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DIALLEL STUDIES FOR DIFFERENT ATTRIBUTES IN PEARL MILLET

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ABSTRACT

Gene action and genetic parameters were studied in 5x5 diallel cross of pearl millet experiment. The experiment was carried out at Millets Research Station, Rawalpindi during kharif 2018. The data were recorded from replicated experiment of F_1 hybrids and their parents. Analysis of variances showed the significant differences at 1% level of significance among genotypes for all the characters. The analysis of data was performed using Hayman's technique and components of genetic variation were calculated for all characters under study. Preponderance of dominance effects were observed in the genetic control of days to 50% flowering, plant height, number of nodes per plant and grain yield characters. Directional dominance was present for days to 50% flowering and grain yield characters while absent in plant height and number of nodes per plant. Genes with positive and negative effects were scattered disproportionately in all the characters studied.

Key words: Diallel, dominance, co dominance, pearl millet

INTRODUCTION

Pearl millet is fast growing cereal crop. It has the potential to have high level of heat tolerance and utilize soil moisture proficiently as compared to other cereals. It ranks sixth most important cereal crop in the world after wheat, rice, maize, barley and sorghum.

Pearl millet is the important kharif crop of barani area which not only provides the grain for humans but also provides dry stalk to livestock when no other fodder is available in the winter season. It is very rich in calories, protein (6-15%), fat (5-6%), carbohydrates (60-72%), fiber (1-1.8%) and minerals with less amount of HCN, which makes it highly nutritive and palatable crop in comparison with other crops. Currently, area under Bajra crop in Pakistan is 456 million hectares with total production of 350 million tones showing an increase of 3.2% during 2018-19.

In the past, less work was made pertaining to exploitation of the genetic potential of pearl millet so that it can compete with other cereals. For this purpose higher yielding varieties (grain fodder) is the dire need as it can provide second defense line toward food security in the changing environment. Knowledge pertaining to genetic mechanism of inheritance of different characters can facilitate the breeders to evolve high yielding dual purpose cultivars of pearl millet. Fisher (1918) was the pioneer who identified the value of biometrical techniques to study the genetics of polygenic characters. Fisher *et al.* (1932) concluded that total genetic variance is the sum of variances arising from additive, non additive and epistatic gene interactions. Yadav *et al.* (2012), Parmar *et al.* (2013), Khanum *et al.* (2018), Santosh *et al.* (2018) and Haq *et al.* (2019) reported the preponderance of dominance type of gene action controlling the inheritance of grain yield and other traits.

Keeping in view the above facts, present study was conducted to comprehend the architecture of pearl millet plant for successful utilization through hybridization.

MATERIALS AND METHODS

This experiment was planned to ascertain the mode of inheritance of different quantitative characters of pearl millet. Five genetically diverse Pearl millet lines were sown in the area of Millets Research Station, Rawalpindi during kharif -2017. Two rows of each entry having four meter length were sown using distance of 75 cm between the rows and inter plant distance of 25 cm. At flowering stage, all lines were used to produce first filial generation seed.

Seed of F_1 along with parents were planted using randomized complete block design with three replications at Millets Research Station, Rawalpindi during kharif -2018. Each entry consisted of two rows of four meter length by keeping row to row and plant to plant distances 75 cm and 25 cm, respectively. Nutritional requirements of the crop were fulfilled using recommended dose of fertilizer (NPK). Cultural practices i.e., thinning and hoeing was done to keep in crop with good health and weeds free.

Data of days to 50 % flowering, plant height, internodal length and grain yield was recorded from five plants of each entry in each replication. The data collected from 25 entries were analyzed to get the genotypic differences for each parameter using procedure given by Steel and Torrie (1980). For genetic analysis, Hayman (1954) technique was used to analyze the data of parents in F_1 to obtain knowledge pertaining to inheritance of different parameters.

