https://doi.org/10.29321/MAJ.10.A02831

Madras agric J. 67. (5): 281—287 May 1980

Genetics of Yield and Yield Traits in Dwarf Pearl Millet (*Pennisetum typhoides* S & H)

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Estimates of the components of variation and combining ability were obtained for five yield and yield traits namely, plant height, effective tillers per plant, ear length, ear girth and yield/plant in a 8×8 diallel set of dwarf pearl millet. The genetic and combining ability analyses revealed the predominance of non-additive genetic variation in the inheritance of all the traits. Effective tillers/plant, ear length and yield/plant were under the influence of non-allelic interactions. The heritability was in general low though it was considerable for ear girth (59.32%). Parents J-1040, 23 D_2B and Cassady were good general combiners for the yield components and grain yield/plant. The estimates of SCA effects for grain yield/plant were high for the crosses J-1040 × Sauna D_2B, Sauna D_2B × J-934 and 23 D_2B×71 B. Based on the present findings it may be suggested that involvement of parents J-1040, 23 D_2B and Cassady in crosses followed by selection might result in superior derivatives.

This investigation was undertaken to study the nature of gene action and combining ability in eight dwarf inbreds of pearl millet.

MATERIAL AND METHODS

Eight *elite* dwarf pearl millet inbreds namely, J-1040, Sauna D_2B, 23 D_2B, Cassady, 71-B, 239 D_2B, J-888 and J-934, representing a wide range of diversity for different yield attributes, were selected. All possible F_1 crosses (diallel without reciprocals i.e. 28 F_1s + 8 parents) were grown in a randomized block design with two replications during *kharif*, 1976, at the Agricultural Research Farm, B.H.U., Varanasi. Plant to plant and row to row distances were 15 cm and 45 cm, respectively. Recommended agronomical practices were followed to raise the crop. Observations on plant height, effective tillers per plant, ear length, ear girth and yield per plant were recorded on ten competitive plants from each of the parents and F_1 s per replication.

Plot means were used for statistical analysis. The analysis of variance was done following Panse and Sukhatme (1967). Components of genetic variances were analysed as per the method of Hayman (1954). Griffing's (1956) method II, model I was followed to compute the combining ability.

RESULTS AND DISCUSSION

Analysis of variance revealed highly significant differences among

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progenies for all the characters. The test of homogenity (t^2) indicated the fulfilment of the assumptions of diallel analysis for all the characters, except effective tillers/plant (Hayman, 1954). The regression coefficient 'b' deviated significantly from zero, indicating the validity of the estimates obtained from diallel analysis. However, its significant deviation from unity for effective tillers/plant, ear length and grain yield/plant suggested the presence of non-allelic interactions for these traits.

COMPONENT ANALYSIS

The estimates of genetic components and their proportions are presented in Table I. The additive component of genetic variance $(\hat{D})$ was significant for plant height and ear girth; for the remaining characters it was non-significant, this may be because of epistatic interaction and relatively high magnitude of the dominance variation in the interaction. The estimates of dominance $(\hat{H}_1, \hat{H}_2)$ and $\hat{h}^2$ were significant for all the characters, except ear girth for which $\hat{h}^2$ was not significant. The relative magnitudes of non-additive components were considerably higher than those of the additive components for all the traits. Positive estimate of $\hat{h}^2$ indicates that the direction of dominance was positive. The estimate of component $\hat{F}$ was positive for all the characters, suggesting an excess of positive alleles governing the traits.

The average degree of dominance $(\hat{H}_1/\hat{D})^{\frac{1}{2}}$ was higher than unity for all the traits, suggesting the importance of non-additive components of genetic variation. However, the presence of non-allelic interactions for effective tillers/plant, ear length and yield/plant may have inflated the average degree of dominance. Plant height and effective tillers/plant exhibited symmetrical distribution of positive and negative alleles($\hat{H}_2/4\ \hat{H}_1 = 0.25$), while the remaining traits showed somewhat a symmetrical distribution. The ratio $\hat{K}_D/\hat{K}_R$ was more than unity for all the characters, except effective tillers/plant, indicating higher proportion of dominant genes. The ratio, $\hat{h}^2/\hat{H}_2$, refers to approximate number of genes or groups of genes that show dominance. Accordingly, plant height, effective tillers/plant and yield/plant were controlled by atleast two pairs of genes or groups of genes. Similar mode of inheritance for the characters studied were reported earlier by Appadurai and Subramanian (1975) in pearl millet.

