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STUDIES ON VARIABILITY, CORRELATION AND PATH ANALYSIS IN PEARL MILLET [*PENNISETUM GLAUCUM* (L.) R. BR.] GENOTYPES

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SUMMARY

A total of 97 pearl millet genotypes were grown in a randomized block design (RBD) with two replications in Research Area of Bajra Section, Department of Genetics & Plant Breeding, CCSHAU, Hisar during **kharif** season of 2013. The objectives of the investigation were to study genetic variability, correlation and path analysis for eight characters viz., days to 50 per cent flowering, plant height (cm), effective tillers/plant, panicle length (cm), panicle diameter (mm), number of nodes/main tiller, internode length (cm) and grain yield (g/plant) among 97 diverse pearl millet genotypes. Significant differences were observed among the genotypes for all the characters studied. The characters, namely, grain yield, panicle diameter, panicle length and plant height showed high phenotypic (PCV), genotypic (GCV) coefficient of variation, heritability and genetic advance. Genotypic and phenotypic coefficients of variation were highest for the trait grain yield. Estimates of heritability ranged from 18.15 per cent for effective tillers to 94.80 per cent for plant height, while grain yield showed 88.75 per cent heritability. High heritability coupled with high genetic advance as per cent of mean was observed for days to 50 per cent flowering, plant height, panicle length, panicle diameter and grain yield indicating the importance of these traits in selection and crop improvement. The results from character association indicated that grain yield (g/ plant) had significant and positive correlation with plant height and panicle diameter at phenotypic level. The genotypic correlation estimates showed significant positive association of grain yield with panicle length, panicle diameter, number of nodes and internode length. Panicle length and plant height exhibited the highest positive and significant direct effect on grain yield. Hence, these traits could be considered as suitable selection criteria for the development of high yielding pearl millet genotypes. Panicle diameter, plant height, internode length and panicle length showed highest positive direct effect on grain yield at genotypic level. Hence, main emphasis should be given to these traits in breeding programme for development of high yielding pearl millet hybrids.

Key words : Pearl millet, genetic variability, estimates of GCV and PCV, grain yield

Pearl millet [*Pennisetum glaucum* (L.) R. Br.] is an important coarse cereal grown for food, feed and fodder in the arid and semi-arid regions of Sub-sahara Africa, South Asia, mainly India and in north and south America. Pearl millet is well adapted in areas characterized by drought, low soil fertility, and high temperature.

In India, pearl millet occupied an area of 7.95 mha with production of 8.79 mt and productivity 1106 kg/ha, respectively (Anonymous, 2014). The grains of pearl millet are very nutritious. It is a good source of protein, fat, carbohydrate and also has good amount of minerals, particularly phosphorus and iron. Its fodder is free from dhurrin, the cyanogenic glycoside found in sorghum and hence can be fed at all stages of crop growth.

The grain yield is a complex character and direct selection for yield is not so much easy. Therefore, improvement in grain yield is made through improvement in contributing characters such as number of tillers/plant, panicle length, panicle girth, number of grains/panicle, 1000-grain weight, etc. along with yield (Arya *et al.*, 2009). In order to have appropriate choice of characters for selection of desirable genotypes under planned breeding programme for yield enhancement, the knowledge of nature and magnitude of variability existing in available breeding material, the association of component characters with yield and their exact

contribution through direct and indirect effect are very important. The present study was, therefore, undertaken to estimate the genetic variability, correlation and path analysis in diverse pearl millet genotypes with a view to identify the genotypes with best potentiality for enhancing yield and its component characters.

