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Genetic Variability Studies in Maintainer Lines of Pearl Millet (*Pennisetum glaucum* (L.) R. Br.)

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ABSTRACT

Genetic variability studies were conducted with forty-two maintainer inbred lines of pearl millet developed at ICRISAT, Patancheru, Hyderabad, India to assess the magnitude of variability, heritability and genetic advance as *per cent* of mean for thirteen yield and yield contributing characters at Agricultural Research Station (Dry Land Agriculture), ANGRAU, Ananthapuram, Andhra Pradesh during *rabi* 2011-12. The field trial was planted with a spacing of 50cm x 15 cm between rows and between hills. Analysis of variance manifested highly significant differences among the inbred lines for all the traits except for number of days taken for germination. Variability for genetic potential was highest (four to five fold) for fodder yield per plant, weight of total panicles per plant and grain yield per plant. The phenotypic coefficient of variation (PCV) was in general higher than the genotypic coefficient of variation (GCV) except for number of days taken for germination for which values of PCV and GCV were observed to be equal. High to moderate estimates of broad sense heritability coupled with high estimates of genetic advance as per cent of mean was noticed for the traits single panicle weight (Main tiller panicle), grain yield per single panicle, fodder yield per plant, weight of total panicles per plant and grain yield per plant, suggesting to go for simple direct selection for the improvement of the genotypes for these characters. Among forty two inbred lines studied based on *per se* performance eight best inbred lines were selected *viz*., 81 B, ICMB 91444, ICMB 92111, ICMB 96666, ICMB 97111, ICMB 01888, ICMB 04111 and ICMB 04777 with higher values for fodder yield per plant, weight of total panicles per plant and grain yield per plant.

Key words: *GCV, Genetic advance as per cent of mean, Heritability and Pearl Millet, PCV.*

Pearl millet (*Pennisetum glaucum* (L.) R. Br.) is a diploid and cross pollinated crop and being a C_4 plant, has a very high photosynthetic efficiency and dry matter production capacity. It is usually grown under the most adverse agro-climatic conditions where other crops fail to produce economic yields.

At country level, India is the largest producer of the crop, both in terms of area (about 9.3 million hectares) and production (about 8.5 million tons) (APR 2011). Pearl millet is ranked third after rice and wheat in area and is grown in Rajasthan, Maharashtra, Gujarat, Uttar Pradesh, Haryana, Tamil Nadu, Andhra Pradesh and Karnataka, though first four states account for more than 90% of acreage in pearl millet (O.P. Yadav *et al*., 2012). Pearl millet improvement research in India is carried out through the All India Coordinated Pearl Millet Improvement Project (AICPMIP) administered by the Indian Council of Agricultural Research (ICAR). In the state of Andhra Pradesh, Agricultural Research Station (Dry Land Farming), ANGRAU, Ananthapuram is one of the coordinating centres, out of 14 coordinating centres of AICPMIP in India, which comes under scarce rainfall zone receiving 553 mm annual rainfall.

In modern field of crop improvement programme, genetic studies have attained significant importance in evolving varieties suited to various environmental conditions and it was earlier found that genetic improvement of crops for quantitative traits requires reliable estimates of genetic variability, heritability and genetic advancement in respect to the breeding material that is presently at hand in order to plan an efficient breeding programme (Dudley and Moll 1969, Chand *et al*., 2008). Therefore it becomes necessary to partition the observed variability in to its heritable and non heritable components and to have an understanding of parameters such as coefficient of variation, heritability and genetic advancement.

With this back ground, here an attempt was made with an objective to estimate variability, heritability and genetic advancement for grain yield and yield contributing traits in a set of designated

elite maintainer inbred lines of pearl millet supplied by ICRISAT and to identify the best female parents among them suitable to scarce rainfall zone.

