Original Research Article

Deciphering Pearl millet grain yield under water stress using genotypic, phenotypic correlation and path coefficient analysis

Abstract

Yield is a polygenic character, usually depends on its various contributing traits like days to 50% flowering, plant height, and panicle length as well as panicle girth. A study was conducted during *kharif* 2018 to evaluate the relationship between grain yield and its components in pearl millet using correlation and path analysis studies. In the current study, significant genotypic and phenotypic correlations were found among five yield contributing traits in eighteen pearl millet hybrids. The traits including days to 50% flowering, plant height, and panicle length were found to have positive correlation with grain yield per plant that implied the importance of those traits in selection of high yielding hybrids. Grain yield per plant was used as a dependent character in path-coefficient analysis at the genotypic level. Plant height and panicle length were the independent variables (cm). The highest positive and direct effect was found for days to 50 percent flowering (0.9946) followed by panicle diameter (cm) (0.5726). Pearl millet having deep root system are often found to survive even in various stressful conditions including water stress. These characteristics have made it popular in dry and semi-arid regions around the world; nevertheless, compared to other major cereals, less work has been put into the study of climate-resilient characteristics of pearl millet. We have revealed here some basic ideas of correlation between the grain yield of pearl millet with its yield contributing constituents under drought condition.

Keywords: Correlation, Yield, Pearl Millet, Path Coefficient, Drought

Introduction

Pearl millet [*Pennisetum glaucum* (L.) R. Br.], or commonly known as bajra (2n = 14) belonging to the family *Poaceae* (earlier *Gramineae*) is a heterogenous as well as heterozygous highly cross-pollinated crop and protogynous in nature (**Animasaun *et al.*, 2019**). In India, pearl millet ranks fourth amongst the most widely cultivated food crop after rice, wheat, and maize. Total cultivable area covers 6.93 million ha throughout the nation and secures 8.61 million tons of annual production with productivity 1,243 kgha^{-1} (**Directorate of Millets Development, 2020**). Pearl millet is thought to be originated in West Africa (**Vavilov, 1950**). Nigeria, Pakistan, Sudan, and Saudi Arabia contribute as the major pearl millet growing countries throughout the globe. In India, the major pearl millet growing states are Rajasthan, Maharashtra, Gujarat, Uttar Pradesh and Haryana, covering nearly 90% acre (**Anonymous, 2000**)

Nutritionally, the energy value, protein and macro nutrient contents of millets is comparable and sometimes higher than conventional cereals. In the context of nutritional status, pearl millet is reported to contain 92.5% dry matter, 2.1% ash, 2.8% crude fiber, 7.8% crude fat, 13.6% crude protein, and 63.2% starch (**Ali *et al.*, 2003**).

Drought is one of the most impeding abiotic stress factors retarding plant growth and development (**Bruce *et al.*, 2002**). Drought is a serious issue to pearl millet during its flowering and grain filling stages (**Garrity *et al.*, 1983; Hattendorf *et al.*, 1988**). Usually, development of drought-tolerant hybrids is hindered by poor understanding of the mechanisms of drought tolerance as well as inadequate selection techniques (**Bruckner and Frohberg, 1987; Richards, 1996**). Low heritability of drought tolerance also contributes in hampering development of drought-resilient hybrids since an era. Strategies for improving drought tolerance include selection of hybrids in low stress environments, high stress environments, a combination of stress and no stress environments (**Byrne *et al.*, 1995**).

Correlation studies are used to determine the nature and extent of relationships between yield and other yield attributing traits in order to better understand the traits that influence yield. A plant breeder's primary goal is to improve yield and stability. As a result, correlation analysis of a particular trait with other yield-related traits is critical for selecting lines with higher yield. The correlation coefficient can be partitioned into direct and indirect effects using path coefficient analysis. The goal of this study was to determine the genotypic and phenotypic correlations, as well as the direct and indirect contributions of various traits to yield.

