

GENETIC STUDIES ON HERITABILITY AND GENETIC ADVANCE FOR DROUGHT TOLERANCE IN PEARL MILLET GERMPLASM

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Abstract: The present study aims to reveal the importance of quantitative traits and genetic variability existing in the 76 pearl millet germplasm accessions. The coefficient of variation at phenotypic and genotypic levels were high for root dry weight followed by green fodder yield per plant, root volume, dry fodder yield per plant, grain yield per plant, ear bearing tillers per hill, green fodder yield per plot, dry fodder yield per plot, grain yield per plot, relative injury, leaf area duration, number of grains per ear head, ear head length and plant height and moderate for test weight, harvest index, ear head girth and root spread while the traits, specific leaf area followed by chlorophyll stability index, days to 50% flowering SCMR, leaf temperature and days to maturity showed low PCV and GCV. From the results, high heritability coupled with high genetic advance observed for relative injury, dry fodder yield per plot, ear bearing tillers per hill, dry fodder yield per plant, root volume, grain yield per plant, leaf area duration, root dry weight, green fodder yield per plot, green fodder yield per plant, number of grains per ear head, ear head length, plant height, test weight and grain yield per plot which indicates the preponderance of additive gene effects in controlling these traits, early and simple selection could be exercised due to fixable additive gene effects.

Keywords: Drought, Pearl Millet, Variability, Heritability, Genetic Advance

INTRODUCTION

Pearl millet (*Pennisetum glaucum* L.), $2n=14$, is an outstanding crop being grown in arid and semi-arid regions of the world with the rainfall ranging from 150-700 mm including West Africa, India and Pakistan. India is a major pearl millet producing country with 43.3 per cent of the world area and 42 per cent of world production. It is the warm season cereal crop predominantly grown as a staple food grain and source of feed and fodder under moisture limiting environments. It ranks first under the category of millets in India, in terms of area, production and productivity. India has the largest area of 8.39 million hectares with a production of 9.15 million tones and productivity of 1091 kg ha^{-1} (www.agropedia.com, 2012). Though, it is a drought tolerant crop, it faces moisture stress very often. Hence, breeding for drought tolerance forms an integral part of pearl millet breeding. An understanding of the architecture of the variability and inheritance of target characters is useful for developing effective breeding strategies. The foremost important consideration in any crop breeding programme for its improvement is the detailed study on genetic variability. Knowledge on the nature and magnitude of genotypic and phenotypic variability for yield and yield attributing traits present in any crop species and their heritability, play a vital role in successful selection for evolving superior cultivars. Therefore, an attempt

has been made to study the heritability and genetic advance in the present study.

MATERIAL AND METHOD

The genetic material for the present study comprised of 76 advance breeding lines, which were selected and obtained from International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Patancheru, and Hyderabad. The crop was raised under complete rainfed condition in a randomized block design with two replications during *kharif*, 2012 at Agricultural Research Station, Perumallapalle, Tirupati. All the bajra genotypes were sown initially in the nursery and 3 week old seedlings were transplanted to the main field with a spacing of 45 cm between the rows and 15 cm between plants within a row. Each genotype was planted in 2 rows of 3 m length consisting of 20 plants. Recommended agronomic and cultural measures were followed to raise a good crop. The observations were recorded on five randomly chosen competitive plants in each genotype in each replication for all the 24 characters, except days to 50% flowering and days to maturity. The latter two characters were recorded on per plot basis. The values of five competitive plants were averaged and expressed as a mean of the respective characters. The data were subjected to statistical analysis to estimate Phenotypic and genotypic variances (Lush, 1940), PCV and GCV (Burton, 1952), heritability in broad

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sense (Hanson *et al.*, 1956a) and genetic advance (Johnson *et al.*, 1955).

RESULT AND DISCUSSION

The analysis of variance revealed highly significant differences among the genotypes for all 24 characters indicating presence of considerable variation in the breeding material under rainfed conditions. The estimates of genetic parameters are presented in Table 1.

