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Elucidation of Genetic Variability and Trait Association in Pearl Millet [*Pennisetum glaucum* (L.) R. BR.] Genotypes

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ABSTRACT

Pearl millet, a major millet crop contributing 50 per cent to global millet production, is vital for the food and nutritional security of over 90 million people. Adapted to arid and semi-arid regions in Africa and Asia, it serves as a crucial resource for the less affluent. The crop's enhancement is essential for the well-being of both farmers and consumers, relying on exploiting existing genetic variability. This study evaluates 25 restorer lines and six maintainer lines, revealing high to moderate estimates of phenotypic and genotypic coefficient variations for yield contributing traits. The observed high heritability and genetic advance suggest additive gene action, making selection rewarding for all traits. Notably, plant height, number of productive tillers, panicle length, and 1000 grain weight are significantly correlated with single plant yield. Among these, plant height, number of productive tillers, and panicle length exhibit a high direct positive effect, making them valuable for selecting high-yielding pearl millet genotypes.

Key words: *Pearl millet, Variability, Correlation and path analysis*

Introduction

Pearl millet, scientifically known as [*Pennisetum glaucum* (L.) R. Br.] is a C_4 crop originating from the Sahel region of Africa. In 2020-21, India contributed 60 per cent (14.2 MT) of the world's total pearl millet production from 7.65 million hectares, yielding 1420 kg/ha (Directorate of Millets Development, 2022). Rich in protein (14%) with a low glycemic index (55), it also having high Fe and Zn content of 80 and 60 ppm, respectively, in germplasm accessions (Rai *et al.*, 2012). Open-pollinated varieties thrive in rainfed, low-input conditions, while hybrid cultivars flourish in irrigated settings with enhanced practices. Pearl millet, resilient to various stresses, faces increasing demand for improvement in yield, nutrition, consumer preference, region-specific adaptation, cultivation practices and stress resistance. This study aims to assess genetic variability in nine quantitative traits and their associations to establish selection criteria for yield improvement, recognizing the importance of considering contributing traits alongside yield for effective selection.

Materials and Methods

The study, conducted at the Department of Millets, Tamil Nadu Agricultural University, Coimbatore, involved 25 restorer and six maintainer lines. The genotypes were arranged in a randomized complete block design with two replications, sown in two rows with a spacing of 45×15 cm. Recommended nutrient and plant protection measures were employed. Biometrical traits from five randomly selected plants, including days to 50 per cent flowering, plant height (cm), number of productive tillers, leaf length (cm), leaf breadth (cm), panicle length (cm), panicle girth (cm), 1000-grain weight (g) and single plant yield (g), were recorded. Phenotypic and genotypic coefficients of variation (PCV and GCV) for nine characters were calculated and categorized as low (<10%), moderate (10-20%), and high (>20%) following the formulae by Burton (1952) and the criteria by Sivasubramanian and Madhavamenon (1973). To assess the heritable portion of variability, broad-sense heritability (h^2) was estimated, categorized as low (<30%), moderate (30-60%) and high (>60%) according to Lush *et al.* (1940). Genetic advance, expressed as a percentage of mean (GAM), was calculated and categorized as low (<10%), moderate (10-20%) and high (>20%) using the formula by Johnson *et al.* (1955). Correlation and path coefficient analyses were performed following the methods given by Goulden (1952) and Wright (1921), respectively. Path coefficients were scaled as negligible (<0.09), low (0.10-0.19), moderate (0.20-0.29), high (0.30-0.99) and very high (>1.00) by Lenka and Misra (1973). These analyses were carried out using the INDOSTAT statistical software.

Results and Discussion

Analysis of variance

The analysis of variance for nine quantitative characters of thirty one pearl millet genotypes showed significance for all the characters *viz.,* days to 50 per cent flowering, plant height, number of productive tillers per plant, leaf length, leaf breadth, panicle length, panicle girth, 1000 grain weight and single plant yield (Table 1). It reveals the presence of considerable amount of variation prevailing among the pearl millet genotypes for all these characters. The reports on variations in pearl millet for these traits were also found in the literatures of Ramya *et al.* (2017) and Shashibhusan *et al.* (2022).

Coefficient of variation

In the present study, PCV estimates were higher than GCV estimates with narrow range of difference for all the traits studied (Fig. 1). It infers the major contribution of genotypes and lesser influence of environment towards the variations among the genotypes. The reports of Rasitha *et al.* (2019) and Shashibhusan *et al.* (2022) on pearl millet were similar with the higher coefficient of variations in the present study.