MATERIALS AND METHODS

The experiment was conducted at Bajra Section, Research Area, Department of Genetics & Plant Breeding, CCS Haryana Agricultural University, Hisar to study the variability among 97 genotypes of pearl millet during **kharif** season of 2013. The experiment was conducted in a randomized block design with two replications with spacing of 45 and 15 cm between and within rows, respectively. Observations were recorded on five random but representative plants of each genotype for eight quantitative traits viz., days to 50 per cent flowering, plant height (cm), effective tillers per plant, panicle length (cm), panicle diameter (mm), number of nodes/main tiller, internode length (between 3rd and 4th node from the top) (cm) and grain yield (g/plant). Recommended package of practices were followed to raise a good crop. The mean value of each genotype was used for statistical analysis. Analysis of variance was performed as per methodology given by Panse and Sukhatme (1967). Genotypic and phenotype coefficients of variation (GCV and PCV) were calculated by formula given by Burton (1952), heritability in broad sense (h^2) by Burton and Vane de (1953) and genetic advance as given by Johnson *et al*. (1955). Correlation and path coefficients were worked out as per method suggested by Al-Jibouri *et al.* (1958) and Dewey and Lu (1959), respectively.

RESULTS AND DISCUSSION

Estimates of Variability

The analysis of variance for all the characters under study revealed significant differences thereby indicating presence of substantial genetic variation among the genotypes. The estimates of variability parameters for yield and its component traits in 97 pearl millet genotypes are presented in Table 1. In the present investigation, high range was observed for all characters viz., days to 50 per cent flowering, plant height (cm), panicle length (cm), panicle diameter (mm), number of nodes/main tiller, internode length (cm) and grain yield (g/plant). Wide range of differences for GCV was observed which varied from 8.12 for days to 50 per cent flowering to 40.06 for grain yield (g/plant) indicating presence of considerable amount of variability among the genotypes. In general, the phenotypic coefficient of variation (PCV) was higher than its corresponding genotypic coefficient of variation (GCV). This suggested the role of environment in the expression of these characters. PCV values were highest for grain yield (g/plant) followed by effective tillers, panicle length (cm) and panicle diameter (mm). GCV values were highest for grain yield (g/plant) followed by panicle length (cm), panicle diameter (mm) and effective tillers per plant indicating availability of sufficient variation and thus exhibited scope for genetic improvement through selection for all these traits. However, days to 50 per cent flowering exhibited least phenotypic and genotypic coefficients of variation. Similar findings were also reported by Lakshmana *et al.* (2010) and Choudhary *et al*. (2012) in pearl millet. These values alone are not

TABLE 1
Estimates of variability parameters for different characters in pearl millet

S. No.	Characters	Mean ±SE (d)	Range	GCV	PCV	Heritability (%)	Genetic advance	Genetic advance (% of mean)
1.	Days to 50% flowering	51.485±2.33	41-60	8.12	9.30	76.28	7.52	14.61
2.	Plant height (cm)	174.189±5.90	108.33-233.33	14.48	14.87	94.80	50.59	29.04
3.	Effective tillers	3.811±1.32	2-7	16.38	38.45	18.15	0.54	14.37
4.	Panicle length (cm)	19.916±3.78	13-49.67	23.95	30.58	61.37	7.70	38.66
5.	Panicle diameter (mm)	20.689±3.18	10.67-34	22.13	26.94	67.45	7.74	37.44
6.	No. of nodes/main tiller	7.941±0.75	5-10.67	13.52	16.55	66.75	1.80	22.75
7.	Internode length (cm)	17.136±2.52	11.67-24.67	11.96	18.95	39.81	2.66	15.54
8.	Grain yield (g/plant)	16.543±2.36	5-35	40.06	42.53	88.75	12.86	77.75

helpful in determining the heritable portion of variation. The difference between estimates of PCV and GCV was also indicative of heritability since the characters with low difference between PCV and GCV like plant height, days to 50 per cent flowering, grain yield, panicle diameter and number of nodes would be useful.