Materials and Methods

For the current study, eighteen hybrids of pearl millet were collected from the Rajasthan Agriculture Research Institute, Durgapura, Jaipur under the supervision of Sri. Karan. Narender. Agriculture. University, Jobner. Those hybrids were planted in a three-replication randomized block design. Each hybrid was planted in a two-row experimental plot measuring 1 meter in length, with 45 x 10 cm inter and intra row spacing. The hybrids were tested in three replications under both the water-rich and water-stressed conditions. Days to 50% flowering, plant height (cm), panicle length (cm), panicle diameter (cm), and grain yield per plant were recorded. In each replication, observations were made on five randomly selected plants from each plot.

Table 1. List of hybrids used in the study

S. No.	Hybrids	S. No.	Hybrids
1	RHB-173	10	HHB-67
2	RHB-177	11	HHB-197
3	RHB-223	12	HHB-299
4	RHB-233	13	9450
5	RHB-234	14	9001
6	GHB-538	15	86-M-86
7	GHB-558	16	MCPH-17
8	GHB-744	17	MARU-TEJ
9	GHB-905	18	KBH-108

Table 2. Characters to be recorded

S.NO	Characters to be recorded
1	Days to 50% flowering
2	Plant height
3	Panical lenth
4	Panical girth
5	Grain yield

Statistical analysis

To better understand, the associations and relationships between traits, the genotypic and phenotypic correlation coefficients were calculated using the method described by **Singh and Chaudhary (1977)**. Path analysis was used to divide the genotypic and phenotypic correlation coefficient into direct and indirect effects in order to establish a cause-and-effect relationship between the traits, as suggested by **Dewey and Lu (1959).**

RESULTS AND DISCUSSIONS

Correlation Coefficient

Grain yield is a complex trait, influenced by a number of factors. As a result, character association was investigated in the current study to assess the relationships between yield and its components in order to improve the usefulness of selection. In general, genotypic correlations are shown to be higher than phenotypic correlations, indicating that though there is strong influence of environment and considering the importance of phenotypic correlation. Correlation coefficient analysis determines the component characters on which selection can be used for genetic yield improvement by measuring the natural relationship between various plant traits. Table 3 and 4 shows the phenotypic and genotypic correlation coefficients between the traits under investigation. The results revealed that traits, namely, panicle length and panicle diameter exhibited significant positive phenotypic and genotypic correlation with grain yield. Grain yield had Positive and non-significant genotypic correlation was recorded with days to 50 per cent flowering (0.2987NS), while positive and significant correlation was observed with panicle length (0.0407*) and panicle diameter (0.455*) (**Table 3**). Grain yield per plant exhibited significant positive association with panicle diameter followed by panicle length and plant height. These findings are similar to those of earlier studies in pearl millet on various traits, such as grain yield, panicle length (**Singh and Singh, 2016**), panical diameter (**Izge *et al*., 2006**), and plant height. (**Shashikant *et al*., 2012**). Grain yield per plant exhibited non-significant association with days to 50% flowering and plant height. The similar findings are reported in pearl millet on various traits, such as grain yield, days to 50% flowering (**Izge *et al*., 2006**), and plant height. (**Shashikant *et al*., 2012**).

Positive and non-significant phenotypic correlation with plant height (0.0551), while positive and significant correlation was observed with panical length (0.2339*) and panicle diameter (0.535*) (Table 4).

It had negative and significant phenotypic correlation with days to 50 per cent flowering (-0.394**). Similar observations were also reported for days to panicle diameter (**Abubakar *et al*., 2020**), **Bello *et al*., (2001)** and **Khairwal *et al*.,** (1999). Grain yield had negative and non- significant genotypic correlation with plant height (-0.097NS).

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.

Path Coefficient

By partitioning the correlation, the path coefficient analysis allows separation of the direct and its indirect effects through other variables (**Wright, 1921**).

The characters with the strongest direct effect on grain yield were days to 50 percent flowering (0.9946) followed by panicle diameter (0.5726) according to the path coefficient analysis at the genotypic level.