Coefficients of Variation

In the present study, the estimates of PCV for all the characters were little higher than the estimates of GCV, which may be due to the interaction of genotypes with the environment. The highest estimate of coefficient of variation was registered for root dry weight followed by green fodder yield per plant, root volume, dry fodder yield per plant, grain yield per plant, ear bearing tillers per hill, green fodder yield per plot, dry fodder yield per plot, grain yield per plot, relative injury, leaf area duration, number of grains per ear head, Ear head length and plant height indicating greater scope of selection for improvement of these characters. Similar results of high estimates of variability were reported by earlier workers for plant height (Lakshmana *et al.*, 2009; Govindaraj *et al.*, 2010; Musa Ishag Mohamed Subi and Atif Elsadig Idris, 2013), ear bearing tillers per hill (Lakshmana *et al.*, 2009), ear head length (Lakshmana *et al.*, 2009; Musa Ishag Mohamed Subi and Atif Elsadig Idris, 2013), number of grains per ear head (Musa Ishag Mohamed Subi and Atif Elsadig Idris, 2013), grain yield per plant (Vidyadhar *et al.*, 2007; Meena Kumari *et al.*, 2008; Lakshmana *et al.*, 2009; Govindaraj *et al.*, 2010), grain yield per plot (Muhammad Hussain Chaudary *et al.*, 2003), green fodder yield (Shanmuganathan *et al.*, 2006) and dry fodder yield (Vidyadhar *et al.*, 2007; Veena Priya *et al.*, 2010) and corroborates the findings of the present study.

Moderate estimates of coefficients of variation were observed for test weight followed by harvest index (%), ear head girth and root spread. These findings were in concurrence with earlier reports for harvest index. On contrary, low PCV and GCV values were recorded for specific leaf area followed by chlorophyll stability index, days to 50% flowering, SCMR, leaf temperature and days to maturity.

Similar kind of low estimates of variability was reported earlier by Sumathi *et al.* (2010) for days to 50% flowering.

Heritability and Genetic Advance

The heritability and genetic advance estimates were interpreted as low, medium and high as per the classification of Johnson *et al.* (1955). Broad sense heritability ranged from 19.99 (chlorophyll stability index) to 96.91 (relative injury) per cent. In general, high heritability estimates in broad sense were registered for almost all the characters under the study except for root spread (22.63%) and chlorophyll stability index (19.99%) which showed low heritability. High heritability coupled with high genetic advance as a per cent of mean were recorded for relative injury, dry fodder yield per plot, ear bearing tillers per hill, dry fodder yield per plant, root volume, grain yield per plant, leaf area duration, root dry weight, green fodder yield per plot, green fodder yield per plant, number of grains per ear head, ear head length, plant height, test weight and grain yield per plot which indicated the inheritance of additive gene effects in the genetic control of these traits. Hence, simple selection can be practiced to improve these traits. This was in conformity with the findings of Govindaraj *et al.* (2011) for ear bearing tillers per hill and Sumathi *et al.* (2010) for ear head length. Further, Meena Kumari *et al.* (2008), Govindaraj *et al.* (2010) and Sumathi *et al.* (2010) revealed high estimate of heritability for grain yield per plant.

The knowledge on heritability of traits is helpful to decide the selection procedure to be followed to improve the trait in a situation. High heritability recorded in a trait indicates the low influence of environment on expression of the trait. Therefore, for improving these traits the selection will be more effective in early generation on the basis of *per se* performance of these traits. These traits may be improved by mass or progeny selection. High heritability recorded for grain yield per plant suggested that direct selection based on grain yield *per se* could be effective for its genetic improvement. High heritability coupled with moderate genetic advance as per cent of mean was recorded for days to 50 per cent flowering, test weight, SPAD chlorophyll reading and specific leaf area. These are more likely to be controlled by both additive and non-additive gene effects. Hence, recurrent selection could be more effective to improve these traits.