MATERIAL AND METHODS

Location of the experiment: The experiment was carried out at Agricultural Research Station, ANGRAU, Ananthapuram, (Lat: 14^0 41^1 N, Long: 77^0 40^1 E and 350 m above mean sea level) located in the Ananthapuram district and in the scarce rainfall zone of Andhra Pradesh, India. This district receives an average annual rainfall of about 553mm per annum and is characterized by receiving very low rainfall that to erratic rainfall in terms of area, time and distribution during the season.

Genetic material used: The experimental materials consists of forty two advanced generation, designated maintainer inbred lines of pearl millet having broad genetic base developed and supplied by ICRISAT, Patancheru, Hyderabad, India.

Experimental design: Forty two maintainer inbred lines of pearl millet were planted in CRBD with three replications during *rabi* 2011-12. Each inbred representing two rows of 2m length spaced 50 cm apart with 15 cm between hills. The field was given medium irrigation and precisely levelled before sowing. Thinning was performed after 15 days of germination when the plant height was 10-15cm, to ensure single plant per hill. The field was uniformly fertilized with recommended dose of 30kg Nitrogen, 20kg P_2O_5 and 20kg K_2O per hectare as basal *i.e.,* just before seeding and 30kg Nitrogen per hectare at 35 days after seeding. The field was irrigated with drip irrigation once at the time of 35 DAS while applying 2^{nd} split dose of nitrogen fertilizer and once in every 3 to 4 days interval continuously throughout all the critical crop growth stages *viz.,* seedling establishment, panicle initiation stage, flowering stage, grain formation stage and grain hardening stage. Standard cultural and agronomic practices were adopted to get good crop growth. Harvesting was made during the month of April 2012 and manual threshing was attended on single plant basis.

Field measurements: Data were recorded for all the inbreds in the experiment on the following thirteen different quantitative morphological and yield parameters *viz.,* 1. Number of Days taken for germination, 2. Days to 50% flowering, 3. Plant Height (cm), 4. Total number of productive tillers / plant, 5. Panicle length (cm), 6. Panicle girth (cm), 7. Leaf width (cm), 8. Test weight (g), 9. Main tiller panicle weight (g), 10. Grain yield of main tiller panicle (g), 11. Fodder yield per plant (g), 12. Weight of total panicles per plant (g) and 13. Grain yield per plant (g). Five random plants excluding boarder plants were selected for recording data in each plot except for days to 50% flowering, which is recorded on whole plot basis.

Statistical analysis: The recorded data was analysed using WINDOWSTAT software of WINDOWS VISTA version. Analysis of variance (ANOVA) was performed as described by Singh and Chowdary (1985). The variability parameters, genotypic and phenotypic coefficient of variation (GCV and PCV) were worked out following Burton (1952). The method suggested by Lush (1940) was adopted to work out the estimates of broad sense heritability. The expected genetic advance was calculated as suggested by Johnson *et al.,* (1955).

RESULTS AND DISCUSSION

In the present investigation analysis of variance (ANOVA) were carried out to partition the variances in to its components. The results of ANOVA revealed that highly significant differences exists among the inbred lines studied for all the traits indicating adequate genetic variability is present among the inbred lines studied except for one character *i.e.*, number of days taken for germination (Table-1). *Per se* performances of all the inbreds for all the characters were presented in Table-2. The variance component derived from further partitioning of genotypic differences in to phenotypic, genotypic and environmental coefficient of variation and heritability are a good index of transmission of characters from parents to their offspring's (Falconer, 1960). The estimates of heritability along with expected genetic advance are more useful in predicting resultant effects on selecting the best individuals. The different estimates of variability *viz*., variances (phenotypic and genotypic), range, coefficient of variances (PCV, GCV), heritability in broad sense and genetic advance as per cent of mean were estimated for all thirteen characters studied and are presented in Table-3. For potential genetic variability, the maximum range of variability was observed for the

Table 1. Analysis of variance of different characters in different Maintainer lines of pearl millet evaluated during rabi-2011-12 at ARS, Ananthapuram.

