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Correlation and Path Analysis of Yield Components in Barnyard Millet (*Echinochloa esculenta* L.)

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Abstract

The experiment was conducted at the Agril. Botany Farm at Government College of Agriculture, Pune, where total 40 genotypes were evaluated for correlation and path analysis in a Randomized Block design with 3 replications during *kharif* 2025. Eleven different characters such as days to 50 per cent flowering, days to maturity, plant height, no. of tillers per plant, panicle length, spikelet length, 1000-grain weight, grain iron content, grain zinc content and grain yield per plant were evaluated. All the characters had positive significant correlation with the grain yield per plant except days to 50 percent flowering, days to maturity, grain zinc content and grain iron content. 1000 grain weight had the highest positive direct effect on grain yield followed by spikelet length, Days to maturity, grain iron content, days to 50 per cent flowering and grain zinc content. This characters can be useful for improving seed yield in barnyard millet. Remaining characters such as plant height, panicle length and number of tillers per plant has negative direct effect on grain yield per plant.

Keywords: Barnyard millet, characters, path analysis, correlation, direct effect

Introduction

Barnyard millet (*Echinochloa esculenta* L.) is the most important and popular small millet in Asia. The Indian barnyard millet is also known as “Billion Dollar Grass” (MoA&FW, GOI). Where its short duration, adaptability and ability to produce grain under relatively limited resource conditions make it a valuable crop. It is cultivated over an area of 0.1 million hectare with the total production of about 0.07 million tonnes with productivity of 0.7 tonnes per hectare (Ministry of Agriculture and Farmers Welfare, GOI). Among the small millets cultivated during the *kharif* season, it ranks second in importance after finger millet (Anuradha *et. al.*, 2014) [2]. Per 100g of grain, it contains about 10.1% protein, 8.7% moisture, 3.9% fat, 6.7% crude fibre, 2.0% total fat and 68.8% carbohydrate providing nearly 398 kcal of energy. Barnyard millet also has high dietary content (12.5%) which include both soluble fibre (4.2%) soluble fibre and (8.4%) insoluble fibre (Ugare *et al.*, 2014). It is the richest source of iron among all millets. Its pale seeds provide a cooling effect and are used to treat cholera and fever. Additionally the germinated seeds offer soothing benefits, aid digestion, and possess astringent and acidic qualities, making them useful for managing nutritional deficiencies digestive problems and abdominal dyspepsia. Correlation analysis provides information on the direction and magnitude of association among yield and its component traits, thereby helping to identify characters that are closely associated with grain yield. While path coefficient analysis partition correlation coefficients into direct and indirect effects, thereby providing a better understanding of the relative contribution of individual traits to grain yield. The information generated from the study would help identify important yield-contributing traits and provide a reliable basis for selecting superior genotypes and formulating effective breeding strategies for genetic improvement of barnyard millet.

Materials and Methods

The present study in Barnyard Millet (*Echinochloa esculenta* L.) was carried out during the *kharif* season of 2025 at the Division of Agril Botany, Government College of Agriculture, Pune.

Total 40 genotypes were evaluated in a Randomized Block Design (RBD), which was collected from the All India Coordinated Research Project on Small Millets AICRP, Kolhapur. Each genotype were grown with spacing of 30 x 10 cm. Five plants were randomly selected for data collection. Improving grain yield in barnyard millet requires a clear understanding of the interrelationships among its yield-associated characters. Correlation analysis provides information on the magnitude and direction of relationships between grain yield and its component traits, while path coefficient analysis further separates these associations into direct and indirect effects, helping to identify characters that make an important contribution to grain yield (Wright, 1921; Dewey and Lu, 1959)^[8, 9]. The combined use of these analytical approaches can provide valuable information for identifying suitable selection criteria and developing efficient breeding strategies for enhancing productivity in barnyard millet.

Results

Correlation analysis provides an understanding of the degree and direction of association among different quantitative traits and grain yield in barnyard millet. The genotypic correlation coefficient reflects the inherent genetic association between traits and is therefore of particular importance in crop improvement, as it provides a better indication of the extent to which selection for one character may influence another. In contrast, phenotypic correlation represents the association expressed at the observable level and is influenced by both genetic and environmental factors. A comparison between genotypic and phenotypic correlations can thus provide useful information about the extent of environmental influence on trait associations. Here the higher phenotypic correlation coefficient observed as compared to that of the genotypic correlation coefficient, it suggests that environmental factors contribute to the observed association between the traits.

