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Phenotypic diversity in Pearl Millet [*Pennisetum glaucum* (L.) R. Br.] germplasm lines

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Abstract
For effective trait selection, it is very important to have knowledge of association between traits and heritability. So, a study on phenotypic diversity in pearl millet [*Pennisetum glaucum* (L.) R. Br.] was intended in a set of 48 maintainer lines using 9 quantitative traits. Significant mean sum of squares indicated presence of sufficient variation in the lines. The GCV were slightly lower than PCV indicating the slight influence of environment on the expression of characters. Number of productive tillers/plant, plant height, 1000 grain weight, grain yield/plant had high heritability with high genetic advance as% of mean suggesting the prevalence of additive gene action in their inheritance which suggest that selection will be more effective based on these traits. Correlation coefficient analysis revealed that days to 50% flowering, spike length, number of productive tillers per plant, 1000 grain weight, dry and green fodder yield were significantly and positively correlated with grain yield per plant. The traits, days to 50% flowering, spike length, number of productive tillers/plant had high significant direct contribution towards grain yield/plant for which indirect selection can be made in future breeding programme to enhance grain yield.

Keywords: Phenotypic diversity**,** GCV, PCV, correlation coefficient, path analysis, pearl millet

Introduction
Pearl millet [*Pennisetum glaucum* (L.) R. Br.] is an annual multipurpose cereal belonging to the family Poaceae and commonly known as bajra. It is cross pollinated crop having chromosome number of 2n=2x =14, originated in West Africa. It is a highly nutritious cereal crop which can provide about 9.8g of protein per day with wide agro-ecological adaptation. Pearl millet protein have higher digestibility than sorghum because of prolamines which have high level of lysine and tryptophan [1]. Pearl millet had low water demand and grain yield can be improved under water-limited environments [2, 3]. Pearl millet provides multiple securities in terms of food, fodder, health, nutrition, livelihood and ecological making them the choice of crop in the arid and semi-arid regions of the world.

Besides its importance as food and feed crop, pearl millet is an ideal species for genetic studies because of its small diploid genome with large chromosome, abundant phenotypic and genotypic diversity. Genetic diversity is outcome of several component traits such as flowering, plant height, leaf length, leaf width, anther color, number of nodes, nodal pubescence, inter node pigmentation, nodal pigmentation, spike length, spikelet glume color, bristle length *etc*. Genetic variability studies provide basic information which is helpful to know about the nature and extent of variability which is useful in any crop improvement venture depends mainly on the magnitude of genetic variability and heritability present in the source material [4]. In heterosis breeding, understanding genetic relationship among parental lines is of paramount importance**.**

Any germplasm collection is of little value in crop improvement until it is evaluated and characterized. Characterization of pearl millet germplasm is imperative for categorization of germplasm and identification of the desirable genotypes for introgression into breeding programmes [5]. Most of the crop germplasm that has been collected is not being used because very little is known about it. Efficient and systematic exploitation of diversity is the key to any crop improvement program. Characterization of genotypes is useful to identify suitable lines and also to avoid duplication. Keeping these in view, present investigation was undertaken to study genetic variability, heritability, correlation coefficient and path analysis in pearl millet maintainer lines.

Materials and Methods

The present investigation was carried out by taking 48 genotypes of pearl millet in randomized block design with three replications raised at the farm area of Department of Genetics and Plant Breeding, CCSHAU, Hisar during *Kharif*, 2014. Each genotype was planted in a plot having size of one row of 4 m length with row to row spacing of 45 cm and plant to plant spacing of 10-12 cm. All recommended package of practices were adopted to raise a good crop. Observations were recorded on plot basis using five random plants per entry per replication at the designated stage for yield and its component traits *viz*., days to 50% flowering, spike length, spike girth, number of productive tillers/plant, plant height, 1000 grain weight, green fodder yield/plant, dry fodder yield/plant and grain yield/plant.

Statistical Analysis

Genotypic and phenotypic coefficients of variation were estimated by formula suggested by [6], heritability in broad sense was calculated according to the formula suggested by [7] the expected genetic advance was calculated at 5% selection intensity by the formula as suggested by [8] for each character. Both genotypic and phenotypic coefficients of correlation between two characters were determined by using the variance and covariance components as suggested by [9] and path coefficient analysis was carried out using genotypic correlation values of yield components on yield as suggested by [10] and further illustrated by [11].