S.No	Character	Treatments Mean Sum of Squares	Error Mean Sum of Squares	CV at 5%	CD at 5%
1	No. of days taken for germination	0.49	0.00	0.00	—-
2	Days to 50% Flowering	55.16**	2.60	2.72	2.61
3	Plant Height (cm)	7.4.09**	90.85	9.52	15.48
4	Total No. of Productive tillers / plant	22.58**	6.39	32.41	4.10
5	Panicle Length (cm)	99.87**	3.03	9.97	2.83
6	Panicle Girth (cm)	5.72**	1.22	14.45	1.80
7	Leaf Width (cm)	1.45**	0.15	14.79	0.64
8	Test Weight (g)	18.21**	0.75	8.95	1.40
9	Main tiller panicle weight (g)	107.88**	1.21	7.58	1.79
10	Grain yield / Main tiller panicle (g)	63.40**	0.90	8.87	1.54
11	Fodder yield / Plant (g)	9698.00**	972.64	25.12	50.65
12	Weight of total panicles /	1135.53**	182.15	28.26	21.92
13	Plant (g)	596.298**	133.55	33.40	18.77
	Grain yield / plant (g)				

** Significant at P = 0.01 level

character fodder yield per plant (57.0 – 246.6) followed by weight of total panicles per plant (18.0 – 97.3) and grain yield per plant (12.5 – 67.5) with four to five fold difference. Apart from these characters, the trait plant height showed a wide range of variation with two fold difference in potential range (70.6 – 140.3), indicating the scope of genetic improvement of the genetic material studied through selection. The highest *per se* values for these characters among the forty two inbred lines studied were recorded by the inbred line 81 B for fodder yield per plant (246.6 g), ICMB 91444 for weight of total panicles per plant (97.5 g) and grain yield per plant (67.5 g) followed by six best inbred lines *viz.,* ICMB 92111, ICMB 96666, ICMB 97111, ICMB 01888, ICMB 04111 and ICMB 04777 with more than 50g grain yield per plant.

Coefficient of variation: The phenotypic coefficient of variation (PCV) was in general higher than the genotypic coefficient of variation (GCV) for all the characters under study except for one character *i.e.*, number of days taken for germination in which there is no difference was observed between PCV and GCV, indicating that, there is no role of environment in the expression of this character. High range of PCV and GCV was observed in the character fodder yield per plant (50.183 & 43.442) followed by grain yield per plant (49.032 & 35.896), weight of total panicles per plant (46.822 & 37.330) and total number of productive tillers per plant (44.016 & 29.778), indicating that there is quite high amount of environmental role in the expression of these characters. Whereas the characters grain yield per single panicle (43.564 & 42.650) and single panicle weight (41.729 & 41.033) showed high range of PCV and GCV but with very little difference between the two estimates, indicating that, the environment had little role in the expression of these characters. Similar results were reported by Gupta and Dhillon (1974), Bhamre and Harinarayana (1992), Vetriventhan and Nirmalakumari (2007), Sumathi *et al*., (2010) and Govindaraj *et al*., (2010). The characters panicle length (34.028 & 32.532) leaf width (28.688 & 24.576), panicle girth (21.52 & 15.953) and plant height (17.175 & 14.291) had expressed moderate PCV and GCV values. However, the lower values of PCV and GCV were observed in the characters

Table 2. *Per se* performance of different Maintainer lines of pearl millet for different characters evaluated during rabi-2011-12 at ARS, Ananthapuram.