RESULTS AND DISCUSSION

The utmost goal of any successful breeding scheme is the evolution of genetically superior varieties in relation to yield and other economic characters. For this purpose, germplasms having maximum genetic diversity for different quantitative characters may be utilized through hybridization. Development and implementation of breeding programs require information on the genetic systems controlling the concerned characters and that predictable increase can be boosted with the use of selection process (Barelli *et al.*, 1999 and Viana *et al.*, 1999). Different techniques for evaluation of varieties or strains in terms of genetic makeup are used. Of these diallel analyses (Hayman) technique is considered powerful for gene action studies as it provides information pertaining to additive genetic variance, dominance genetic variance, expected environmental variance, sharing of dominant, recessive, positive and negative genes in the parents. This technique also guides maternal and reciprocal effects along with various genetic ratio.

In present study, the data of under studied characters were analyzed following Steel and Torrie (1980) to find the genotypic differences among genotypes. Highly significant differences were observed among parents for all parameters (Table 1). Therefore, the diallel tables were prepared for Hyman analysis for each trait under study and are discussed as under.

DAYS TO 50% FLOWERING

Significant differences of items “a” and “b” (Table 2) suggested that both additive and dominance genetic effects are contributing in the manifestation of days to 50% flowering parameter. The significance of b_1 item indicated the presence of directional dominance effects of genes. The significance of b_2 and b_3 items showed asymmetrical gene distribution and specific dominant effects among the parents. The significance of “c” item revealed the presence of maternal effects while reciprocal effects were apparent due to the significance of d item.

In case c and d items became significant, the mean squares of a and b items need to be retested against mean square “c” and “d” items respectively as suggested by Mather and Jinks (1982). After retesting “a” and “b” items against mean squares of “c” and “d” the significance remained unchanged.

Significance of additive and non additive genetic effects revealed the equal importance for the development of days to flowering character (Table 4). Higher value of H_1 than D denoted higher degree of non additive genetic components. Dominant genes are more frequent as compared to recessive alleles due to positive value of F-ratio of $(H_1/2)^{1/2}$showed the predominant role of over dominance type of gene action. Uneven genes distribution in the parents was apparent due to deviation from its expected value of 0.25. Dominant and recessive genes are equally distributed as the KD/KR value is not greater than unity.

PLANT HEIGHT

The ANOVA results of F_1 data for plant height revealed that non additive genetic effects are controlling the development of this character (Table 2). Significant value of b_1 item signified the directional dominance. The significance of b_2 and b_3 items showed irregular distribution of genes and specific gene effect, respectively. Significance of “c” and “d” exhibited the maternal and reciprocal effects. After retesting of b_2 and $b_3$against the mean square of “d” as proposed by Mather and Jinks (1982) the b_2 item become non significant while the significance of b_3 item remained same.

It is evident from table-4 that both D and H components were significant displaying the importance of inheritance of both additive and non additive genes effects. The high value of H_1 than D made non additive effect more valuable than additive effects for this character. The significant and positive value of F predicted the greater frequency of dominant alleles as compared to recessive alleles. The involvement of over dominance is apparent because value of $(H_1/D)^{1/2}$ (1.73) is greater than one. Unbalanced gene distribution relates to less value of $H_2/4H_1$ (0.22 than 0.25).

NUMBER OF NODES PER PLANT

Hayman’s analysis of variance results are presented in Table 3 for said character. Significant of item “a” and “b” indicated that number of nodes per plant in pearl millet is the under the control of additive as well as dominance type of gene action. Directional dominance is absent due to non significance of b_1 item. However significance of items b_2 and b_3 indicated the occurrence of asymmetrical distribution of genes among the parents and part of dominance deviation which are not attributed to b_1 and b_2. Due to significances of items c and d, existence of maternal and reciprocal effects verified. The levels of significance of b and b_3 items remain unchanged after testing against mean square of d while the value of b_2 which was previously significant reduced to non significant.

Table 1. Mean square values of different parameters of Pearl millet in 5x5 diallel crosses.

S.O.V	d. f	Days to 50% flowering	Plant height (cm)	No. of nodes per plant	Grain yield kg/ha
Replications	2	0.173	31.61	0.33	22.80
Genotypes	24	66.10 **	406.58 **	1.72 **	693.94 **
Error	48	1.13	61.40	0.45	56.12

Table 2. Hayman's analysis of variance for days to 50% flowering and number of nodes per plant.