The proportion of genetic variability which is transmitted from parents to offspring is reflected by heritability. Estimates of heritability in broad sense ranged from 18.15 per cent for effective tillers to 94.80 per cent for plant height, while grain yield showed 88.75 per cent heritability. Moderate to high heritability coupled with high genetic advance as per cent of mean was observed for grain yield, panicle length, panicle diameter, plant height and number of nodes indicating predominance of additive gene action in the inheritance of these characters. High heritability values were also obtained by Bhoite *et al.* (2008), Govindaraj *et al*. (2011) and Kumari *et al.* (2013) in pearl millet for majority of the above mentioned traits. Thus, based on the present study, characters like grain yield, panicle length, panicle diameter and plant height will aid in a selection programme owing to their high heritability value.

Genetic Advance

In the present study, the expected genetic advance showed wide range (0.54) for effective tillers to 50.59 for plant height and genetic advance in terms of per cent of mean ranged from 14.37 for number of effective tillers/plant to 77.75 for grain yield. Genetic advance was highest for plant height (50.59), intermediate for grain yield (12.86), whereas low for effective tillers (0.54), number of nodes (1.80) and internode length (2.66). Moderate to high genetic advance for majority of these traits was also reported by Govindaraj *et al*. (2011) and Kumari *et al.* (2013). High estimates of coefficient of variation along with high heritability and genetic advance as per cent over mean for grain yield, panicle length and panicle diameter are indicative of additive gene action for these characters. The high heritability with low genetic advance was observed for the characters like days to 50 per cent flowering and number of nodes. It indicated more influence of non-additive gene effects so selection in later generation would be more effective for these traits. Days to 50 per cent flowering, panicle diameter and panicle length had moderate heritability with moderate genetic advance which indicated both additive and non-additive gene effects. In such a case, reciprocal recurrent selection may be followed. High heritability, low genetic advance and low variability were observed for number of nodes and internodal length indicating prevalence of non-additive gene action. Here, high heritability seems to be due to environment rather than the genotype itself. Selection for such traits will not be rewarding. However, selection in later generations might be more effective.

Correlation Coefficient

Correlation coefficient analysis measures natural relation between various plant traits and determines the component characters on which selection can be used for genetic improvement in yield. Phenotypic correlation coefficients between the traits under study are depicted in Table 2. The results revealed that traits, namely, plant height, panicle length, panicle diameter and number of nodes/main stem exhibited significant positive phenotypic and genotypic correlation with grain yield. Grain yield had positive and non-significant phenotypic correlation with number of nodes (0.069) and panicle length (0.109), while positive and significant correlation was observed with panicle diameter (0.288) and plant height (0.218) (Table 2). It had negative and non-significant phenotypic correlation with days to 50 per cent flowering (-0.062), effective tillers (-0.064) and internode length (-0.022). Positive and non-significant genotypic correlation was recorded with number of nodes (0.124) and internode length (0.052), while positive and significant correlation was observed with panicle diameter (0.363), plant height (0.247) and panicle length (0.198). Grain yield (g/plant) had negative and non- significant genotypic correlation with days to 50 per cent flowering (-0.036) and effective tillers (-0.068). 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. Plant height had positive and highly significant phenotypic correlation with panicle length (0.226), number of nodes (0.603) and internode length (0.241), whereas positive and non significant correlation was observed with effective tillers (0.099) and panicle diameter (0.051) and also had high genotypic correlation with panicle length (0.298), effective tillers (0.208), number of nodes (0.751) and internode length (0.382). Panicle length had positive and significant phenotypic correlation with panicle diameter (0.178) and genotypic correlation was also positive and significant (0.279). These findings are in accordance with the results of Choudhary *et al*.