S.No	Name of the Germplasm	No. of days taken for germination	Days to 50% Flowering	Plant Height (cm)	Total No. of Productive tillers / plant	Panicle Length (cm)	Panicle Girth (cm)	Leaf Width (cm)	Test Weight (g)	Main tiller panicle weight (g)	Grain yield / Main tiller panicle (g)	Fodder yield / Plant (g)	Weight of total panicles / Plant (g)	Grain yield / plant (g)
1	81 B	4	68.3	88.6	13.0	24.3	7.6	3.3	7.0	15.0	9.0	246.6	94.0	56.6
2	841B	5	62.6	103.3	5.3	15.0	6.6	2.6	8.0	10.8	8.0	88.3	37.0	26.4
3	842B	4	55.3	110.3	8.6	16.3	7.1	3.1	10.0	16.0	11.0	102.3	35.3	23.5
4	863B	5	57.3	117.3	6.0	16.1	9.1	3.1	11.0	19.0	13.5	200.3	61.0	41.7
5	ICMB88004	5	56.6	100.0	9.6	10.3	9.1	1.6	11.0	13.0	11.0	89.3	31.6	26.7
6	ICMB89111	5	58.3	106.6	10.0	12.5	6.0	2.1	12.0	15.0	12.0	131.6	42.6	34.1
7	ICMB91444	5	58.6	112.6	5.6	26.0	5.8	3.5	13.0	18.0	12.5	236.6	97.3	67.5
8	ICMB91666	5	70.3	92.3	8.3	19.0	6.5	3.3	11.0	26.0	17.0	124.3	45.0	29.4
9	ICMB91777	5	56.6	111.6	5.6	17.8	6.0	3.5	10.0	18.0	13.0	178.6	51.6	39.7
10	ICMB92111	5	56.3	103.0	11.0	16.0	4.8	2.1	11.0	10.0	8.0	220.3	63.0	50.4
11	ICMB93222	5	62.6	123.6	5.0	16.6	7.8	2.1	10.0	10.0	8.0	134.0	41.0	32.8
12	ICMB93333	5	58.6	140.3	6.3	17.5	7.1	3.1	15.0	37.0	30.0	232.0	49.6	40.2
13	ICMB94444	5	59.0	116.6	4.3	13.6	7.6	2.1	9.0	11.0	10.0	146.0	54.6	47.2
14	ICMB95222	5	55.3	112.3	10.3	14.1	5.6	2.1	7.0	11.0	5.5	59.3	25.0	12.5
15	ICMB96333	5	64.6	77.0	12.0	15.0	8.6	2.1	12.0	11.0	9.0	66.6	47.3	38.7
16	ICMB96666	5	58.3	94.3	7.3	15.3	9.0	3.0	13.0	20.0	17.0	167.3	74.0	62.9
17	ICMB97111	5	53.0	113.0	7.0	14.3	8.0	2.1	7.0	10.5	8.5	147.3	68.0	51.8
18	ICMB97333	5	55.3	101.6	11.3	14.3	6.0	2.0	14.0	11.0	10.0	158.0	46.0	40.5
19	ICMB97444	5	57.6	70.6	7.6	12.3	6.6	2.0	12.0	7.0	6.5	77.0	34.3	30.0
20	ICMB98222	5	50.0	100.0	3.6	11.0	8.0	3.0	9.0	12.5	12.0	58.6	24.6	21.7
21	ICMB98777	5	57.0	115.0	10.6	12.6	6.6	2.5	6.0	13.0	11.0	188.3	58.3	49.3
22	ICMB99555	6	56.6	76.3	6.0	13.3	10.0	3.3	9.0	17.0	10.0	92.0	38.3	22.5

Table 2 cont..........

