Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2018; 7(6): 1983-1987
Received: 13-09-2018
Accepted: 15-10-2018

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Study on genetic variability, heritability and correlation in pearl millets germplasm

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Abstract
An evaluation of 34 germplasm of pearl millet for genetic variability, heritability, genetic advance as per cent of mean along with the association of grain yield with component traits was performed. The ANOVA showed highly significant differences among the genotypes for all the characters studied, indicating the presence of sufficient variability in the experimental material. The PCV were slightly higher than GCV indicating little influence of environment on the expression of characters. High PCV and GCV were recorded for all the characters. High heritability with high genetic advance as *per cent* of mean for ear girth, protein content and seed density suggested the prevalence of additive gene action in their inheritance indicating the selection based on these traits to be quite effective. The traits, number of effective tillers per plant, ear length, ear girth and seed density showed positive association with grain yield for which indirect selection can be made in future breeding programme to enhance grain yield.

Keywords: Variability, heritability, correlation and pearl millet

Introduction
Pearl millet (*Pennisetum glaucum* (L.) R. Br.] is an important cereal crop in arid and semi-arid regions of the world, mainly in dry regions of Asia and Africa. In terms of area and production, pearl millet occupies the sixth rank following wheat, rice, maize, barley and sorghum in area and production. It is a highly cross-pollinated rainy season crop with very high grain yield potential of 15-20 quintal per hectare crop and holds an important position in agriculture of arid and semi-arid region due to its ability to survive drought, low pH, low soil fertility and even high temperature (Shah *et al.*, 2012). It is very rich in calories, proteins (6-15%), fat (5-6%), carbohydrates (60-72%), fibre (1-1.8%) and minerals with less amount of HCN, which makes it highly nutritive and palatable crop in comparison with other crops (Fleck, 1981) [8]. It is a dual-purpose crop because it is widely used by livestock industry as either green fodder or Stover (Hanna and Cardona, 2001) [11]. In India, pearl millet occupied 9.3 lakh hectare areas with 8.3 lakh production in 2015-2016 (Anonymous, 2016). The low production of pearl millet in India leads to the need of developing varieties with stable production irrespective of growing place and time under stress conditions. Information on genetic variability about a crop is prerequisite for crop improvement program. In particular, the genotypic and phenotypic coefficient of variability are used for assess the available the genetic variability. Genetic advance can be used for determining the expected actual gain, while heritability used for phenotypic variation in a population (Ogunniyan and Olakojo, 2014) [19]. Therefore, this study aimed to assess the magnitude of genetic variability, heritability and genetic advance of morphological quality traits of 34 inbreds of pearl millet. Therefore, keeping in view the above points, the present work was undertaken to estimation genetic variability heritability and correlation in pearl millets germplasm.

Materials and Methods
Thirty four pearl millet genotypes selected from pearl millet germplasm maintained at the Bajra Section, Department of Genetics and Plant Breeding, CCS Haryana Agricultural University, Hisar, were used for the experiment. The experiment was conducted at Research Farm of CCS Haryana Agricultural University, Hisar during *Kharif*, 2014. All 34 genotypes were grown in a randomized block design (RBD) with three replications, in double row plots of 4 m length, keeping row to row and plant to plant distance of 50 cm and 12 cm, respectively. All the recommended package of practices was followed to raise the crop. At maturity five plants from each accession were selected randomly for collect data on grain yield and yield related characters *viz.*, grain yield (GY), days to flowering (DF), plant height (PH), days to maturity (DM), number of effective tillers per plant (ET/P), ear length (EL), ear girth

(EG), seed size (S Size), seed density (SD) and protein content (PC). Statistical analyses were done by using software R.