The correlation between parental order of dominance and parental measurement was significantly negative for plant height and ear girth which indicated the presence of an excess of positive genes with dominance. Equal proportion of positive and negative genes with dominance was inferred for remaining traits.

The estimate of heritability in narrow sense was moderate to low, being the highest for ear girth (59.32%). It was the lowest in case of effective tillers/plant (14.19%). Low estimate of heritability indicated that non-additive gene action and environmental variations contributed a major part in the expression of the traits.

COMBININIG ABILITY ANALYSIS

The mean sum of squares due to both general and specific combining ability were significant for all the traits, except effective tillers/plant (GCA). The variance ratio $\hat{\sigma}^2_{bg} / \hat{\sigma}^2_{bs}$ was less than unity for all the traits, indicating the importance of non-additive component over additive component of variation in the inheritance of characters under study (Table II), as also suggested by the average degree of dominance.

The parents other than 239 D_2 B and J-888, exhibited highly significant GCA effects for plant height; parents J-1040, 23 D_2 B and J-934 had negative GCA effects and thus were good general combiners for dwarfness. Significant positive GCA effects for ear length were recorded for the parents J-1040, Sauna D_2 B, 23 D_2 B and 71 B, out of which Sauna D_2 B was the best general combiner. Further, inbreds, J-1040 and Sauna D_2 B, were the only two good general combiners for ear girth. For grain yield/plant, inbreds, J-1040, 23 D_2 B and Cassady, were the good general combiners (Table III).

The estimates of specific combining ability effects (Table IV) indicated that crosses 2×3, 2×4, 6×7, 5×8, 4×7 and 1×4 were good specific combinations for dwarfness. Remaining crosses exhibited significantly positive SCA effects for plant height. For grain yield/plant cross 3×5 was the best hybrid combination besides 2×8, 1×2. Crosses 1×4 and 2×8 exhibited significantly positive higher SCA effects for effective tillers/plant. Almost all the crosses for ear length showed significant positive SCA effects, while crosses 3×5, 3×4 and 1×3 in that order were the best crosses for ear length. Ear girth exhibited highest SCA effects for 1×5 and 1×6 cross combinations.

The good general combiners for most of the yield components, namely, J-1040, 23 D_2 B and Cassady showed high GCA effect for grain yield also. The SCA estimates of the cross combinations, 1×2, 2×8, and 3×5, were very high and significant for grain yield/plant. Most of the observations of the present study are in accordance with the findings of Murty and Tiwari (1967) and Ahmed *et al.* (1973).

The predominance of non-additive gene action for all the characters in the present study suggested that the response to selection from hybrid populations will be limited. However, the availability of parents such as J-1040, 23 D_2 B and Cassady possessing high GCA may provide basic material to develop superior lines through selection from crosses involving these lines.

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TABLE I. Estimates of components of variation and their proportions for five characters in a 8×8 diallel t of dwarf pearl millet.

Components/ proportions	Plant height	Effective tillers/ plant	Ear length	Ear girth	Yield/ plant
$\hat{D}$	618.50**	0.04	20.68	0.03*	24.02
	±129.39	±0.18	±17.16	±0.02	±27.19
$\hat{H}_1$	1850.21**	2.09**	137.60**	0.12*	235.90**
	±297.46	±0.41	±39.44	±0.04	±62.51
$\hat{H}_2$	1692.03**	1.90**	108.10*	0.09*	202.60**
	±258.79	±0.36	±34.32	±0.03	±54.38
$\hat{h}^2$	5385.95**	4.53**	147.03**	0.05*	444.75**
	±173.56	±0.24	∓23.01	±0.02	±36.47
$\hat{F}$	350.60	0.01	33.35	0.02	15.31
	±305.75	±0.42	±40.54	±0.04	±64.25
$\hat{E}$	2.26	0.19*	0.41	0.02	8.41
	±43.13	±0.06	±5.72	±0.01	±9.06
$(\hat{H}_1/\hat{D})^{1/2}$	1.73	7.17	2.58	1.44	3.13
$\hat{H}_2/4\hat{H}_1$	0.23	0.23	0.19	0.20	0.21
$\hat{K}_D/\hat{K}_R$	1.39	1.05	1.91	1.24	1.23
$\hat{h}^2/\hat{H}_2$	3.18	2.38	1.36	0.47	2.19
Heritability (narrow sense)	33.35	14.19	23.47	59.32	26.23
't^2'	0.01	10.13**	1.02	0.48	0.63
'b'	0.84	0.41	0.53	0.69	0.36
	±0.31	±0.19	±0.14	±0.23	±0.13
Correlation coefficient 'r'	−0.72*	−0.64	−0.66	−0.75**	−0.54