The strong relationship between grain yield per plant and the days to 50 percent flowering, panicle length and panicle diameter proved to be the key determinant **(Rakesh *et al*., 2015**). Plant height (-0.3339) and panicle diameter (-0.2735) had negative direct effect on grain yield. Similar findings reported by **Patil and Jadeja** (2005). For genotypic path coefficient analysis, the residual effect was 0.5980. The residual effect is moderate, it indicates that the characters studied, there are some other attributes which contribute for grain yield.

Table 3. Genotypic correlation coefficients for five traits in hybrids of pearl millet

Traits	DF	PH	PL	PD	GY
DF	1	0.762**	-0.0348	-0.6031**	0.2987NS
PH		1	0.2707	0.6575**	-0.097NS
PL			1	0.446*	0.0407*
PD				1	0.455*
GY					1

*, ** Significant at 5 and 1 per cent level. DF = days to 50% flowering, PH = plant height, PL = panicle length, PD = panicle diameter, GY = grain yield plant $^{-1}$

Table 4. Phenotypic Correlation coefficients for five traits in hybrids of pearl millet

Traits	DF	PH	PL	PD	GY
DF	1	0.521**	0.1573	0.0422	-0.394**
PH		1	0.1875	0.278*	0.0551NS
PL			1	-0.041	0.2339*
PD				1	0.535*
GY					1

*, ** Significant at 5 and 1 per cent level. DF = days to 50% flowering, PH = plant height, PL = panicle length, PD = panicle diameter, GY = grain yield plant $^{-1}$

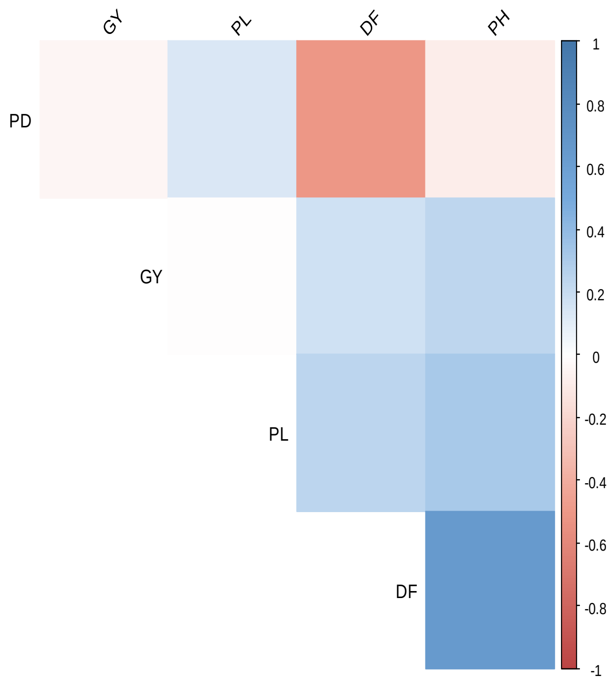

Figure 1. Correlalogram of yield contributing traits studied under the current investigation

Table 5. Direct and indirect effects (genotypic level) of yield contributing traits on grain yield plant^{-1} (g) in hybrids of pearl millet

Traits	DF	PH	PL	PD
DF	**0.9946**	0.7579	0.35	-0.5998
PH	-0.2545	**-0.3339**	-0.1194	0.0324
PL	-0.0962	-0.0978	**-0.2734**	-0.0399
PD	-0.3453	-0.0556	0.0836	**0.5726**
GY	0.2987	0.2707	0.0407	-0.0348
Partial R2	0.2971	-0.0904	-0.0111	-0.0199

