Indian J. Genet., 59(3): 301-308 (1999)

GENE EFFECTS FOR GRAIN CHARACTERS IN PEARLMILLET [*PENNISETUM GLAUCUM* (L.) R. BR.]

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(Received: October 21, 1998; accepted: May 26, 1999)

ABSTRACT

Genetic analysis of data of six basic generations of each of the three crosses of pearlmillet (*Pennesitum glaucum*) involving one grey and two white grained parents was used to elucidate the inheritance of grain density, grain weight and protein content. Additive gene effect was significant for protein content in one of the crosses while additive as well as non- additive gene effects were indicated for grain density, grain weight and protein content in all the three crosses except for protein content in one cross. Protein content analysis of pearlmillet grain showed wide variability ranging from 10.30- 18.75% in grey and from 12.30-19.40% in white grained inbred lines. The highest protein content was observed in white grained genotype WGI-105 (19.40%) whereas among grey type PPMI-402 had highest protein content (18.75%). Protein content and endosperm texture did not show any correlation.

Key Words : Pearlmillet, *Pennisetum glaucum*, grain protein, gene effect, endosperm texture

Among the cereal crops in India, pearlmillet is fourth in average behind rice, wheat and sorghum and fifth in production ranging from 5 to 6 million tonnes behind rice, wheat, sorghum and maize. Pearlmillet is widely grown in arid and semiarid areas, on marginal lands with scanty rainfall. Pearlmillet is a major source of dietary proteins for the large vegetarian population of India.

The grain of pearlmillet is consumed in various forms like *chapati*, porridge, biscuits, etc. Major consumption of pearlmillet is in the form of *chapati* which is made from flour. With the enhanced production of rice and wheat, more and more people are changing their food habits and have started consuming rice and wheat.

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Therefore, to make pearlmillet a competitive foodgrain it becomes essential that besides the improvement in yield level, the protein quantity in the grain is also increased to maximise the protein production per unit area. This would necessitate an attempt to identify and elucidate genetic control of grain protein content in pearlmillet.

MATERIALS AND METHODS

The following material listed in table was utilised for the experiment

S. No.	Parent	Colour of grain	500 grain weight (g)	Crosses and generations
1.	D-763 (P1)	Dark grey	3.65	(P1 × P2), F1, F2, BC1, BC2
2.	W-367-2(P2)	Pearly white	4.19	(P2 × P1), F1, F2, BC1, BC2
3.	W-123 (P3)	Pearly white	4.72	(P1×P3), F1, F2, BC1, BC2

The experimental material was raised in a compact family design with four replications in 2.4 m. long rows. The plots consisted of ten rows each with 75 cm. and 10 cm. distance between and within rows respectively for all generations.

Parents were grown during kharif 1989 to make the F1 crosses. F2 and backcrosses were developed during 1990 and F1's were again developed during the same year. For protein analysis, 10 g each of white and grey seed was utilised from the genetic stock maintained at the Division of Genetics, Indian Agricultural Research Institute, New Delhi.

1. Grain Density

Number of grains per square centimeter were recorded in all the six generations in each replication in randomly selected five earheads of each generation of the three crosses

2. 500 grain weight

Five hundred seed weight of all the six generations of the three crosses were taken.

3. Protein content

The total protein (%) was estimated with the Autoanalyser [1]. Nitrogen was estimated in 100 mg of the grain flour in all the six generations of the three crosses. The estimated value of N was multiplied by 6.25 to obtain the crude protein percentage on the assumption that the protein of pearlmillet contains 16% N.

Similarly, protein (%) was estimated in 51 white and 20 grey inbred lines.

4. Endosperm texture

Endosperm texture was scored on matured dry grain split longitudinally, into the following classes : Completely corneous (CC), almost corneous (AC) partly corneous (PC), almost starchy (AS) and completely starchy (CS).

Statistical analysis

Mean values of each of the three character namely grain density, grain weight and protein content (%) in all six generations of the three crosses was worked out. Standard error of mean was calculated by the normal statistical procedures.

The scaling tests A, B and C were computed and their variances were calculated to test the adequacy of the additive-dominance model in each case [2]. When additive-dominance model was inadequate, the perfect fit solution given by Jinks and Jones [3] was used to estimate additive, dominance and non-allelic interactions.

For the estimation of genetic parameters where absence of interaction was indicated, unweighted mean analysis was carried out to estimate additive-dominance effects.

RESULTS AND DISCUSSION

In the present study (Table 1), the non-allelic interactions were significant only for grain weight in the cross D-763 × W-637-2. The non-allelic interactions were significant for all the three characters in the reciprocal cross W-637-2 × D-763. In the third cross D-763 × W-123 the non-allelic interactions were significant for grain weight and protein content.