Results and Discussion

Analysis of variance revealed significant differences among the genotypes for all the ten characters studied, indicating the existence of considerable genetic variation in the experimental materials (Table 1). The analysis of mean, range, genotypic and phenotypic coefficients of variation, heritability and genetic advance as percent of mean for different characters (Table 2) revealed that, large differences in mean values for most of the characters were observed. The range of variation was maximum for plant height (110.20 - 197.47cm) followed by days to maturity (60.33 - 81.67 days) and days to flowering (35.33 - 55.67 days) while it was lowest in the case of seed density (0.80 - 1.64 g/ml) and seed size (2.08 -- 5.75 g).

In present study, the estimates of phenotypic coefficient of variation (PCV %) were slightly higher than genotypic coefficient of variation (GCV %). The estimates of PCV ranged from 7.87 for days to maturity to 31.90 *per cent* for number of effective tiller per plant and the corresponding values for GCV were 7.63 to 31.61 *per cent*, respectively. This indicated that the large amount of variation was contributed by genetic component and least by environment. High estimates of PCV and GCV were obtained for number of effective tiller per plant (31.90 and 31.61%), grain yield (28.86 and 27.83%), seed size (20.88 and 20.45%) and ear length (17.72 and 17.09%), which indicates significant role of these characters in improvement of breeding programme. The high PCV and GCV were earlier reported in pearl millet by Kumar *et al.* (2014) [16] for productive tillers per plant, grain yield per plant and panicle length traits, similarly by Bhuri *et al.* (2014) [5] for grain yield per plant. Moderate levels of PCV and GCV were obtained for the seed density, protein content, ear girth, plant height and days to flowering in the decreasing order of magnitude. However, low values were obtained for days to maturity (7.87). Similar findings were also reported by Lakshmana *et al.* (2010) [18] and Choudhary *et al.* (2012) [7] for days to flowering and days to maturity in pearl millet.

High heritability estimates was observed for ear girth (98.90%), number of effective tiller per plant (98.10%) and protein content (98.00%) while lowest for plant height (72.80%). Similar findings were also reported for grain yield per plant and panicle length traits by Govindaraj *et al.* (2011) [10] and Talawar *et al.* (2017) [24]. Estimates of high heritability obtained by these characters were governed by additive gene effects (Panse 1957) [20] and these characters are amenable for improvement by selection, particularly through mass selection (Krishnawat and Sharma 1988 and Ashok *et al.* 2000) [1]. The high heritability magnitude indicates the reliability, which represent the high chance of the genotype to be recognized by its phenotypic expression.

The genetic advance as percent of mean varied from 15.25 to 64.50% for days to maturity and number of effective tillers per plant, respectively. In the present investigation, high heritability values coupled with high genetic advance as percent of mean was recorded for number of effective tiller per plant, grain yield and seed size. This indicates generous scope for improving these characters through simple selection. The present findings are in broad agreement with the earlier results of Kumari *et al.* (2013) [17], Kumar *et al.* (2014) [16] and Bhuri *et al.* (2014) [5]. High heritability coupled with moderate genetic advance as percent of mean was observed for ear girth, protein content and seed density. High heritability along with low genetic advance as percent of mean was noticed for days to maturity.

Simple correlation coefficients among the grain yield and yield component characters in pearl millet are presented in Figure 1.

Grain yield per plant *vs* other characters

Grain yield is a complex character and is dependent on several contributing traits. Hence, character association was studied in the present investigation to assess the relationships among yield and its components for enhancing the usefulness of selection. Grain yield per plant was highly significant and positively associated with number of effective tiller per plant (0.64), ear length (0.56), ear girth (0.49) and seed density (0.45). Thus, these traits can serve as selection indices for grain yield improvement in pearl millet. These results are similar to the earlier studies reported in pearl millet by several workers *i.e.,* Pareek (2002) [21], Borkhataria *et al*. (2005) [6], Izge *et al.* (2006) [12], Kale *et al.* (2011) [13], Atif *et al.* (2012) [2], Angarawai *et al.* (2015), Kumar *et al.* (2016) [15], Singh and Singh (2016) [22] and Talawar *et al.* (2017) [24] indicated a positive relationship of different intensity between grain yield per plant, number of tillers per plant, plant height panicle length and panicle girth. Plant height (-0.34) and protein content (-0.44) were significant and negatively correlated with grain yield per plant. The characters days to flowering and days to maturity had non-significant and positive association with grain yield per plant. The relationship between grain yield per plant and protein content is presented in figure: 2.

