flowering			Days to maturity			Number of nodes on main stem		
	E_1	E_2	E_3	E_1	E_2	E_3	E_1	E_2	E_3
D	5.90± 1.29**	6.16± 2.30**	4.83± 1.23**	5.42± 0.94**	6.02± 2.02**	5.20± 1.27**	0.50± 0.19*	0.93± 0.22**	0.52± 0.18**
F	-0.69± 3.02	7.13± 5.38	2.37± 2.89	-4.96± 2.19*	6.06± 4.71	1.73± 2.96	-0.05± 0.44	0.54± 0.52	0.23± 0.43
H_1	12.50± 2.86*	19.55± 5.09**	13.02± 2.73**	9.46± 2.07**	17.32± 4.46**	14.49± 2.80**	3.0± 0.42**	2.29± 0.49**	1.57± 0.40**
H_2	12.31± 2.46*	16.07± 4.38**	10.37± 2.35**	9.84± 1.78**	14.51± 3.83**	11.12± 2.41**	2.58± 0.36**	2.04± 0.42**	1.50± 0.34**
h^2	5.16± 1.64**	12.27± 2.93**	14.21± 1.57**	5.41± 1.19**	16.25± 2.56**	10.32± 1.61**	0.42± 0.24	0.82± 0.28**	-0.05± 0.23
E	2.35± 0.41**	1.41± 0.73	1.78± 0.39**	2.14± 0.29**	1.65± 0.63**	1.98± 0.40**	0.06± 0.06	0.11± 0.07	0.13± 0.05*
$(H_1/D)^{1/2}$	1.45	1.71	1.64	1.31	1.69	1.66	2.44	1.57	1.73
$H_2/4H_1$	0.24	0.20	0.19	0.26	0.20	0.19	0.21	0.22	0.29
KD/KR	0.92	1.96	1.35	0.48	1.84	1.22	0.96	1.46	1.29
h^2/H_2	0.41	0.76	1.37	0.55	1.11	0.92	0.17	0.40	-0.03
Heritability (%) Narrow Sense	0.38	0.19	0.36	0.52	0.20	0.41	0.40	0.33	0.25
t^2	0.20	0.08	1.66	1.28	0.32	2.88*	47.14**	1.72	3.06**

** and ** significant at 5 and 1 per cent levels of significance, respectively*

Table 2: Estimates of genetic components of variances for number of effective tillers per plant, plant height (cm) and ear head length (cm) in individual environments in pearl millet

Parameters	Number of effective tillers per plant			Plant height (cm)			Ear head length (cm)		
	E_1	E_2	E_3	E_1	E_2	E_3	E_1	E_2	E_3
D	0.04± 0.04	0.01± 0.02	0.01± 0.07	86.82± 54.83	180.23± 57.29**	114.79± 47.32*	2.66± 2.17	2.84± 2.99	4.05± 2.21
F	-0.11± 0.10	-0.02± 0.06	-0.01± 0.16	-55.69± 127.92	105.95± 133.66	21.40± 110.40	-4.26± 5.08	2.13± 6.97	3.20± 5.17
H_1	0.36± 0.10**	0.28± 0.06**	0.39± 0.15**	718.77± 121.03**	628.54± 126.46**	584.94± 104.45**	36.80± 4.81**	39.41± 6.60**	33.82± 4.89**
H_2	0.28± 0.08**	0.25± 0.05**	0.36± 0.13**	621.90± 104.04**	453.01± 108.71**	432.63± 89.79**	32.97± 4.13**	29.35± 5.67**	28.52± 4.20**
h^2	0.32± 0.05**	0.21± 0.03**	0.12± 0.09	425.67± 69.70**	389.53± 72.82**	168.71± 60.15**	43.26± 2.77**	17.22± 3.80**	9.41± 2.81**
E	0.02± 0.01	0.01± 0.01	0.00± 0.02	25.65± 17.34	16.58± 18.11	21.17± 14.96	1.24± 0.68	1.64± 0.94	0.98± 0.70
$(H_1/D)^{1/2}$	4.93	7.81	6.55	2.87	1.86	2.25	3.71	3.72	2.88
$H_2/4H_1$	0.19	0.22	0.23	0.22	0.18	0.18	0.22	0.18	0.21
KD/KR	0.14	0.44	0.77	0.79	1.37	1.08	0.64	1.22	1.37
h^2/H_2	1.15	0.87	0.33	0.68	0.86	0.39	1.31	0.58	0.33
Heritability (%) Narrow Sense	0.54	0.32	0.20	0.39	0.49	0.48	0.36	0.37	0.27
t^2	118.34**	49.20**	109.84**	3.67**	1.68	1.09	8.73**	8.82**	2.39**

