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Exploring Genetic Variability and Assessment of Genetic Parameters for Grain yield, Morpho-physiological, Nutritional Traits in Pearl Millet (*Pennisetum glaucum* (L.) R. Br.)

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ABSTRACT: Seventy genotypes which includes fifty hybrids and fifteen parents along with five checks of pearl millet were studied for fifteen economically important characters to estimate variability, heritability (broad sense) and genetic advance. This study was aimed to realize the magnitude of variability among hybrids developed through crossing between inbreed lines and along with highly adaptable checks diverse origin and also to forecast the pearl millet biofortification prospects for essential micronutrients. Higher Phenotypic coefficient of variation (PCV) was observed than genotypic coefficient of variation (GCV) for all the characters under study suggesting the role of environment in the expression of these characters. High amount of genotypic coefficient of variation (GCV) for Grain yield, green fodder yield, dry fodder yield and harvest index also moderate estimates of GCV were observed for number of productive tillers per plant, plant height, panicle length, 1000 grain weight, relative water content, Grain Fe content (ppm), Grain Zn content (ppm). High broad sense heritability was noticed for all the traits advised that these traits would respond to selection due to presence of high genetic variability and transmissibility. Maximum GAM coupled with high heritability was noted for number of productive tillers plant^{-1}, plant height, panicle length (cm), panicle girth (cm), 1000 grain weight (g), grain yield plot^{-1} (kg ha^{-1}), green fodder yield plot^{-1} (kg ha^{-1}), dry fodder yield plot^{-1} (kg ha^{-1}), relative water content (%), harvest index (%), grain Fe content (ppm) and grain Zn content (ppm) indicating these traits administered by additive gene action.

Keywords: Variability, heritability, genetic advance, yield, Pearl millet.

INTRODUCTION

Pearl millet (*Pennisetum glaucum* [L.] R. Br.) is the world's sixth essential and widely grown prospective staple food cereal crop. It is catering nutritionally excellent primary food for people living in rural area as well as fodder for livestock in many regions of India and world. The crop is generally grown in area where environmental conditions, especially rainfall, temperature and soil fertility, are too harsh to grow other cereal crops. In India, it is cultivated in a total area of 7.50 million hectares with a production of 9.8 million tonnes and productivity of 1245 kg/ha (Anonymous, 2019a). It is majorly grown in states like Rajasthan, Uttar Pradesh, Gujarat, Haryana, Maharashtra, Karnataka and Andhra Pradesh. In Andhra Pradesh, pearl millet crop is grown in an area of 0.048 million hectares with a production and productivity of 0.093 million tonnes and 1714 kg/ha, respectively (Anonymous, 2018b). One of the causes ascribed to the less productivity and production of pearl millet is the lower ability of the available varieties. It has also been noticed that lack of variability is another main aspect for the poor improvement made in breeding programmes with respect to grain yield and nutritional parameters. The contribution of pearl millet to the total Fe and Zn intake from all food sources has been reported to very widely vary across rural India. For instance, it was observed to be contributing 19-63% of the total Fe intake and 16-56% of the total Zn intake in parts of Rajasthan, Maharashtra and Gujarat states (Parthasarathy Rao *et al.,* 2006). Large genetic variability for Fe and Zn density observed in the breeding lines, improved populations and germplasm (Velu *et al.,* 2007, Rai *et al.*, 2012) provides for good prospects to breed improved pearl millet cultivars with elevated levels of these micronutrients. Africa covering an area of more than 29 where micronutrient deficiencies are particularly concentrated (Shukla *et al*., 2014). It has high protein content with balanced amino acids, carbohydrates and fat. It is also rich in many micronutrients such as calcium, iron and zinc and is free from anti nutritional compounds like tannins (Malhotra and Dhindsa, 1984).