* Significant at P=0.05

** Significant at P=0.01

TABLE II ANOVA for combining ability for five characters in a 8×8 diallel set of dwarf pearl millet

Soucre	d. f.	Plant height	Effective tillers/ plant	Ear length	Ear girth	Yield/ plant
GCA	7	1099.78**	0.30	32.53**	0.15**	88.49**
SCA	28	611.03**	0.75**	34.89**	0.03**	73.05**
Error	35	12.25	0.19	0.41	0.02	8.41
$\hat{\sigma}^2_g / \hat{\sigma}^2_s$		0.15	0.14	0,01	0.77	0.50

** Significant at P=0.01

TABLE III Estimates of GCA. effects for five characters in a 8×8 diallel set of dwarf pearl millet

Parents	Plant height	Effective tillers/ plant	Ear length	Ear girth	Yield/ plant
J-1040	−15.07**	0,18	1.10**	0.22**	2.36**
Sauna D_2B	12.42**	0.09	2.48**	0.14**	1.30
23 D_2B	−5.69**	0.01	1.63**	−0.04**	2.58**
Cassady	7.67**	−0,19	1.70**	−0.05**	2.84**
71 B	11.57**	0.18	0.45*	−0.01	0.04
239 D_2B	0.93*	−0.16	−1.89**	−0.13**	−5.28**
J-838	0.89	−0.05	0.37	−0.04**	−0.39
J-934	−12.72**	−0.16	−2.43**	−0.10**	−3.45**
S. E. $\hat{g}i$	±0.44	±0.13	±0.19	±0.01	±0.86

* Significant at P=0.05

** Significant at P=0.01

TABLE IV Estimates of SCA effects for five characters in a 8×8 diallel set of dwarf pearl millet

Crosses	Plant height	Effective tillers/ plant	Ear length	Ear girth	Yield/ plant
1×2	5.60**	0.03	5.83**	0.18**	14.38**
×3	31.24**	−0.50	8.40**	0.07	0.20
×4	−1.56**	1.34**	0.01	−0.24**	2.11*
×5	16.21*	0.34	6.88**	0.33**	2.95*
×6	3.23**	0.60	4.02**	0.36**	3.02*
×7	6.28**	0.65	3.02**	−0.01	2.42**
×8	19.22**	0.12	3.43**	0.27**	3.06*
2×3	−35.28**	−0.10	−3.49**	0.16**	−0.61
×4	−8.15**	0.46	5.06**	0.17**	4.84**
×5	17.09**	0.35	2.50**	−0.01	−1.17
×6	29.72**	0.83*	3.61**	0.05	−1.34
×7	13.49**	0.81	3.89**	0.14**	1.21
×8	18.42	1.26**	7.22**	−0.11**	15.42**
3×4	33.53**	0.65	8.97**	0.12**	0.61
×5	13.22**	−0.26	13.26**	0.14**	22.21**
×6	5.63**	1.02*	0.45	−0.07	1.00
×7	8.22**	0.47	−2.49**	−0.06	0.59
×8	10.30**	−0.30	−3.02**	−0.09	1.25
4×5	25.46**	1.02*	1.84**	−0.12**	5.01**
×6	1.77**	−0.72	0.08	0.08	−0.87
×7	−2.53**	−0.70	−0.53	0.16**	1.25
×8	5.53**	−0.90*	−3.31**	0.01	−5.04**
5×6	19.65**	0.23	−0.73	−0.11**	−1.83*
×7	15.46**	0.15	−1.54*	0.01	6.57**
×8	−6.18**	0.42	0.52	0.10*	−3.43**
6×7	−6.26**	−0.68	1.25*	−0.14**	1.04
×8	15.84**	0.74	1.73**	−0.01	6.30**
7×8	5.77**	0.31	1.72**	0.10*	0.19
S. E.	±0.43	±0.39	±0.58	±0.04	±0.83

1=J−1040, 2=Sauna D_2B, 3=23 D_2B, 4=Cassady, 5=71 B, 6=239 D_2B, 7=J−888 and 8=J−934.

* Significant at P=0.05

** Significant at P=0.01