TABLE 2
Phenotypic and genotypic correlation coefficients among eight characters in pearl millet

Characters		Days to 50% flowering	Plant height (cm)	Effective tillers	Panicle length (cm)	Panicle diameter (mm)	No. of nodes/main tiller	Internode length (cm)	Grain yield (g/plant)
Days to 50% flowering	P	1.000	0.119^{NS}	0.118^{NS}	0.136^{NS}	-0.024^{NS}	0.024^{NS}	-0.021^{NS}	-0.062^{NS}
	G	1.000	0.140^{NS}	0.168*	0.176*	-0.026^{NS}	0.067^{NS}	-0.043^{NS}	-0.036^{NS}
Plant height (cm)	P		1.000	0.099^{NS}	0.226**	0.051^{NS}	0.603**	0.241**	0.218**
	G		1.000	0.208**	0.298**	0.064^{NS}	0.751**	0.382**	0.247**
Effective tillers	P			1.000	-0.007^{NS}	-0.083^{NS}	0.021^{NS}	-0.046^{NS}	-0.064^{NS}
	G			1.000	0.044^{NS}	-0.113^{NS}	0.098^{NS}	0.066^{NS}	-0.068^{NS}
Panicle length (cm)	P				1.000	0.178*	0.199**	0.081^{NS}	0.109^{NS}
	G				1.000	0.279**	0.325**	0.205**	0.198**
Panicle diameter (mm)	P					1.000	0.075^{NS}	-0.215**	0.288**
	G					1.000	0.008^{NS}	-0.422**	0.363**
No. of nodes/main tiller	P						1.000	0.109^{NS}	0.069^{NS}
	G						1.000	0.166*	0.124^{NS}
Internode length (cm)	P							1.000	-0.022^{NS}
	G							1.000	0.052^{NS}
Grain yield (g/plant)	P								1.000
	G								1.000

*, **Significant at P=0.05 and P=0.01 levels, respectively.
P–Phenotypic correlation coefficient values.
G–Genotypic correlation coefficient values.
NS–Not Significant.

(2012), Dhakar *et al.* (2012) and Kumar *et al.* (2014).

Path Coefficient

Path coefficient provides an effective way of finding direct and indirect sources of correlation. Direct and indirect effects of these components determined on grain yield at phenotypic level are presented in Table 3. The results of path coefficient analysis revealed that panicle diameter (0.385) exerted the highest positive direct effect on grain yield followed by plant height (0.250), internode length (0.130) and panicle length (0.028) which supports the finding of Kumar *et al.* (2014). Therefore, these characters could be considered as main components for selection in a breeding programme for higher grain yield. Path analysis further revealed that though panicle length had low direct effect but it contributed to grain yield *via* panicle diameter, plant height, internode length and panicle length. The present study thus suggests that panicle diameter (mm),

TABLE 3
Direct (diagonal and bold) and indirect effects of different characters on grain yield at genotypic level in pearl millet

Characters	Days to 50% flowering	Plant height (cm)	Effective tillers	Panicle length (cm)	Panicle diameter (mm)	No. of nodes/main tiller	Internode length (cm)	rg with grain yield
Days to 50% flowering	**-0.042**	-0.006	-0.007	-0.007	0.001	-0.002	0.001	-0.036^{NS}
Plant height (cm)	0.035	**0.250**	0.051	0.074	0.015	0.187	0.095	0.247**
Effective tillers	-0.011	-0.014	**-0.069**	-0.003	0.007	-0.006	-0.004	-0.068^{NS}
Panicle length (cm)	0.005	0.008	0.001	**0.028**	0.007	0.009	0.005	0.198**
Panicle diameter (mm)	-0.010	0.024	-0.043	0.107	**0.385**	0.002	-0.162	0.363**
No. of nodes/main tiller	-0.005	-0.065	-0.008	-0.028	-0.0006	**-0.087**	-0.014	0.124^{NS}
Internode length (cm)	-0.005	0.049	0.008	0.026	-0.054	0.021	**0.130**	0.052^{NS}

rg–genotypic correlation. Residual value is 0.79053. **Significant at P=0.01 level. NS–Not Significant.

plant height (cm), internode length (cm) and panicle length (cm) should be major traits to be taken into consideration for selection of desirable genotypes in pearl millet breeding programmes for developing high yielding cultivars.

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