Association between other characters

Days to flowering exhibited highly significant and positive correlation with plant height (0.47), days to maturity (0.46), ear length (0.44), ear girth (0.45) and seed density (0.37), while it showed non-significant correlation with other characters. This indicates that late flowering is important for increased plant height as reported by Balakrishnan and Vijendra Das (1995) [3], Sumanth *et al.* (2014) [23] and Govindaraj *et al.* (2009) [9] for plant height. Plant height showed significant and positive correlation with days to maturity (0.38) while, it was significant and negatively correlated with number of effective tiller per plant (-0.42) and grain yield per plant (-0.34). Days to maturity had significant negative correlation with seed size (-0.34). Number of effective tillers per plant exerted positive and significant association with ear length (0.54), ear girth (0.32), seed size (0.47) and seed density (0.64) which is in agreement with earlier report of Bhuri *et al.* (2014) [5], Kumar *et al.* (2016) [15], Bhasker *et al.* (2017) [4] and Talawar *et al.* (2017) [24]. Ear length manifested positive and significant association with seed size (0.35) and seed density (0.49). Similar results were reported by Bhuri *et al.* (2014) [5], Bhasker *et al.* (2017) [4] and Talawar *et al.* (2017) [24]. The correlation between ear girth and seed density (0.33) was found to be significant and positive. Seed size exerted significant positive correlation with seed density (0.48) while it was negatively correlated with protein content (-0.41). Protein content had significant and negative correlation with grain yield (-0.44) and seed size (-0.41).

Table 1: ANOVA for 10 characters in 34 germplasm lines of pearl millet

ANOVA	Mean Sum of Square										
	DF	GY	DF	PH	DM	ET/P	EL	EG	S Size	SD	PC
Replication	2	0.63	1.67	432.496	1.25	0.10	0.32	0.07	0.09	0.02	0.10
Genotypes	33	97.57**	70.941**	1509.43**	96.34**	3.74**	42.59**	4.08**	2.05**	0.12**	6.94**
Error	66	6.85	3.041	410.70	5.66	0.07	2.94	0.05	0.08	0.03	0.14
Total	101	36.40	25.199	770.12	35.20	1.27	15.84	1.36	0.73	0.04	2.36

Note:- Grain Yield= GY; Days to flowering=DF; Plant Height = PH; Days to Maturity = DM; Number of Effective Tillers/Plant = ET/P; Ear Length = EL; Ear Girth = EG; Seed Size = S Size; Seed Density = SD; Protein Content = PC.

Table 2: Mean, range, coefficient of variability (genotypic and phenotypic), heritability and genetic advance as *per cent* of mean for 34 germplasm lines of pearl millet

Characters	Range	Mean ± SE	GCV	PCV	h^2	GAM
GY	10.80 - 29.81	19.76 ± 1.51	27.83	28.86	93.00	55.28
DF	35.33 - 55.67	47.66 ± 1.01	9.98	10.20	95.70	20.12
PH	110.20 - 197.47	154.35 ± 11.70	12.40	14.53	72.80	21.79
DM	60.33 - 81.67	72.05 ± 1.37	7.63	7.87	94.10	15.25
ET/P	1.20 - 5.53	3.50 ± 0.15	31.61	31.90	98.10	64.50
EL	12.60 - 27.47	21.27 ± 0.99	17.09	17.72	93.10	33.98
EG	5.30 - 9.83	7.96 ± 0.12	14.57	14.65	98.90	29.85
S Size	2.08 - 5.75	3.96 ± 0.17	20.45	20.88	96.00	41.28
SD	0.80 - 1.64	1.15 ± 0.03	16.92	17.16	97.20	34.36
Protein	7.54 - 13.30	10.35 ± 0.21	14.55	14.70	98.00	29.68

Note:- Grain Yield= GY; Days to flowering=DF; Plant Height = PH; Days to Maturity = DM; Number of Effective Tillers/Plant = ET/P; Ear Length = EL; Ear Girth = EG; Seed Size = S Size; Seed Density = SD; Protein Content = PC.