Table I represents the relationship between the grain yield and yield related traits. It shows that plant height (0.9528), 1000-grain weight (0.8947), Number of tillers per plant (0.8427), Panicle length (0.8374), Spikelet length (0.8040) were significantly and positively correlated with the grain yield per plant at genotypic level. Grain zinc content (0.1671) and grain iron content (0.1403) were positive but non-significantly correlated with the grain yield per plant. Days to maturity (-0.5436) was negative but significantly correlated with grain yield per plant. Days to 50 per cent flowering is negative but non significantly correlated with the grain yield per plant.

Days to 50 percent flowering was positive but significantly correlated with grain iron content (0.6007) however it is positive but non-significantly correlated with plant height (0.0671), panicle length (0.0355), 1000-grain weight (0.0323). Days to maturity (-0.2594), grain zinc content (-0.1667), spikelet length (-0.1584), number of tillers per plant (-0.0916) were negative but non significantly correlated with days to days to 50 per cent flowering.

Days to maturity showed highly significant negative correlations with panicle length (0.5249), 1000-grain weight (-0.4618). Furthermore, it revealed a significant negative association with grain iron content (-0.3946). It shows positive but non-significant correlation with plant height (0.1256), negative but non-significant correlation with the number of tillers per plant (-0.2175), spikelet length (-

0.3538) and positive but non-significant correlation with grain zinc content (0.0576). Plant height exhibited highly significant and positive correlations with panicle length (0.9661) followed by 1000-grain weight (0.9498), number of tillers per plant (0.8698) and spikelet length (0.8147). It showed positive but non-significant associations with grain zinc content (0.2180) and grain iron concentration (0.1665). Number of tillers per plant exhibited positive but significant correlation with spikelet length (0.8029), panicle length (0.7748), 1000-grain weight (0.7748). Grain zinc content (0.1718) showed positive but non-significant correlation while grain iron content showed negative but non-significant correlation with number of tillers per plant.

Panicle length showed highly significant positive correlation with 1000-grain weight (0.9504) and spikelet length (0.5822). Its interrelationships with grain iron content (0.1273) and zinc content (0.0681) content were positive but statistically nonsignificant.

Spikelet length was positively and highly significantly correlated with 1000-grain weight (0.5576), statistically negative non-significant associations with grain iron content (-0.0120) and positive non-significant correlation with grain zinc content (0.1404).

The 1000-grain weight exhibited positive but non-significant correlations with grain iron (0.1318) and grain zinc content (0.0971).

Grain iron content showed a negative and non-significant correlation with grain zinc content (-0.0202).

Plant height, number of tillers per plant, panicle length, spikelet length, and 1000-grain weight were the characteristics that most strongly positively correlated with grain yield per plant. While grain iron concentration, and grain zinc content had positive but non-significant relationships with grain yield per plant, days to maturity demonstrated a significant negative correlation. The traits which exhibit strong positive relationships with grain yield per plant is useful for indirect selection to increase grain output in barnyard millet.

Path analysis is a statistical approach used to assess the direct and indirect relationships among different variables. A relationship in which one variable influences another directly is considered a direct effect, whereas an association transmitted through one or more other variables represents an indirect effect. By separating the correlation coefficients into their direct and indirect components, path analysis facilitates the identification of important yield-contributing traits and provides a useful basis for indirect selection. It also strengthens the interpretation of observed correlations and provides greater clarity regarding the underlying relationships among characters, thereby supporting the development of appropriate selection strategies for a particular breeding objective (Bhuva *et al.*, 2020)^[10]. Dewey and Lu (1959)^[9] employed path coefficient analysis to estimate the direct and indirect effects of yield-associated characters on yield. Thus, selection strategies for crop improvement can be guided by both correlation coefficients and the magnitude and direction of direct and indirect effects. Traits exhibiting a positive and substantial direct effect on yield are generally considered useful selection criteria, whereas traits having weak or negative correlations with yield may require consideration of their indirect effects through other associated characters.

Table II. showed the direct as well as indirect relationship between each character towards the grain yield per plant.

