

## Original Research Article

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## Panicle Traits and Plant Height are Important Selection Indices to Enhance Productivity in Pearl Millet (*Pennisetum glaucum* L.R.Br.) Populations

K. Sudarshan Patil<sup>1,2\*</sup>, S.K. Gupta<sup>2</sup>, Kuldeep Singh Dangi<sup>1</sup>,  
D. Shashibhushan<sup>1</sup>, M. Balram<sup>1</sup> and T. Ramesh<sup>1</sup>

<sup>1</sup>College of Agriculture, PJTSAU, Hyderabad-030, Telangana, India

<sup>2</sup>ICRISAT, Patancheru, Hyderabad-030, Telangana, India

\*Corresponding author

### ABSTRACT

#### Keywords

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The study was conducted to determine the correlation and path coefficients among the yield and yield component characters in 14 parental lines and 91 hybrids of pearl millet (*Pennisetum glaucum* L. R. Br), formulated by a diallel cross excluding reciprocals. Strong and significant genotypic and phenotypic correlations were observed between grain yield ( $\text{kg ha}^{-1}$ ) with panicle girth (cm), plant height (cm) and panicle length (cm). The path analysis indicated that panicle girth (cm) and plant height (cm) had the highest direct effects on grain yield. The days to 50% flowering, 1000-grain weight (g) and number of productive tillers had the least direct effects on grain yield. The direct effect of panicle girth (cm) was greatly reduced by the negative indirect effects through days to 50% flowering and 1000-grain weight (g). Similarly, the direct effect of plant height was very much influenced by the negative indirect effects of days to 50% flowering. The panicle girth, plant height and panicle length in this study has been identified as selection indices for obtaining good parental lines and hybrids in a pearl millet breeding program.

### Introduction

Pearlmillet (*Pennisetum glaucum* L.R.Br.), known as bulrush or cat tail millet is also known as 'Bajra' in India. It is grown widely in the arid and semi-arid tropical regions in Indian subcontinent and African continent under the most adverse agro-climatic conditions where other crops like sorghum and maize fail to produce economic yields. In India, pearl millet is the third most widely cultivated food crop after rice and wheat. It is a rich source of iron and zinc. Apart from being a main staple food crop, its use for

poultry feed is on the increase. It is also an important source of fodder and the only source of feed in dry months (Hash *et al.*, 2003). It is grown on 9 million ha with an average productivity of  $1,000 \text{ kg ha}^{-1}$  (Yadav and Rai, 2013). The ultimate aim in most plant breeding programs is the improvement in the productivity of grains as measured in terms of the yield per unit area. The possibilities of achieving this goal through genetic manipulation have been elucidated by evolving high yielding hybrids and varieties of pearl millet in Asia and West Africa. These newly evolved varieties and hybrids owe their

high yielding ability to a reconstruction of an ideal plant type. It is now widely recognized that the improvement in plant type can make a very significant contribution to a higher total grain yield.

The grain yields largely under subsistence farming are low (500–700 kg ha<sup>-1</sup>). Low soil fertility, rain-fed farming characterized by erratic and inadequate rainfall, negligible external inputs, continued use of mostly unimproved cultivars with a low harvest index (<20%) and the prevalence of diseases and insect pests being the major causes of low productivity. Grain yield character in pearl millet and as in all crop plants is quantitative in nature and is polygenically controlled. Selection based on grain yield character alone is usually not very effective and efficient. However, selection based on its component characters could be more efficient and reliable. Knowledge of the association between yield and its component characters and among the component characters themselves can improve the efficiency of selection in plant breeding. Owing to a complex situation, selection for an optimum advance on grain yield should be based on judiciously computed index. The correlation studies taken alone are often misleading and the actual dependence of grain yield on the correlated yield component characters needs confirmation, which can easily be untangled and unraveled by path coefficient analysis.

The path coefficient analysis is simply a standardized partial regression coefficient and as such, it measures the direct influence of one variable upon the other and permits the separation of correlation coefficients into components of direct and indirect effects.

Studies of correlation and path analysis were conducted in different crops such as in groundnut, by (Izgeet *et al.*, 2004), in sorghum, by (Ezeaku and Mohammed, 2006), Singh and Singh (1973), Bello *et al.* (2001), in cowpea by

(Oseni, 1994), and in rice by Kumar and Saini (1973). The present study was undertaken to study the correlations and path analysis in different pearl millet populations and their hybrids to develop a criterion for selection that could be effectively used for selecting the desirable genotypes or lines with high yield potential in the future.

## **Materials and Methods**

Fourteen (14) pearl millet populations together with their 91 population hybrids obtained from a diallel cross excluding reciprocals produced at International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Patancheru, Hyderabad, were used for the study. The experiment was conducted during rainy season of 2016 at three locations in Patancheru (18°N, 78°E), Professor Jayashankar Telangana State Agricultural University (PJTSAU), Regional Agricultural Research station (RARS), Palem (17°N, 78°E), and Jamnagar Agricultural University (JAU), Pearl millet research station, Jamnagar (22°N, 70°E).