Results and discussion

1. Genetic variability

Mean sum of squares were significant for all the characters studied. This indicated prevalence of enough genetic variability in the material. The mean, range, PCV, GCV, heritability and genetic advance as per cent of mean of different maintainer lines for different traits have been presented in Table 1. Large variation among maintainer lines were found for the traits like days to 50% flowering, spike length, number of productive tillers/plant, plant height, 1000 grain weight, dry fodder yield/plant, green fodder yield/plant and grain yield/plant in the present study. The results were in agreement with [12, 13].

The magnitude of PCV was higher than GCV indicating the little influence of environment on a trait [12, 14-16]. High heritability along with high genetic advance as percent of mean were observed for the characters, spike length, spike girth, number of productive tillers/plant, plant height, 1000 grain weight and grain yield/plant as also observed by [16]. [14, 17, 18] found high heritability with high genetic advance as percent of mean for green and dry fodder yield/plant.

High PCV and GCV values were reported in pearl millet for plant height, productive tillers/plant, ear length, grain yield per plant by [16, 19, 20, 21]. Number of productive tillers/plant had highest (58.07%) and days to 50% flowering had lowest (6.88) genetic advance as% of mean. Here, reciprocal recurrent selection can be followed. High estimates of coefficient of variation along with high heritability and genetic advance as per cent over mean for spike length, spike girth, number of productive tillers/plant, plant height, 1000 grain weight, green fodder yield/plant, dry fodder yield/plant and grain yield/plant indicated the role of additive gene action.

Results reported by [22] revealed that grain yield, dry fodder yield and green fodder yield had high magnitude of phenotypic range, genotypic co-efficient of variation, phenotypic co-efficient of variation, heritability and genetic advance expressed as percentage of mean thereby suggesting the importance of additive gene action.

Table 1: Estimates of variability parameters in pearl millet for different characters

Characters	Mean ±S.E(m)	Range	PCV (%)	GCV (%)	Heritability (h^2) (%)	Genetic advance as% of mean
1. Days to 50% flowering	45±2	41-55	9.67	5.68	34.51	6.88
2. Spike length (cm)	18.65±1.24	13.40-32.27	20.95	19.29	84.83	36.61
3. Spike girth (cm)	2.11±0.22	1.22-2.68	23.58	19.66	69.52	33.77
4. Number of productive tillers/ plant	2.47±0.30	1.13-4.53	34.60	31.23	81.49	58.07
5. Plant height (cm)	83.87±3.97	46.20-125.07	22.07	21.30	93.10	42.33
6. 1000 grain weight (g)	9.73±0.74	4.62-14.35	28.47	26.90	89.27	52.35
7. Green fodder yield/plant(g)	198.99±14.09	115-310	25.69	24.18	88.60	46.89
8. Dry fodder yield/ plant (g)	87.85±6.70	50-136.67	28.74	27.18	89.42	52.94
9. Grain yield/ plant(g)	39.26±3.25	17.96-57.45	27.58	25.66	86.52	49.16

2. Correlation coefficient

Correlation between yield, its component traits and among themselves is of considerable importance in selection programmes. The magnitude of correlation coefficients at genotypic level was higher than corresponding correlation coefficients at phenotypic level revealing a strong inherent association between different attributes.

The results of correlation coefficient analysis revealed that days to 50% flowering, spike length, number of productive tillers per plant, plant height, 1000 grain weight, dry fodder yield per plant and green fodder yield per plant were significantly and positively correlated with grain yield per plant (Table 2). Similar results were also reported by [16, 23, 24, 25, 26, 27]. Positive and significant correlation of fodder yield with grain yield was found encouraging for the development of dual purpose hybrids. The positive correlation of grain yield with these characters implies that improving one or more of these traits could result in higher grain yield for pearl millet. In Table 3, summary of some selected work related to correlation coefficient has been presented.

3. Path coefficient analysis

Path coefficient provides the real picture of association between characters by delineating the correlation coefficient into direct and indirect effect (Table 4). The results revealed that dry fodder yield/plant had the highest direct contribution towards grain yield/plant followed by number of productive tillers/plant, 1000 grain weight, days to 50% flowering, spike length and green fodder yield/plant [14, 23, 28, 29, 30, 31]. Plant height had high negative direct effect which showed that selection should be done in negative direction [15, 32, 33]. It is suggested that these characters can be considered as main components for selection in a breeding programme for higher grain yield. Indirect effects of independent traits indicated that

spike length, plant height, 1000 grain weight and green fodder yield contributed indirectly to grain yield per plant via other characters [28].

Low value of residual effects (0.024) indicated that contribution of independent characters included in this study explained about 99.97% of variation for grain yield.