Table 1. Mean, coefficients of variation, heritability (broad sense) and genetic advance as per cent of mean for twenty four characters in 76 Pearl millet genotypes

Sl. No.	Character	Mean	Range		Variance		Coefficient of Variation		Heritability (Broad sense) (%)	Genetic advance (GA)	Genetic Advance as per cent of mean (%)
			Max.	Min.	Genotypic	Phenotypic	Genotypic	Phenotypic			
1.	Days to 50% flowering	64.08	77.50	51.00	24.02	28.43	7.65	8.32	84.49	9.28	14.48
2.	Days to maturity	98.98	104.50	92.50	4.07	7.92	2.04	2.84	51.43	2.98	3.01
3.	Plant height (cm)	149.96	205.65	65.23	691.24	952.50	17.53	20.58	72.57	46.14	30.77
4.	Ear bearing tillers per hill	1.83	4.20	0.65	0.57	0.61	41.29	42.73	93.38	1.50	82.19
5.	Ear head length (cm)	27.75	42.00	15.88	31.90	42.22	20.35	23.42	75.55	10.11	36.44
6.	Ear head girth (cm)	2.78	3.54	2.04	0.07	0.12	9.38	12.40	57.18	0.41	14.61
7.	Test weight (g)	10.91	14.50	5.18	2.64	3.59	14.90	17.35	73.70	2.88	26.35
8.	Number of grains per ear head	2852.15	4524.50	810.35	582152.20	724686.40	26.75	29.85	80.33	1408.73	49.39
9.	Grain yield per plant (g)	298.04	650.75	92.55	208799.80	248875.40	35.02	37.90	85.38	198.66	66.66
10.	Green fodder yield per plant (g)	1127.37	2377.50	335.00	11686.67	12652.29	40.53	44.25	83.90	862.20	76.48
11.	Dry fodder yield per plant (g)	260.71	591.50	84.90	0.56	0.85	41.47	43.15	92.37	214.03	82.10
12.	Grain yield per plot (t/ha)	2.93	0.97	5.60	3.11	3.62	25.44	31.51	65.16	1.24	42.30
13.	Green fodder yield per plot (t/ha)	5.12	3.63	7.90	0.86	0.90	34.42	37.17	85.77	3.36	65.67
14.	Dry fodder yield per plot (t/ha)	2.57	1.71	3.04	22.78	58.70	36.21	36.94	96.05	1.88	73.10
15.	Harvest index (%)	53.39	64.48	39.49	0.48	1.47	8.94	14.35	38.81	6.12	11.47
16.	Leaf temperature ($^{\circ}$ C)	31.27	33.67	29.50	17.59	18.27	2.21	3.88	32.43	0.81	2.59
17.	SCMR	56.87	67.25	48.10	132.05	193.96	7.37	7.52	96.25	8.48	14.90
18.	Specific leaf area (cm^2g^{-1})	153.87	211.30	128.43	45.16	46.60	7.47	9.05	68.08	19.53	12.69
19.	Relative Injury	19.99	42.62	9.66	11.18	55.91	33.61	34.14	96.91	13.63	68.15
20.	Chlorophyll Stability Index	76.18	88.89	63.42	4.79	5.27	4.39	9.82	19.99	3.08	4.04
21.	Leaf area duration ($\text{cm}^2\text{day}^{-1}$)	7.53	12.46	2.55	3.58	15.81	29.05	30.50	90.76	4.29	57.02
22.	Root spread (cm)	30.67	39.45	23.84	40.03	45.04	6.17	12.96	22.63	1.85	6.04
23.	Root dry weight (g)	14.86	34.68	3.97	190.51	210.89	42.56	45.15	88.88	12.29	82.66
24.	Root volume (ml)	33.03	72.50	11.50	10892.90	12758.25	41.79	43.97	90.34	27.02	81.83

CONCLUSIONS

Based on results of this study, it could be concluded that there was considerable amount of variability present in the genotypes. To sum up, higher GCV, heritability and genetic advance as per cent of mean were observed for root dry weight, root volume, dry fodder yield per plant, green fodder yield per plot, relative injury, leaf area duration, number of grains/ear head, grain yield per plot and ear head length indicating that simple directional selection could be effective for improving these traits as additive gene effects were predominantly inherent in these traits. Conversely, low estimates of GCV, heritability and genetic advance as per cent of mean were registered for root spread, chlorophyll stability index and leaf temperature indicating little scope of improvement of these traits by selection as they are governed by the non-additive gene effects.

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