***** *and ** significant at 5 and 1 per cent levels of significance, respectively*

Table 3: Estimates of genetic components of variances for ear head girth (cm), green ear head weight (g) and dry ear head weight (g) in individual environments in pearl millet

Parameters	Ear head girth (cm)			Green ear head weight (g)			Dry ear head weight (g)		
	E_1	E_2	E_3	E_1	E_2	E_3	E_1	E_2	E_3
D	1.31± 0.21**	1.13± 0.26**	2.02± 0.21**	59.23± 22.93**	64.76± 25.61*	79.58± 28.01**	20.36± 6.23**	18.38± 8.76*	35.08± 12.29**
F	-0.25± 0.50	-0.30± 0.61	0.66± 0.49	-21.77± 53.49	18.58± 59.75	36.43± 65.34	-12.63± 14.55	-5.41± 20.45	19.29± 28.67
H_1	3.02± 0.47**	2.16± 0.58**	1.68± 0.46**	221.26± 50.61**	240.50± 56.53**	200.32± 61.82**	67.79± 13.77**	81.04± 19.35**	82.57± 27.13**
H_2	2.74± 0.41**	2.04± 0.50**	1.34± 0.40**	189.85± 43.50**	192.99± 48.60**	187.10± 53.14**	59.04± 11.83**	67.66± 16.63**	76.44± 23.32**
h^2	0.84± 0.27**	0.77± 0.33*	0.71± 0.27**	363.00± 29.14**	9.12± 32.55	39.14± 35.60	115.15± 7.93**	-2.72± 11.14	18.16± 15.62
E	0.07± 0.06	0.09± 0.08	0.07± 0.06	19.00± 7.25*	18.99± 8.10*	13.22± 8.85	7.78± 1.97**	7.56± 2.77**	6.75± 3.88
$(H_1/D)^{1/2}$	1.51	1.30	0.91	1.93	1.92	1.58	1.82	2.10	1.53
$H_2/4H_1$	0.22	0.23	0.19	0.21	0.20	0.23	0.21	0.20	0.23
KD/KR	0.87	0.82	1.44	0.82	1.16	1.34	0.70	0.86	1.43
h^2/H_2	0.30	0.38	0.53	1.91	0.05	0.20	1.95	-0.04	0.24
Heritability (%) Narrow Sense	0.54	0.56	0.67	0.45	0.41	0.32	0.48	0.43	0.30
t^2	0.21	0.10	1.99	5.76**	1.81	0.53	2.97**	4.08**	0.40

** and ** significant at 5 and 1 per cent levels of significance, respectively*

Table 4: Estimates of genetic components of variances for grain yield per plant (g), 1000 grain weight (g) and panicle index (%) in individual environments in pearl millet

Parameters	Grain yield per plant (g)			1000 grain weight (g)			Panicle index (%)		
	E_1	E_2	E_3	E_1	E_2	E_3	E_1	E_2	E_3
D	1.64± 2.63	4.40± 3.98	4.40± 5.06	0.13± 0.32	0.34± 0.20	0.29± 0.19	25.80± 9.52**	81.76± 11.99**	72.72± 5.75**
F	-8.66± 6.14	-7.95± 9.29	-2.60± 11.80	-0.45± 0.74	-0.17± 0.47	-0.09± 0.46	52.85± 22.21	118.83± 27.97**	113.96± 13.42**
H_1	35.89± 5.81**	39.02± 8.79**	35.03± 11.16**	1.65± 0.70**	2.46± 0.45**	2.51± 0.43**	-9.51± 21.01	128.66± 26.46**	70.72± 12.70**
H_2	28.99± 5.00**	33.09± 7.55**	34.30± 9.60**	1.41± 0.60**	1.87± 0.39**	2.22± 0.37**	-27.77± 18.06	87.50± 22.75**	27.61± 10.91*
h^2	84.15± 3.34**	22.41± 5.06**	18.29± 6.43**	0.68± 0.40	1.51± 0.26**	1.28± 0.25**	150.44± 12.10**	560.06± 15.24**	45.56± 7.31**
E	3.91± 0.83**	4.34± 1.25**	2.99± 1.60	0.17± 0.10	0.14± 0.06*	0.11± 0.06	53.52± 3.01**	27.87± 3.79**	13.86± 1.81**
$(H_1/D)^{1/2}$	4.67	2.97	2.82	3.49	2.67	2.92	0.60	1.25	0.98
$H_2/4H_1$	0.20	0.21	0.24	0.21	0.19	0.22	0.73	0.17	0.10
KD/KR	0.27	0.53	0.81	0.35	0.83	0.90	3.91	3.75	8.73
h^2/H_2	2.90	0.67	0.53	0.48	0.80	0.57	5.41	6.40	1.65
Heritability (%) Narrow Sense	0.43	0.42	0.25	0.44	0.47	0.33	0.10	0.03	0.04
t^2	7.88**	5.79**	3.84**	26.64**	10.22**	2.72**	7.93**	26.74**	0.03