The high PCV and GCV estimates were observed for the trait, single plant yield (Fig. 1). High PCV and moderate GCV were observed for the characters *viz.,* leaf breadth and panicle length. Moderate PCV and GCV were observed for the characters *viz.*, days to 50 per cent flowering, plant height, number of productive tillers per plant, leaf length, panicle girth and 1000-grain weight. Collectively, all the studied traits were found with high to moderate levels of PCV and GCV estimates. The research findings of Subbulakshmi *et al.* (2018) and Rasitha *et al.* (2019) for single plant yield and Shashibhusan *et al.* (2022) for number of productive tillers per plant and plant height and Govindaraj *et al.* (2010) for panicle traits in pearl millet supports the present study. Hence,

Table 1. Analysis of variance for nine quantitative characters in pearl millet

S. No.	Characters	Mean Squares		
		Replication (df=1)	Genotypes (df=30)	Error (df=30)
1.	Days to 50 per cent flowering	0.79	71.92**	0.72
2.	Plant height	2.54	1761.27**	34.16
3.	Number of productive tillers	0.13	0.62**	0.04
4.	Leaf length	3.54	189.46**	6.91
5.	Leaf breath	0.51	1.11**	0.10
6.	Panicle length	15.67	45.41**	6.48
7.	Panicle girth	2.66	3.35**	0.65
8.	1000-grain weight	0.21	4.41**	1.02
9.	Single plant yield	104.77	463.05**	30.54

** Significance at 1% probability level

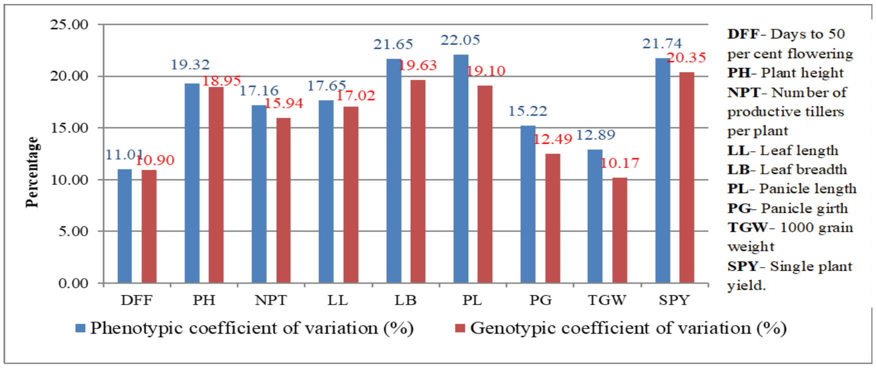

Fig. 1. Phenotypic and genotypic coefficients of variations for nine yield related characters in pearl millet genotypes

the presence of considerable amounts of variations for all the characters guarantees the improvement of single plant yield through effective selection.

Heritability and Genetic advance

In the present study, high heritability coupled with high genetic advance were found for the characters *viz.,* days to 50 per cent flowering, plant height, number of productive tillers per plant, leaf length, leaf breadth, panicle length, panicle girth and single plant yield (Fig. 2). The trait 1000-grain weight showed high heritability with moderate genetic advance. Shashubhusan *et al.* (2022) reported high heritability and genetic advance for all the above traits in pearl millet. Further, it is supported by the Kaushik and Vart (2022) for plant height, number of productive tillers, panicle length and panicle girth. The presence of high heritability for all these characters is due to the additive gene action. Along with this, high to moderate genetic advance displays the possibility of effective improvement of the traits through selection process.

Association analysis

Single plant yield, being a complex dependent character, the selection of elite genotype based on yield alone will not be effective. The selection for grain yield will be rewarded when it is made along with its associated characters.

The path coefficient analysis (Fig. 3) revealed a residual effect (0.414) providing a reasonable 59 per cent determination coefficient of the regression. Single plant yield showed significant positive genotypic correlation with plant height (0.586), number of productive tillers per plant (0.602), panicle length (0.616), and 1000-grain weight (0.449). Among these, plant height (0.385) and panicle length (0.347) had a high positive direct effect on single plant yield (Fig. 3). The crop's photosynthetic efficiency is reflected in increased yield as plant height and number of productive tillers per plant enhance source and sink size. Panicle length directly contributes to increased yield by expanding the sink space. Although the correlated trait, number of productive tillers per plant, had a low direct effect (0.102), it contributed