S.No	Name of the Germplasm	No. of days taken for germination	Days to 50% Flowering	Plant Height (cm)	Total No. of Productive tillers / plant	Panicle Length (cm)	Panicle Girth (cm)	Leaf Width (cm)	Test Weight (g)	Main tiller panicle weight (g)	Grain yield / Main tiller panicle (g)	Fodder yield / Plant (g)	Weight of total panicles / Plant (g)	Grain yield / plant (g)
23	ICMB99666	5	56.0	89.6	7.3	15.0	8.6	2.5	6.0	12.0	9.0	69.3	20.6	15.5
24	ICMB00999	5	64.0	108.0	11.6	18.0	8.0	2.8	6.0	7.5	6.5	210.0	18.0	14.4
25	ICMB01555	5	62.6	82.3	9.3	13.6	8.0	2.5	13.0	11.0	10.0	65.6	33.0	27.0
26	ICMB01888	5	62.3	107.0	4.6	23.6	9.3	2.6	16.0	18.5	12.0	104.3	79.3	51.4
27	ICMB02333	5	56.3	118.3	4.0	16.0	9.6	2.8	9.0	20.5	17.0	108.0	44.0	36.5
28	ICMB02444	5	57.0	97.6	9.0	16.0	8.6	2.5	10.0	15.0	10.0	79.6	39.0	26.0
29	ICMB03666	5	58.3	75.6	10.0	11.0	7.0	2.0	8.0	9.5	7.0	96.6	35.0	25.7
30	ICMB03777	5	54.6	93.0	13.0	16.3	8.0	2.1	8.0	7.0	4.5	119.0	40.3	23.0
31	ICMB04111	5	62.3	73.0	5.3	24.6	6.3	4.0	9.0	10.5	6.0	208.0	89.0	50.8
32	ICMB04333	5	56.0	83.6	10.0	20.6	6.0	2.3	7.0	12.0	6.5	78.6	48.0	25.9
33	ICMB04777	5	63.6	95.6	4.6	33.3	9.5	4.5	9.0	26.0	19.0	188.0	70.3	51.4
34	ICMB05222	6	56.3	90.3	4.0	20.3	10.6	3.5	8.0	15.0	10.0	86.0	53.0	35.3
35	ICMB05888	5	65.0	99.0	2.3	35.3	7.5	3.5	8.0	25.0	16.5	64.6	39.6	25.4
36	ICMB06333	6	58.0	84.3	9.6	12.0	6.0	2.1	7.0	11.0	9.0	67.0	23.6	19.4
37	ICMB06555	5	57.6	111.3	6.3	16.3	8.3	2.5	8.0	14.0	12.0	79.0	55.0	47.1
38	ICMB06777	5	56.6	86.3	9.3	12.6	8.6	2.0	11.0	15.5	10.5	85.6	30.0	20.5
39	ICMB07111	6	56.6	108.0	10.3	18.6	8.0	2.0	10.0	10.0	5.3	109.6	36.0	18.0
40	ICMB08888	6	59.3	105.6	7.0	31.0	9.6	4.0	10.0	8.5	7.0	111.0	56.3	46.1
41	ICMB09888	5	62.0	116.6	7.3	19.0	6.3	1.8	7.0	11.0	7.5	81.3	53.3	33.9
42	ICMB96444	5	68.0	89.3	7.3	16.0	7.5	1.5	10.0	19.0	11.6	57.0	21.6	12.5

days to 50% flowering (7.588 & 7.081). The overall range of PCV (7.588 to 50.183) and GCV (7.081 to 43.442) were found between days to 50% flowering and fodder yield per plant.

Heritability (h^2) in broad sense and Genetic advance as per cent of mean: Estimates of GCV and PCV alone do not assess the amount of heritable variation. GCV computed in conjunction with heritability estimates would provide a better indication for selection on the phenotypic performance (Burton, 1952). Heritability in conjunction with genetic advance would give a more reliable index of selection value (Johnson *et al*., 1955). The heritability and genetic advance estimates were interpreted as low, medium and high as per classification of Johnson *et* al., (1955). In this study, broad sense heritability ranged from 45.8% (total number of productive tillers per plant) to 100% (number days taken for germination). While genetic advance as *per cent* of mean (more than 50%) was observed for single panicle weight (96.7% & 83.119%) followed by grain yield per single panicle (95.8% & 86.01%) and panicle length (91.4% & 64.070%). This situation indicates that the genetic variances for these traits are probably owing to their additive gene effects (Johnson *et al*., 1955) and thus there is better scope for improvement of these traits through direct selection. High heritability combined with moderate genetic advance (20 – 50%) as *per cent* of mean was noted for test weight (88.6% & 48.268%). The characters fodder yield per plant (74.9% & 77.469%), weight of total panicles per plant (63.6% & 61.311%) and grain yield per plant (53.6% & 54.135%) recorded moderate heritability (50 – 85%) combined with high values of genetic advance as *per cent* of mean. Whereas the characters leaf width (73.4% & 43.369%), plant height (69.2% & 24.494%) and