Table 2: Estimates for Genotypic (below diagonal) and Phenotypic (above diagonal) Correlation Coefficient of pearl millet maintainer lines for quantitative characters

Characters	Days to 50% flowering	Spike length (cm)	Spike girth (cm)	Number of productive tillers/plant	Plant height (cm)	1000 grain weight (g)	Green fodder yield/plant(g)	Dry fodder yield/plant (g)	Grain yield /plant(g)
Days to 50% flowering	1	0.40**	0.22**	0.29**	0.34**	0.30**	0.42**	0.16	0.33**
Spike length (cm)	0.76**	1	-0.04	0.44**	0.59**	0.26**	0.39**	0.33**	0.45**
Spike girth (cm)	0.28**	-0.09	1	0.12	0.16	0.15	0.11	0.05	0.11
Number of productive tillers/plant	0.51**	0.52**	0.17*	1	0.71**	0.41**	0.49**	0.31**	0.51**
Plant height (cm)	0.63**	0.66**	0.20*	0.85**	1	0.39**	0.56**	0.31**	0.57**
1000 grain weight (g)	0.55**	0.29**	0.22**	0.50**	0.45**	1	0.60**	0.45**	0.66**
Green fodder yield/plant (g)	0.60**	0.44**	0.11	0.60**	0.61**	0.69**	1	0.68**	0.78**
Dry fodder yield/plant (g)	0.33**	0.40**	0.11	0.36**	0.34**	0.51**	0.76**	1	0.77**
Grain yield /plant(g)	0.66**	0.51**	0.14	0.60**	0.64**	0.75**	0.93**	0.88**	1

* Significant at p= 0.05, ** Significant at p= 0.01

Table 3: Summary of selected works reporting correlations between quantitative traits

Correlation between		Type	References
Days to 50% flowering	Tillers, plant height, 1000 grain weight, grain yield	Positive	[16]
Spike length	Tillers, plant height, grain yield	Positive	[16, 23, 28, 34]
Number of productive tillers/plant	Green fodder yield, grain yield	Positive	[14, 16, 23, 24, 28]
Plant height	Green fodder yield, grain yield	Positive	[14, 23, 24, 28, 35, 36, 37, 38, 39]
1000 grain weight	Grain yield	Positive	[23, 34, 36, 40, 41, 42]
Green fodder yield	Dry fodder yield	Positive	[43]
Dry fodder Yield	Grain yield	Positive	[36, 41, 42]

Table 4: Path coefficient analysis of grain yield per plant with its component characters in pearl millet maintainer lines

Characters	Days to 50% flowering	Spike length (cm)	Spike girth (cm)	Number of productive tillers/plant	Plant height (cm)	1000 grain weight (g)	Green fodder yield/ plant (g)	Dry fodder yield/ plant(g)	Genotypic Correlation coefficient
Days to 50% flowering	0.260	0.171	-0.023	0.182	-0.242	0.153	0.085	0.252	0.657**
Spike length (cm)	0.197	0.226	0.008	0.187	-0.252	0.080	0.062	0.306	0.513**
Spike girth (cm)	0.072	-0.021	-0.084	0.061	-0.077	0.061	0.015	0.084	0.137
Number of productive tillers/plant	0.132	0.118	-0.014	0.358	-0.324	0.140	0.086	0.273	0.598**
Plant height (cm)	0.165	0.148	-0.017	0.302	-0.383	0.127	0.087	0.264	0.644**
1000 grain weight (g)	0.142	0.064	-0.018	0.179	-0.173	0.280	0.097	0.394	0.746**
Green fodder yield/plant(g)	0.156	0.099	-0.009	0.215	-0.235	0.191	0.142	0.586	0.928**
Dry fodder yield/plant (g)	0.085	0.090	-0.009	0.127	-0.132	0.143	0.108	0.768	0.880**

Residual effect (0.024)

Conclusion

The correlation coefficients at genotypic level had higher magnitude than their corresponding correlation coefficients at phenotypic level, thereby, revealing a good amount of strong inherent association between different attributes. Results of correlation study revealed that the following characters *viz.*, days to 50% flowering, number of productive tillers/plant, plant height, 1000 grain weight, dry fodder yield and green fodder yield were the important component traits of grain yield and during the course of development of populations and inbred lines, these traits may get due attention of the breeders in pearl millet. Due to high direct effect and high correlation coefficient, characters like days to 50% flowering (days), spike length (cm), number of productive tillers/plant, 1000 grain weight (g) and dry fodder yield/plant (g) can be directly selected for breeding programme.

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