It is a allogamous crop because of the protogynous nature of its hermaphrodite flowers. It believed that the center of origin of Pearl millet is West Africa particularly from northern–central Sahel region and from there introduced in India (Oumar *et al*., 2008). Use of hybrids in pearl millet has saved a way of great success since the inception of idea using hybrids as commercial varieties, particularly in field-crops (Tripp and Pal 1998). In India started to produce pearl millet hybrids as early as 1951 (Rao *et al*., 1951) and commercialized to farmers in year 1965 using cytoplasmic male sterile line Tift 23A (Yadav and Rai 2013). The variability in plant population is the first requirement for crop improvement Programme. The amount of variability in the germplasm or hybrids of any crops set the limits of progress that can achieve through selection (Sanadya *et al*., 2018).

Many efforts put together to judge the extent of variability in pearl millet with respect to grain yield and nutritional parameters. However, the assessment of variation made on truly diverse germplasm gives an idea of the range of variation which would support in evaluating the variability and elements for limited developments made in pearl millet. The imperative factor for bringing yield enhancement is to pick up the genotypes with high variability.

Genetic variability is important for characters in choosing the desirable genotypes. Genetic parameters such as genotypic coefficient of variation (GCV) and Phenotypic coefficient of variation (PCV) are helpful in encounter the magnitude of variability present in the germplasm. Heritability in aggregate with high genetic advance would be greater helpful in estimating the resultant effect in selection of the best genotypes for yield and its attributing characters. The current experiment was laid out comprising of fifty hybrids and fifteen parents along with five checks of pearl millet to determine the genetic variability and heritability for Grain yield, Morpho-physiological and Nutritional traits.

MATERIALS AND METHODS

This trial was conducted with seventy genotypes of pearl millet consisting of 50 hybrids, 5 A-lines, 10 R-lines and 5 checks during *kharif,* 2020 at ARS, Podalakur in RBD replicated thrice. Every genotype was sown in one row of four meters length with 45 × 15 cm spacing. All management practices were followed as and when required to establish a good crop.

Observations were recorded on 15 economically important characters viz., Number of productive tillers plant^{-1}, Plant height (cm), Panicle length (cm), Panicle girth (cm), 1000 grain weight (g), Grain yield plot^{-1} (kg ha^{-1}), Green fodder yield plot^{-1} (kg ha^{-1}), Dry fodder yield plot^{-1} (kg ha^{-1}), Days to 50% flowering, Days to maturity, SPAD chlorophyll meter readings (60 DAS), Relative water content (%), Harvest index (%), Grain Fe content (ppm), Grain Zn content (ppm).

Data from all the characters studied were exposed to analysis of variance technique on the basis of model proposed by Panse and Sukhatme (1961). The genotypic and phenotypic coefficients of variability were calculated as per the formulae proposed by Burton and Devane (1952). Heritability in broad sense and genetic advance were estimated using the formula given by Lush (1940); Johnson *et al.,* (1955) respectively.

The analysis of variance (ANOVA) method, as described by Singh and Chowdary (1985), was used. Burton's method was used to calculate the variability parameters, genotypic and phenotypic coefficients of variation (GCV and PCV). PCV and GCV (Robinson *et al.,* 1949) and GA and GAM (Johnson *et al.,* 1955) were classified into three groups: low (0-10%), moderate (10.1-20%) and high (>20%). Heritability was classified into three categories: low (0-30%), moderate (30.1-60%) and high (>60%).

RESULTS AND DISCUSSION

The analysis of variance revealed that genotypes of pearl millet differed significantly for all the traits studied suggesting presence of adequate variability among the genotypes (Table 1). The higher estimates of PCV than GCV were observed for all the characters under study (Table 2). The high estimates of GCV were realized for grain yield, green fodder yield, dry fodder yield and harvest index. The results are in conformity with grain yield by Narasimhulu *et al.,* (2021). The Moderate values of PCV and GCV noticed in the study for number of productive tillers per plant, plant height, panicle length, 1000 grain weight, relative water content, Grain Fe content (ppm) and Grain Zn content (ppm). The results are in accordance with Sathya *et al.,* (2014) for number of productive tillers and panicle length; Sowmiya *et al.,* (2016) for plant height; Sumathi & Revathi (2016) for 1000 grain weight.