The experiment consisted of 105 treatments (14 parental lines + 91 hybrids) laid out in alpha-lattice design with two replications. In each replication, the size of the plot consisted of 4 rows with a length of 4 meters. The spacing between and within the rows was maintained at 75 cm and 12-15 cm, respectively. Seeds after germination were thinned down to one plant per hill after two weeks of sowing. A basal dose of 100 kg of di-ammonium phosphate (18% N and 46% P) was applied at the time of field preparation and 100 kg of urea (46% N) was applied as top dressing in two-split dose at the stage of three weeks and five weeks after sowing. Trials were regularly irrigated to avoid any moisture stress. All the recommended agronomic practices were followed for raising good crop.

## Data collection

Data collection was done for the grain yield and seven yield component characters. The observations were taken on 15 random plants from each population for the traits like plant height (cm), number of productive tillers/plant, panicle length (cm), and panicle girth (cm). Other traits such as days to 50% flowering, grain yield, 1000-grain weight (g) and dry stover yield data were recorded on plot basis. Further, data of grain yield and stover yield was converted to  $\text{kg ha}^{-1}$ .

## Data analysis

Phenotypic and genotypic linear correlation coefficients were calculated for all the possible comparisons using the formula suggested by Falconer (1964). The correlation coefficients were partitioned into direct and indirect effects using the path coefficient analysis according to Dewey and Lu (1959). Data analysis was carried out using SAS v 9.4 software (SAS, Inc., 2017).

## Result and Discussion

### Phenotypic and genotypic correlation

The phenotypic and genotypic correlation coefficients between grain yield and its component traits are presented in Table 1. The genotypic correlation coefficient of 0.570 between grain yield with panicle girth and phenotypic correlation coefficient of 0.335 between grain yield with dry stover yield were among the highest values obtained in the present study. The correlation coefficients for most of the pairs of characters revealed the presence of strong positive genotypic association between grain yield with all the traits except for number of productive tillers. Moderate positive phenotypic association was found between grain yield with plant height, panicle girth and dry stover yield. The genotypic correlations were of higher

magnitude than their corresponding phenotypic correlations, indicating a strong inherent relationship among the characters studied. This strong genotypic correlation over phenotypic correlations were reported in previous studies in pearl millet (Khairwal *et al.*, 1999, Izge *et al.*, 2006, Bhuri Singh *et al.*, 2015 and Bhasker *et al.*, 2017) and in Sorghum (Bello *et al.* 2001, Ezeaku and Mohammed, 2006).

Significant positive genotypic correlation between grain yield with days to 50% flowering (0.461) and significant negative genotypic correlation between grain yield with number of productive tillers was observed in the present study. On the contrary, Izge *et al.*, (2006) and Bhuri Singh *et al.*, (2015) found negative genotypic correlation between grain yield and days to 50% flowering and positive correlation between grain yield and number of productive tillers per plant. This difference might be due to use of more number of African based populations involved in the study, which are generally late flowering in nature, and differ in their adaptation to the changed environment condition in Indian sub-continent. However, most correlation studies reported no correlation between days to 50% flowering and grain yield (Chaudhary, 1992, Ezeaku and Mohammed 2006, Izge *et al.*, 2004).

The result also revealed the presence of positive and highly significant genotypic correlations of days to 50% flowering with plant height (0.909), panicle length (0.698), and dry stover yield (0.833). Negative and highly significant genotypic correlations were observed between days to 50% flowering with number of productive tillers (-0.809). In addition, number of productive tillers showed significant negative correlation with all the traits in both types of correlations. Whereas, plant height showed significant positive genotypic and phenotypic correlation with all the traits except for panicle girth.

**Table.1** Analysis of genotypic (above diagonal) and phenotypic(below diagonal) correlation coefficients for grain yield and yield components characters in pearl millet combined three across locations

	DFE	PHT	NPT	PL	PG	TKW	DSY	GY
DFE		0.909**	-0.809**	0.698**	0.160**	0.096	0.833**	0.461**
PHT	0.604**		-0.500**	0.667**	0.083	0.251**	0.853**	0.395**
NPT	-0.264**	-0.214**		-0.467**	-0.574**	-0.543**	-0.383**	-0.367**
PL	0.479**	0.538**	-0.162**		0.023	0.108	0.657**	0.409**
PG	0.093	0.103	-0.219**	0.020		0.731**	-0.098	0.570**
TKW	0.090	0.153*	-0.123*	0.038	0.502**		-0.046	0.469**
DSY	0.537**	0.641**	-0.145*	0.384**	-0.016	-0.013		0.361**
GY	0.104	0.268**	-0.143*	0.116	0.241**	0.110	0.335**	

\*, \*\*, Significance at 0.05, 0.01 levels of probability, respectively.