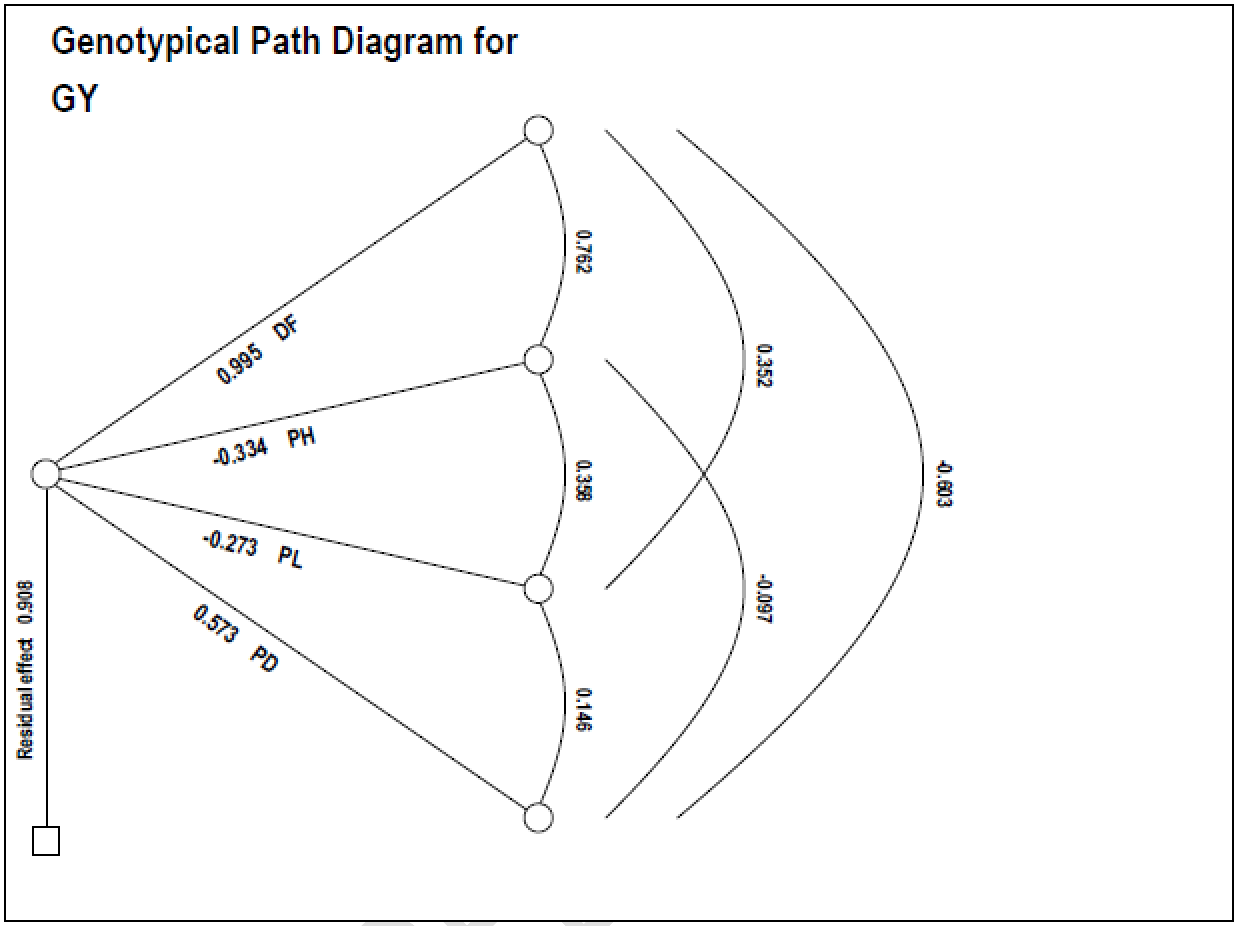

Figure 2. Genotypic path diagram for grain yield plant^{-1}

CONCLUSION

Eighteen hybrids of pearl millet were evaluated in randomized block design to determine yield and yield component relationships. The results revealed that panical length and panical diameter expressed positive and significant correlation with grain yield. Grain yield per plant exhibited significant positive association with panicle diameter followed by panicle length and plant height. Grain yield per plant exhibited non-significant association with days to 50% flowering and plant height.

key yield contributing traits in pearl millet are panical diameter and panicle length, according to correlations and path studies.

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