Days to 50% flowering							Number of nodes per plant				
Items	DF	SS	MS	F. Ratio	Retested against		SS	MS	F. Ratio	Retested against	
					c	d				c	d
a	4	194	48.4	42.79**	2.44n.s		8.36	2.09	4.56**	1.27n.s	
b_1	1	684	684	604.44**		56.06*	1.61	1.613	3.52 ns		
b_2	4	419	104.8	92.60**		8.59*	11.53	2.88	6.29**		0.99 n .s
b_3	5	54088	10817.7	9559.06**		886.70*	1989.2	297.84	649.84**		102.70*
b	10	55192	5519.2	4877.01**		452.39*	1502.36	150.236	327.79**		51.81*
c	4	79	19.8	17.54**			6.60	1.65	3.60*		
d	6	73	12.2	10.79**			17.4	2.9	6.33**		
Total	74	54	1.1				22.0	0.458			

Table 3. Hayman's analysis of variance for plant height and grain yield kg/ha.

Items	DF	SS	MS	F. Ratio	Retested against		SS	MS	F. Ratio	Retested against	
					c	d				C	d
a	4	626	156	2.548ns	0.32n.s		11755	2939	52.37**	3.77 n.s	
b_1	1	16	16	0.266ns			325	325	5.80*		0.50 n.s
b_2	4	2106	526	8.5739**		0.77n.s	1949	487	8.68**		0.74
b_3	5	1750158	350032	5700.37**		515.51*	168158	33632	599.33**		51.26*
b	10	1752280	175228	2853.64*		258.07*	170433	17043	303.72**		25.98*
c	4	1953	488	7.95**			3115	779	13.88**		
d	6	4074	679	11.057**			3938	656	11.6973**		
Total	74	2947	61				2694	56			

It is clear from the Table 4 that number of nodes per plant in pearl millet is under the control of dominance type of inheritance due to the significant value of non additive genetic effects. The proportional value of $(H_1/D)^{1/2}$ i.e., 2.73 confirm the dominance gene action. The proportion ratio of $H_2/4H_1$ less than 0.25 revealed the lop-sided distribution of genes with positive and negative effect at loci showing dominance. The excess of dominant alleles as compared to recessive alleles is evident from value of KD/KR which is more than unity.

GRAIN YIELD

Hayman's analysis for grain yield (Table 3) revealed that both additive and non additive type of gene action due to significance of "a" and "b" items. Significant value of b item denoted the directional dominance. Uneven distribution of genes and specific dominance effects were obvious due to the value of b_2 and b_3 respectively. Existence of maternal and reciprocal effects was in accordance with significant value of "c" and "d". After retesting, no change was observed for a, b and b_3 items whereas items b_1 and b_2 which were previously significant reduced to non significant. Significance of genetic components D and H (Table 4) indicated that both additive as well as non additive genetic variances are equally important for the inheritance of grain yield trait. Higher amount of D than H_1 showed more prominent additive genes. Positive F value depicted the maximum dominant alleles. Partial degree of dominance was observed by the ratio of $(H_1/D)^{½}$. Symmetrical distribution of alleles at loci evidenced from the ratio $H_2/4H_1$.

Table 4. Estimation of components of genetic variance for different characters.

Components	Days to flowering	Plant height	No. of nodes per plant	Grain yield
D $\pm$ S.E	29.16$\pm$5.27*	159.54*	0.48$\pm$0.39ns	616.56$\pm$ 87.67*
F $\pm$ S.E	40.75$\pm$13.17*	324.89*	1.43ns	67.74$\pm$219.0
$H_1\pm$ S.E	99.05$\pm$14.24*	480.12*	3.60**	322.56$\pm$236.77*
$H_2\pm$ S.E	94.44$\pm$12.91*	404.56*	3.52*	1520.06$\pm$214.75*
$h_2\pm$ S.E	145.69$\pm$9.37*	-9.36	0.25*	57.71$\pm$155.88
E	0.36*	20.07	0.15n.s	18.26$\pm$35.79
$(H_1/D)^{½}$	1.84	1.73	2.73	0.72
$H_2/4H_1$	0.24	0.21	0.24	0.25
KD/ KR	1.01	1.00	1.51	1.16
h_2/H_2	1.54	0.02	0.07	0.04

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