As the analysis indicates, additive as well as non-additive gene actions controlled the traits grain density, 500 grain weight, in all the three crosses (Table-2). Out of the three types of epistasis, additive × additive is fixable and can be made use of in developing pure lines. However, due to the presence of additive × dominance and dominance × dominance interactions, the selection would have to be postponed to later generations and the genetic variability has to be maintained even upto the later generations when sufficient epistatic interactions become fixed. Diallel selective mating [4] and biparental matings in segregating generations may be helpful.

Table 1. Scaling tests for three characters

Scaling Test	Grain density	500 grain weight	Protein content (%)
Cross I : D 763 × W-637-2			
A	3.20 ± 2.26	5.70 ± 0.98*	0.04 ± 1.02
B	6.20 ± 3.36**	3.55 ± 0.33	-1.91 ± 1.86
C	3.40 ± 4.70	4.96 ± 1.77**	-.52 ± 2.236
Cross II : W-637-2 × D-763			
A	-0.20 ± 2.56	3.18 ± 0.67*	3.67 ± 1.64*
B	-6.20 ± 2.04*	4.16 ± 0.62*	0.21 ± 0.80
C	0.20 ± 5.21	0.41 ± 1.63	-3.04 ± 0.85*
Cross III D-763 × W-123			
A	14.80 ± 2.13	0.46 ± 0.51	2.87 ± 1.41*
B	-4.00 ± 3.76	2.51 ± 0.51	0.93 ± 0.68
C	-3.80 ± 3.98	1.66 ± 0.99	-0.68 ± 3.06

** = Significant at 1% level, * = significant at 5% level

Table 2. The estimates of additive, dominance and interaction parameters

Estimates	Grain density	500 grain weight	Protein content (%)
Cross I : D 763 × W-637-2			
m	13.50 ± 5.58*	0.26 ± 1.84	14.77 ± 2.39*
d	0.50 ± 0.63	-0.27 ± 0.07*	-0.45 ± 0.16*
h	22.70 ± 13.91**	16.34 ± 3.88**	-.98 ± 6.55
i	48.00 ± 5.54	3.66 ± 1.84*	-
j	-3.00 ± 4.96	1.52 ± 0.56*	-
l	-15.40 ± 8.68	-12.28 ± 2.08*	-
Cross II : W-637-2 × D-763			
m	26.30 ± 4.02*	-.18 ± 1.84	7.07 ± 1.86*
d	-0.50 ± 0.63	0.27 ± 0.07*	0.45 ± 0.16*
h	-11.05 ± 9.69**	19.87 ± 4.19*	18.4 ± 5.44*
i	-.00 ± 3.97	6.10 ± 1.84*	6.92 ± 1.85*
j	6.20 ± 2.49	-2.88 ± 0.90*	3.46 ± 2.24
l	13.40 ± 6.84*	-12.62 ± 2.41*	-10.80 ± 3.63*

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Cross III : D-763 × W-123			
m	22.10 ± 5.25	2.88 ± 1.08*	9.67 ± 3.22*
d	-0.10 ± 0.73	-0.53 ± 0.11*	-0.61 ± 0.16*
h	-10.90 ± 14.00	5.17 ± 2.60*	14.62 ± 7.18*
i	-	1.30 ± 1.80	4.48 ± 3.22
j	-	-1.79 ± 0.66*	1.94 ± 1.45
l	-	-4.01 ± 1.59*	-8.28 ± 4.13*

*, ** significant at 5% and 1% level respectively.

Protein content :

Protein content in the grey inbred lines ranged from 10.30 to 18.75% while in the white grain types the range was 12.50 to 19.40% (Tables 3 and 4). The highest protein content (19.40%) was observed in white coloured genotype WGI 105. In the grey types (Table 4) line no. 2 and 16 are of importance as they contain 17.24% and 18.75% protein content respectively. Interestingly, J- 104 which has been utilised in as many as five commercial hybrids contains only 12.71% protein content. Thus, improvement of J-104 with regard to protein content is desirable as it has very good combining ability and produces drought tolerant hybrids.