** and ** significant at 5 and 1 per cent levels of significance, respectively*

Table 5: Estimates of genetic components of variances for total biomass per plant (g) and Fe content (ppm) in individual environments in pearl millet

Parameters	Total biomass per plant (g)			Fe content (ppm)		
	E_1	E_2	E_3	E_1	E_2	E_3
D	60.28± 21.69**	64.92± 22.19**	56.87± 30.91	32.06± 92.16	29.62± 55.52	19.20± 85.07
F	-16.32± 50.60	-6.07± 51.76	40.99± 72.12	76.33± 215.01	71.18± 129.52	59.01± 198.46
H_1	234.63± 47.87**	165.19± 48.97**	260.38± 68.24**	714.14± 203.43**	514.21± 122.54**	716.13± 187.78**
H_2	177.18± 41.15**	140.20± 42.10**	236.28± 58.66**	639.50± 174.87**	459.01± 105.34**	655.16± 161.42**
h^2	195.89± 27.57**	-6.17± 28.20	0.88± 39.29	-7.86± 117.15	-3.32± 70.57	13.76± 108.13
E	13.85± 6.85	18.35± 7.01**	19.97± 9.77**	25.22± 29.14	14.99± 17.55	13.68± 26.90
$(H_1/D)^{1/2}$	1.97	1.59	2.14	4.72	4.16	6.10
$H_2/4H_1$	0.18	0.21	0.22	0.22	0.22	0.22
KD/KR	0.87	0.94	1.40	1.67	1.81	1.67
h^2/H_2	1.10	0.04	0.03	0.01	0.01	0.02
Heritability (%) Narrow Sense	0.53	0.47	0.20	0.07	0.05	0.06
t^2	0.03	4.26**	3.62**	21.51**	8.80**	104.48**

** and ** significant at 5 and 1 per cent levels of significance, respectively*

Table 6: Estimates of genetic components of variances for Zn content (ppm) and harvest index (%) in individual environments in pearl millet

Parameters	Zn content (ppm)			Harvest index (%)		
	E_1	E_2	E_3	E_1	E_2	E_3
D	-0.03± 5.95	1.73± 8.55	2.86± 5.60	2.83± 2.27	7.85± 2.64**	0.82± 3.98
F	0.55± 13.90	4.03± 19.96	8.05± 13.06	4.22± 5.30	4.05± 6.17	6.01± 9.28
H_1	52.98± 13.15**	65.63± 18.89**	61.48± 12.36**	23.74± 5.02**	26.63± 5.84**	38.39± 8.78**
H_2	49.32± 11.30**	59.53± 16.24**	53.22± 10.62**	19.36± 4.31**	22.70± 5.02**	30.07± 7.55**
h^2	-3.30± 7.57	-2.67± 10.87	-1.55± 7.11	25.00± 2.89**	22.58± 3.36**	16.26± 5.05**
E	9.03± 1.88**	9.48± 2.70**	9.62± 1.77**	3.75± 0.71**	3.31± 0.83**	2.78± 1.25*
$(H_1/D)^{1/2}$	41.02	6.15	4.62	2.89	1.84	6.82
$H_2/4H_1$	0.23	0.22	0.22	0.20	0.21	0.19
KD/KR	1.54	1.46	1.87	1.69	1.32	3.29
h^2/H_2	0.06	0.05	0.03	1.29	0.99	0.54
Heritability (%) Narrow Sense	0.08	0.07	0.06	0.14	0.30	0.13
t^2	0.17	0.16	0.17	0.75	0.36	4.82**

**** and ** significant at 5 and 1 per cent levels of significance, respectively***

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