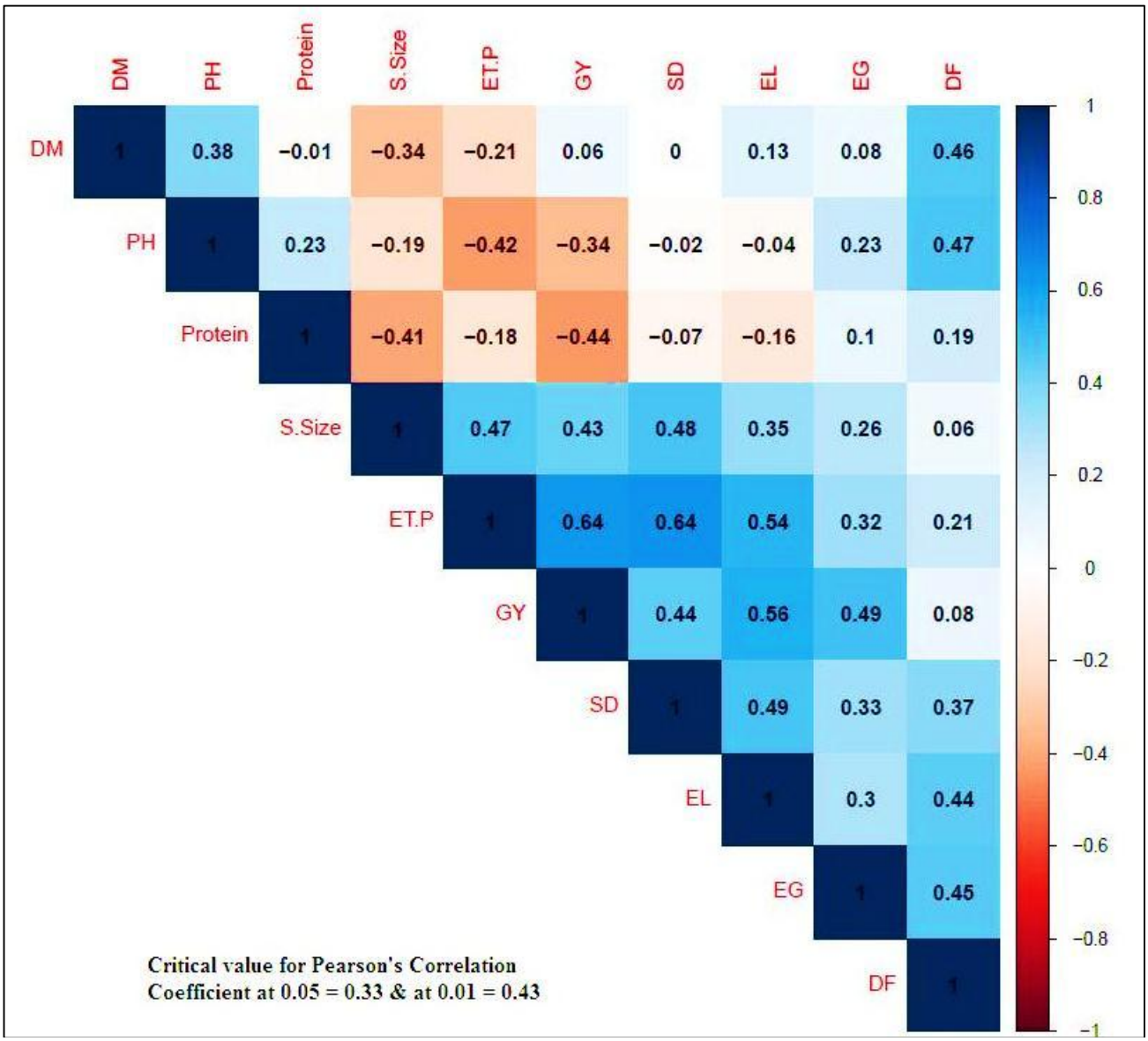

Fig 1: Correlation coefficients for 10 quantitative characters in pearl millet

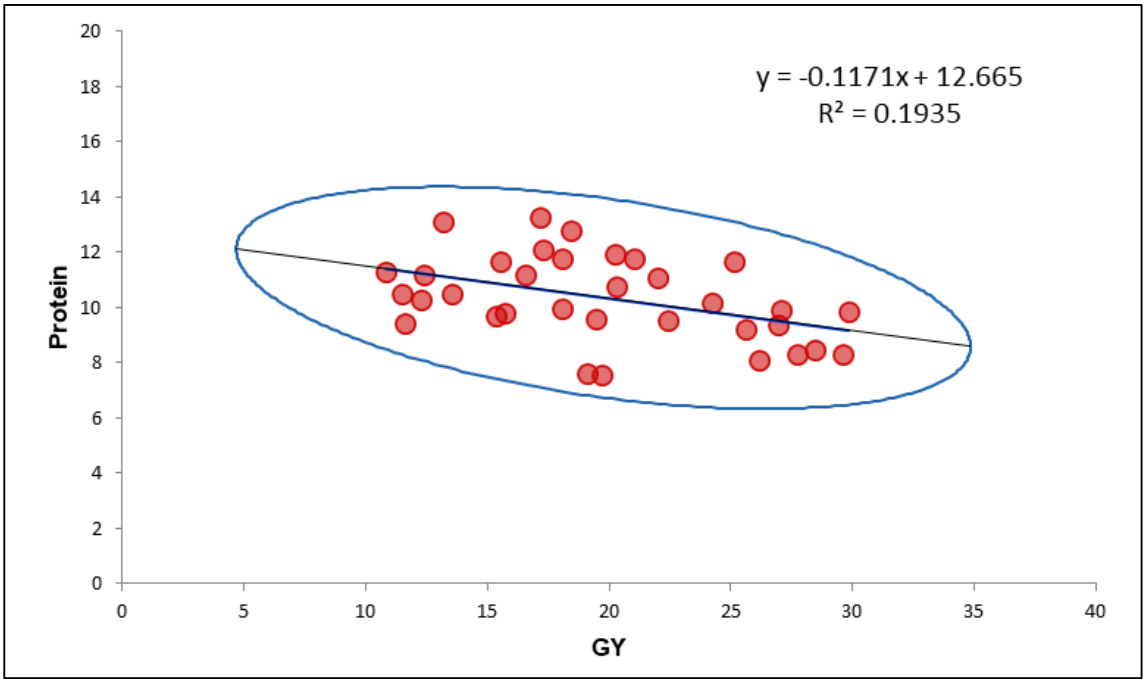

Fig 2: Relationship between Protein content and grain yield

Conclusion

Grain yield per plant could be increased by selection of number of effective tiller per plant, ear length, ear girth and seed density, because they had high positive correlation with gain yield per plant and they also showed high heritability estimates. The value of heritability estimates high for all characters; therefore, the genotypic variability prevails over the general phenotypic variability in all studied characters. This indicated that the greatest genotypic variability was observed for these traits and that variability could be utilized in breeding programs. This suggests a definite scope for improvement of these characters through direct selection. It is also suggested that hybridization of genotypes possessing combination of above characters is most useful for obtaining desirable high yielding segregation.

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