DFE: Days to50% flowering, PHT: Plant height(cm), NPT: Number of productive tillers/plant, PL: Panicle length(cm), PG: Panicle girth(cm), TGW: 1000-grain weight(g), DSY-Dry stover yield (kg ha<sup>-1</sup>), GY-Grain yield (kg ha<sup>-1</sup>)

**Table.2** Path coefficient analysis of grain yield [direct effects (diagonal) and indirect effects] with other yield components in pearl millet, combined across locations

	DFE	PHT	NPT	PL	PG	TGW	DSY	Genotypic correlation with GY
DFE	<b>-1.032</b>	0.600	0.260	0.208	0.128	-0.035	0.332	0.461**
PHT	-0.938	<b>0.660</b>	0.161	0.198	0.066	-0.093	0.340	0.395**
NPT	0.835	-0.330	<b>-0.321</b>	-0.139	-0.458	0.200	-0.153	-0.367**
PL	-0.720	0.440	0.150	<b>0.298</b>	0.018	-0.040	0.262	0.409**
PG	-0.165	0.054	0.185	0.007	<b>0.797</b>	-0.269	-0.039	0.570**
TGW	-0.099	0.166	0.175	0.032	0.582	<b>-0.368</b>	-0.018	0.469**
DSY	-0.859	0.563	0.123	0.196	-0.078	0.017	<b>0.399</b>	0.361**

\*, \*\*, Significance at 0.05, 0.01 levels of probability, respectively.

DFE: Days to50% flowering, PHT: Plant height(cm), NPT: Number of productive tillers/plant, PL: Panicle length(cm), PG: Panicle girth(cm), TGW: 1000-grain weight(g), DSY-Dry stover yield (kg ha<sup>-1</sup>), GY-Grain yield (kg ha<sup>-1</sup>)

Significant positive correlation of lower magnitude (0.409) was observed between grain yield with panicle length. The difference of opinion in the various studies undertaken by many authors could be attributed to the differences in the materials used and the prevailing weather conditions. Generally, the genotypic correlations showed more significant difference between pairs of characters than the phenotypic correlations. Significant and positive correlations between yield and other yield variables are quite desirable in plant breeding, because it facilitates the selection process. Similar observations were reported by Thangasamy and Gomathinayagam (2003), Izge *et al.*, (2006), Sumanth *et al.*, (2014) and Bhasker *et al.*, (2017) in pearl millet and Rajni *et al.*, (1978), Bello *et al.*, (2001), and by Aba and Obilana (1994), in various other crops.

### **Path Coefficient Analysis**

The path coefficient analysis of yields and its components are presented in Table 2. The path coefficient analysis revealed that panicle girth and plant height gave the highest direct effect on total grain yield at 0.797 and 0.660, respectively. The direct and indirect contributions by days to 50% flowering through most of the characters were negative. Number of tillers/plant had the positive indirect effect towards total grain yield/ha through rest of the other traits. Panicle girth had a very strong correlation with grain yield (0.57), there was high indirect effect through 1000-grain weight (0.582), with very low indirect effects through plant height (0.066) and panicle length (0.018), whereas negative indirect effects were found through number of tillers/plant (-0.139) and dry stover yield (-0.078). The highest indirect effect of 0.835 toward grain yield was found through days to 50% flowering and number of tillers/plant, while the minimum indirect effect of -0.859 was made by days to 50% flowering through

dry stover yield. Higher indirect values could most likely be neutralized in most cases by the negative indirect effects via other characters and this can lead to their low and non-significant genotypic correlation with total grain yield. In that regard therefore, selection for such characters may not enhance yield improvement and are not to be encouraged.

Plant height, panicle length, panicle girth and 1000-grain weight were also important yield determinant characters because of their positive and highly significant levels of correlations with yield. Plant height had a direct effect of 0.66 toward grain yield and indirect effects of 0.440, 0.166 and 0.054 through panicle length, 1000-grain weight and panicle girth respectively. Similarly, Izge *et al.*, (2006) also found high direct effects and significant high positive correlations for plant height with grain yield. Panicle length exhibited the positive indirect effect through plant height (0.198) and the lowest indirect effect of -0.139 through number of productive tillers per plant. The correlation coefficient between panicle length and grain yield was also high. Panicle girth contributed highest positive indirect effect through 1000-grain weight (0.582), and low positive effects through plant height (0.066) and panicle length (0.018). On the contrary, Sumanth *et al.*, (2014) found high direct effects for number of productive tillers and negative direct effects for plant height and panicle length. Bhasker *et al.*, (2017) and Rakesh *et al.*, (2015) reported high direct effects for fodder yield followed by panicle length, plant height, 1000-grain weight and number of productive tillers per plant on grain yield.

Panicle girth, plant height and panicle length appeared to be the prominent characters when selecting for grain yield in pearl millet, because of their highly significant genotypic and phenotypic correlations with grain yield.



Thangasamy and Gomathinayagam (2003) and Bhuri Singh *et al.*, (2015) reported these traits to be important for selection process to improve grain yield in pearl millet. These characters also had the highest direct effects on grain yield and high indirect effects through most of the other characters. This investigation therefore suggests that panicle girth, plant height and panicle length should be given maximum consideration for total yield improvement as the appropriate selection indices. The selection procedure should be formulated so that the advance in one component is not jeopardized by the deterioration effect of the other.

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