The Low estimates of GCV and PCV were detected for Panicle girth (cm), Days to 50% flowering, Days to maturity and SPAD chlorophyll meter readings (60 DAS). The results are in similar with Sumathi *et al.,* (2010) for Panicle girth (cm) in pearl millet for Days to 50% flowering in finger millet.

The High heritability recorded for all the characters pointed out that there is least effect of environment on the trait expression. Thus, for enhancement of this trait expression simple selection will be more impressive in early generations on the basis of *per se* performance. High heritability for grain yield per plant advocates that straight selection based on grain yield alone would be impressive for bringing improvement.

Table 1: Analysis of variance for the characters studied.

Sr. No.	Character(s)	Mean sum of squares		
		Replications (df: 2)	Treatments (df: 69)	Error (df: 138)
1.	Number of productive tillers plant^{-1}	0.0005	0.42**	0.027
2.	Plant height (cm)	31.75	1301.75**	39.85
3.	Panicle length (cm)	2.83	30.01**	1.40
4.	Panicle girth (cm)	0.04	0.25**	0.02
5.	1000 grain weight (g)	0.51	7.93**	0.42
6.	Grain yield plot^{-1} (t ha^{-1})	0.06	1.65**	0.05
7.	Green fodder yield plot^{-1} (t ha^{-1})	21.78	93.33**	3.85
8.	Dry fodder yield plot^{-1} (t ha^{-1})	0.41	8.60**	0.58
9.	Days to 50% flowering	3.10	21.08**	1.60
10.	Days to maturity	4.08	26.92**	1.78
11.	SPAD chlorophyll (60 DAS)	25.07	48.49**	2.10
12.	Relative water content (%)	28.87	237.69**	9.44
13.	Harvest index (%)	5.63	146.26**	12.73
14.	Grain Fe content (ppm)	2.83	278.80**	2.64
15.	Grain Zn content (ppm)	0.10	143.11**	1.21

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

Table 2: Estimates of genetic parameters for grain yield, morpho-physiological and nutritional traits in *kharif*.

Sr. No.	Character(s) (k)	Mean	Range		Variance		Coefficient of Variation		Heritability (Broad sense) (%)	Genetic advance (GA)	Genetic Advance as percent of mean (%)
			Min.	Max.	Genotypic	Phenotypic	Genotypic	Phenotypic			
1.	Number of productive tillers plant^{-1}	2.27	1.60	3.24	0.13	0.16	16.07	17.62	83.20	0.88	38.71
2.	Plant height (cm)	151.75	88.00	190.67	420.62	460.49	13.52	14.14	91.30	51.75	34.10
3.	Panicle length (cm)	23.95	16.91	31.71	9.54	10.94	12.89	13.81	87.10	7.61	31.77
4.	Panicle girth (cm)	2.94	2.08	3.52	0.08	0.10	9.41	10.59	78.90	0.65	22.05
5.	1000 grain weight (g)	12.02	8.73	15.97	2.51	2.93	13.17	14.24	85.60	3.87	32.15
6.	Grain yield plot^{-1} (t ha^{-1})	2.80	1.42	4.36	0.53	0.58	26.05	27.27	91.20	1.84	65.69
7.	Green fodder yield plot^{-1} (t ha^{-1})	19.74	8.58	31.25	29.83	33.68	27.66	29.40	88.50	13.57	68.72
8.	Dry fodder yield plot^{-1} (t ha^{-1})	5.88	2.42	10.49	2.67	3.26	27.79	30.69	82.00	3.91	66.43
9.	Days to 50% flowering	47.77	40.33	51.67	6.49	8.10	5.33	5.96	80.20	6.02	12.61
10.	Days to maturity	82.20	73.67	88.0	8.38	10.16	3.52	3.88	82.50	6.94	8.44
11.	SPAD chlorophyll meter readings (60 DAS)	53.87	45.37	62.17	15.47	17.56	7.30	7.78	88.00	9.74	18.08
12.	Relative water content (%)	77.30	56.00	88.33	76.08	85.53	11.28	11.96	89.00	21.72	28.10
13.	Harvest index (%)	32.92	21.63	51.73	44.51	57.24	20.27	22.98	77.80	15.53	47.18
14.	Grain Fe content (ppm)	69.73	49.00	86.61	92.06	94.70	13.76	13.96	97.20	24.97	35.82
15.	Grain Zn content (ppm)	42.54	28.00	55.0	47.30	48.52	16.17	16.38	97.50	17.93	42.14