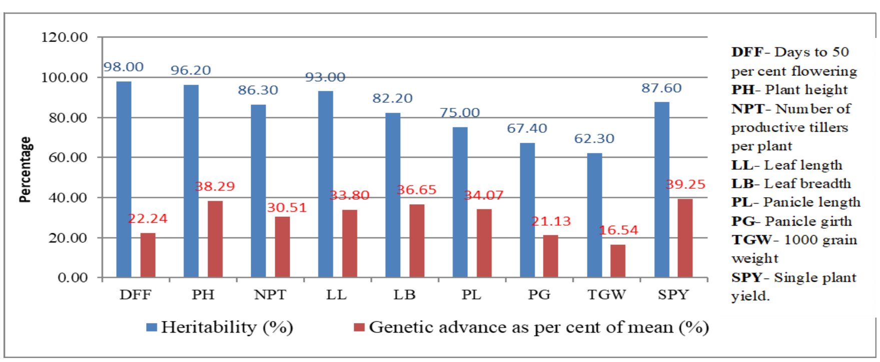

Fig. 2. Heritability and genetic advance as per cent of mean for nine yield related characters of pearl millet genotypes

Table 2. Genotypic correlation coefficients among nine quantitative characters of pearl millet genotypes

Traits	Days to 50 per cent flowering	Plant height	Number of productive tillers	Leaf length	Leaf breath	Panicle length	Panicle girth	1000 grain weight	Single plant yield
Days to 50 per cent flowering	1	-0.092	-0.285	0.077	0.307	-0.121	-0.302	0.056	-0.472**
Plant height		1	0.300	0.212	-0.203	0.312	0.237	0.200	0.586**
Number of productive tillers			1	0.378*	0.147	0.506**	0.048	0.187	0.602**
Leaf length				1	0.611**	0.010	0.079	0.375*	0.328
Leaf breath					1	-0.136	-0.192	0.304	0.012
Panicle length						1	-0.154	0.332	0.616**
Panicle girth							1	0.104	0.159
1000-grain weight								1	0.449*

*Significance at 5% probability level; **Significance at 1% probability level

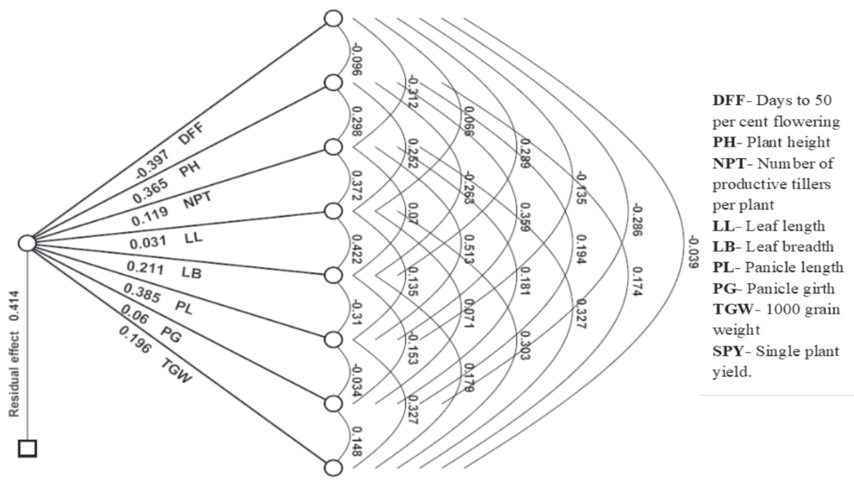

Fig. 3. Genotypic path coefficient diagram for single plant yield of pearl millet

more indirectly to single plant yield through other independent traits. Previous studies by Shashibhusan *et al.* (2022) and Kamble *et al.* (2022) reported a positive correlation and high direct effect of plant height, number of productive tillers, panicle length, and panicle girth with single plant yield. The trait 1000-grain weight had positive but low direct effect (0.19) and indirect effects on single plant yield, with significant positive correlation due to the cumulative effect of other independent traits. These results were supported by the findings of Sharma *et al.* (2018) in pearl millet.

Among the independent characters, number of productive tillers per plant showed positive correlations with panicle length (0.506) and leaf length (0.378). Additionally, leaf length exhibited significant positive correlations with leaf breadth (0.611) and 1000-grain weight (0.375). Similar interrelationships among independent traits were reported by Rasitha *et al.* (2019) and Shashibhusan *et al.* (2022). Thus, traits *viz.,* plant height, panicle length, and number of productive tillers per plant can be considered as significant contributors to single plant yield.

Based on variability and association studies, positive selection for plant height, panicle length, and number of productive tillers per plant, along with negative selection for days to 50 per cent flowering, can enhance pearl millet yield with a shorter duration.

Conclusion

In the present study it was concluded that, the considerable variations are present in all the studied characters could be improved as they were regulated by additive gene action. The development of high yielding short duration variety is possible through positive selection for the traits *viz.,* plant height, panicle length and number of productive tillers per plant and single plant yield and negative selection for days to 50 per cent flowering.

Conflict of Interest- None

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