Table 3. Estimates of variability parameters of different characters in different Maintainer lines of pearl millet evaluated during rabi- 2011-12 at ARS, Ananthapuram.

S.No	Character	General Mean	Range	Genotypic Coefficient of Variation (GCV)	Phenotypic Coefficient of Variation (PCV)	Heritability (h^2)	Genetic Advance as % of Mean
1	No. of days taken for germination	5.0714	4.0 – 6.0	8.022	8.022	100	16.525
2	Days to 50% Flowering	59.1191	50.0 – 68.3	7.081	7.588	87.1	13.611
3	Plant Height (cm)	100.0476	70.6 – 140.3	14.291	17.175	69.2	24.494
4	Total No. of Productive tillers / plant	7.8016	2.3 – 13.0	29.778	44.016	45.8	41.501
5	Panicle Length (cm)	17.4643	10.3 – 35.3	32.532	34.028	91.4	64.070
6	Panicle Girth (cm)	7.6706	4.8 – 10.6	15.953	21.527	54.9	24.353
7	Leaf Width (cm)	2.6722	1.5- - 4.5	24.576	28.688	73.4	43.369
8	Test Weight (g)	9.6905	6.0 – 16.0	24.899	26.459	88.6	48.268
9	Main tiller panicle weight (g)	14.5318	7.0 – 37.0	41.033	41.729	96.7	83.119
10	Grain yield / Main tiller panicle (g)	10.7024	4.5 – 30.0	42.650	43.564	95.8	86.016
11	Fodder yield / Plant (g)	124.1429	57.0 – 246.6	43.442	50.183	74.9	77.469
12	Weight of total panicles /	47.7546	18.0 – 97.3	37.330	46.822	63.6	61.311
13	Plant (g)	34.5992	12.5 – 67.5	35.896	49.032	53.6	54.135
	Grain yield / plant (g)						

panicle girth (54.9% & 24.353%) expressed moderate heritability (50 – 85%), suggesting that the careful and restricted selection will be effective for the improvement of this character. High heritability in combination with low genetic advance as *per cent* of mean was recorded for number of days taken for germination (100% & 16.525%) and days to 50% flowering (87.1% & 13.611%). While total number of productive tillers per plant had expressed low heritability (less than 50%) along with moderate estimates of gentic advance as per cent of mean (45.8% & 41.501%), indicating the predominant role of non-additive gene action and environment plays major role in governing the character and improvement of this character is complicated and it might be possible through heterosis breeding. Similar type of observations were recorded by Ghorpade and Metta (1993), Saraswathi *et al*., (1995), Yogendra Sharma (2002), Vetriventhan and Nirmalakumari (2007), Bhoite *et al*., (2008), Meenakumari and Nagarajan (2008), Sumathi *et al*., (2010) and Govindaraj *et al*., (2010).

In conclusion, studies on variability, heritability and genetic advance as per cent of mean emphasised the need for selection based on the plant type having greater values for single panicle weight, grain yield per single panicle, fodder yield per plant, weight of total panicles per plant and grain yield per plant. Among forty two maintainer inbred lines evaluated, based on the *per se* performance the inbred lines namely; 81 B, ICMB 91444, ICMB 92111, ICMB 96666, ICMB 97111, ICMB 01888, ICMB 04111 and ICMB 04777 were identified as best lines for these characters.

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