High estimates of genetic advance as per cent mean for Number of productive tillers plant^{-1}, Plant height (cm), Panicle length (cm), Panicle girth (cm), 1000 grain weight (g), Grain yield plot^{-1} (kg ha^{-1}), Green fodder yield plot^{-1} (kg ha^{-1}), Dry fodder yield plot^{-1} (kg ha^{-1}), Relative water content (%), Harvest index (%), Grain Fe content (ppm) and Grain Zn content (ppm) and moderate estimates for the characters Days to 50% flowering and SPAD chlorophyll meter readings (60 DAS) observed in the study pointed out that greater influence of genetic causes in the trait inheritance. Simple selection would help to fix these traits. The low genetic advance as per cent mean noticed for Days to maturity indicated simple selection may not be effective.

In the current experiment high heritability in combination with high genetic advance as per cent of mean recorded Number of productive tillers plant^{-1}, Plant height (cm), Panicle length (cm), Panicle girth (cm), 1000 grain weight (g), Grain yield plot^{-1} (kgha^{-1}), Green fodder yield plot^{-1} (kg ha^{-1}), Dry fodder yield plot^{-1} (kg ha^{-1}), Relative water content (%), Harvest index (%), Grain Fe content (ppm) and Grain Zn content (ppm) advocated that additive gene action was involved in the genetic control of these traits. Thus, simple selection may be practiced to betterment of these traits. The results are in agreement with Number of productive tillers plant and Grain yield plot^{-1} (kg ha^{-1}) by Narasimhulu *et al.,* (2021); Panicle length (cm) and 1000 grain weight (g) by Yadav *et al.,* (2020); grain Fe content (ppm) and grain Zn content (ppm) by Chaudhary *et al.,* (2012).

The High heritability in combination with moderate genetic advance as per cent of mean recorded for Days to 50% flowering and SPAD chlorophyll meter readings (60 DAS) asuggests that these characters are controlled by both additive and non-additive gene action. High heritability along with low genetic advance observed for Days to maturity indicate the influence of non-additive gene action in the inheritance of these characters. In this case simple selection alone may not be effective and necessitates adoption of heterosis breeding programme. The same outcomes are in accordance with Days to 50% flowering by Narasimhulu *et al.,* (2020).

The perusal of results revealed that there is adequate genetic variability in the present material studied. High heritability combination with high genetic advance noticed for all the characters indicates that additive gene action is involved in the genetic control of these traits and these traits are less influenced by environment. Therefore, simple selection for these characters based on phenotypic values can be advocated for yield improvement in pearl millet. High heritability coupled with low genetic advance Days to maturity indicates the presence of non-additive gene action. Hence, simple selection may not be effective and hence this character enhancement could be done by intermating of selected superior genotypes through recombination breeding. The identified hybrids with high yield and enriched nutrients would be useful as the crucial genetic resources for developing biofortified and agronomically superior hybrids.

Authors' contributions. All authors contributed equally to the planning and execution of the research.

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Conflict of Interest. The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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