Table 3. The endosperm texture and protein content (%) of 20 grey grained inbred lines

Line	Endosperm texture	Protein content (%) Mean ± SE
PPMI-303 (714-5)	PC	16.15 ± 0.13
PPMI-235 (1034-4)	PC	17.24 ± 0.08
PPMI-32 (1054 bulk)	PC	12.96 ± 0.65
PPMI-55 (1158-7)	PC	16.24 ± 0.96
PPMI-362(1223-4)	PC	16.93 ± 0.96
D-763 (1316-1)	PC	16.62 ± 0.97
D-23 (1330-1)	PC	15.62 ± 0.88
PPMI-128 (1017-1)	PC	18.59 ± 0.99
PPMI-162 (917 bulk)	PC	13.74 ± 0.44
PPMI-379 (946-3)	AS	12.18 ± 0.79

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PPMI-465 (957-1)	AS	15.62 ± 1.32
PPMI-305 (1188-2)	AS	15.81 ± 1.06
M-46 (1301-1)	AS	13.74 ± 0.88
PPMI-135(785-1)	CS	15.30 ± 0.88
PPMI-245 (818 bulk)	CS	17.49 ± 1.32
PPMI-402 (1077 bulk)	CS	18.75 ± 0.00
PPMI-493 (965-1)	CS	14.99 ± 0.44
PPMI-520 (973-3)	CS	15.77 ± 1.54
J-104 (1290)	CS	12.71 ± 0.57
PPMI-280 (1943-1)	CS	10.30 ± 4.41

AS - Almost corneous; CS - Completely corneous; PC - Partly corneous

Table 4. The endosperm texture and means and standard errors of protein content (%) of 51 white grained inbred lines

Line (WGI)	Endosperm texture	Protein content (%) Mean ± SE
15 (1526-1)	CC	17.02 ± 0.21
117 (1501-2)	PC	14.99 ± 0.88
129 (1508-1)	PC	13.59 ± 0.66
112 (1513-1)	PC	15.30 ± 0.88
112 (1514-1)	PC	14.99 ± 0.44
109 (1515-1)	PC	14.99 ± 0.88
9 (1527-2)	PC	14.99 ± 0.88
9 (1528-1)	PC	16.24 ± 0.88
104 (1538-1)	PC	12.96 ± 1.54
108 (1547-1)	PC	14.21 ± 1.11
50 (1561-1)	PC	15.49 ± 1.15
30 (1563-1)	PC	14.6 ± 3.09
147 (1574-2)	PC	13.90 ± 1.10
110 (1434-1)	PC	14.12 ± 1.41
31, 142 (bulk)	PC	13.65 ± 0.74
145 (1442-1)	PC	14.06 ± 0.00
145 (1443-2)	PC	13.81 ± 0.97
100 (1452-1)	PC	13.12 ± 0.00

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91 (1454-2)	PC	17.12 ± 0.08
91 (1455-2)	PC	16.15 ± 1.45
89 (1457-2)	PC	16.31 ± 0.79
105 (1466-1)	PC	19.40 ± 0.84
108 (1468-1)	PC	13.12 ± 1.32
90 (1474-1)	PC	15.00 ± 1.76
73 (1485)	PC	14.84 ± 0.22
73 (1486-1)	PC	13.90 ± 1.10
73 (1487-1)	PC	15.78 ± 1.10
144 (1491-1)	PC	13.90 ± 0.66
2 (1506-5)	AS	14.99 ± 0.44
101 (1517-1)	AS	15.77 ± 0.21
101 (518-1)	AS	15.62 ± 0.00
29 (1521-1)	AS	14.68 ± 0.00
8 (1529-1)	AS	16.22 ± 0.22
28 (1544-1)	AS	13.59 ± 0.66
108 (15487-1)	AS	13.59 ± 0.22
69 (1549-1)	AS	13.96 ± 0.30
949 (1554-1)	AS	18.81 ± 0.79
8 (1557-1)	AS	16.71 ± 0.21
71 (1446-2)	AS	17.65 ± 1.98
71 (1448-1)	AS	17.21 ± 0.84
80 (1461-1)	AS	17.51 ± 0.48
146 (1496-)	AS	13.71 ± 0.04
90 (1470-1)	AS	16.93 ± 1.23
52 (1488 -1)	AS	13.75 ± 0.00
146 (1463-1)	AS	12.56 ± 0.35
55 (1463-1)	AS	14.68 ± 0.44
55 (1464-1)	CS	14.52 ± 0.21
109 (1516-1)	CS	14.52 ± 1.98
100 (1451-2)	CS	16.71 ± 0.21
80 (1460-1)	CS	15.77 ± 1.54

AS - Almost Starchy, CC - Completely Corneous, CS - Completely Starchy, PC - Partly Corneous

The figures in the parenthesis indicate field row number of the germplasm line

Analysis of 71 grey as well as white grained, genotypes has shown that there exists a very wide range of variability for protein content in pearlmillet grain. However, there was no clearcut correlation between protein content and endosperm texture in both the types.

ACKNOWLEDGEMENT

Financial assistance obtained from I.A.R.I. by the senior author of Junior Research Fellowship is gratefully acknowledged.

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