For path analysis genotypic correlation coefficient was considered. 1000-grain weight (1.0032), days to maturity (0.1198), grain iron concentration (0.0798), days to 50% flowering (0.0784), spikelet length (0.6034) and grain zinc content (0.0605) were the component features with the most positive direct influence. On the other hand, grain yield was negatively influenced by plant height (-0.2494), panicle length (-0.1737), and the number of tillers per plant (-0.0089). Strong overall positive correlations with yield were maintained by traits including 1000-grain weight, days to maturity, grain iron concentration, days to 50% flowering, spikelet length and grain zinc content. These correlations were mainly caused by significant direct contributions or strong indirect effects mediated through other yield components.

The genotypic correlation analysis revealed that out of nine characters considered as independent variables, six characters showed a significant association with grain yield per plant. Days to maturity exhibited a highly significant negative correlation (-0.5436) with grain yield per plant. In contrast, plant height (0.9528), 1000-grain weight (0.8947), number of tillers per plant (0.8427), panicle length (0.8374) and spikelet length (0.8040) showed highly significant and positive correlations with grain yield per plant. The remaining three characters, namely days to 50 per cent flowering (-0.0001), grain iron content (0.1403) and grain zinc content (0.1671), exhibited non-significant correlations with grain yield per plant. Thus, a total of five characters showed highly significant positive associations, while one character showed a highly significant negative association with grain yield per plant. According to the current study, plant height, the number of tillers per plant, panicle length, spikelet length, and 1000-grain weight were the most crucial characteristics for choosing superior genotypes with higher grain yield per plant because they showed highly significant and positive associations with grain yield per plant. Days to maturity showed a highly significant negative correlation, suggesting that selection for increased grain yield may also benefit from taking these factors into consideration.

Days to 50% flowering (0.0784) showed direct positive effect on grain yield while negative indirect effect with grain zinc concentration (-0.0131), spikelet length (-0.0124) and number of tillers per plants (-0.0072), while grain iron content (0.0471), plant height (0.0053), panicle length (0.0028), 100-seed weight (0.0025) showed comparatively positive indirect effects. Days to maturity (0.1198) had

direct positive effect on grain yield. Plant height (0.0151), grain zinc content (0.0069) showed positive indirect effects, whereas days to 50% flowering (-0.0311), number of tillers per plant (-0.0261), panicle length (-0.0629), spikelet length (-0.0424), 1000-grain weight (-0.0553) and grain iron content (-0.0473) had negative indirect effects.

Plant height has negative indirect effects through days to 50 per cent flowering, days to maturity, grain iron content, grain zinc content, spikelet length, number of tillers per plant, 1000-grain weight and panicle length. Also plant height has negative direct effect (-0.2494).

Number of tillers per plant revealed positive indirect effects through characters days to 50% flowering, days to maturity and grain iron content, while negative indirect effects were found through plant height, panicle length, spikelet length, 1000-grain weight, and grain zinc content.

Panicle length showed a highly significant positive correlation with grain yield per plant (0.8374), with positive indirect effects through days to maturity and negative indirect effects through days to 50% flowering, plant height, spikelet length, 1000-grain weight, grain iron content and grain zinc content. Spikelet length results showed a highly significant positive correlation with grain yield per plant (0.8040). Positive indirect effects were observed in plant height, number of tillers per plant, panicle length, 1000-grain weight, and grain zinc content and negative indirect effects were found in days to 50% flowering, days to maturity, and grain iron content. 1000-grain weight showed positive indirect effects through days to 50% flowering, plant height, number of tillers per plant, panicle length, spikelet length, grain iron content, and grain zinc content, whereas negative indirect effects were found through days to maturity. Grain iron content showed positive indirect effects with days to 50% flowering, plant height, panicle length, and 1000-grain weight; negative indirect effects were found in days to maturity, spikelet length, number of tillers per plant, and grain zinc content.

Grain zinc content exhibited positive indirect effects in days to maturity, plant height, number of tillers per plant, panicle length, spikelet length, and 1000-grain weight and negative indirect effects were found in days to 50% flowering, and grain iron content. The residual effect is the variation in the dependent variable that remains unexplained by the associated traits included in the analysis. In present study residual effect was low (0.2828) explaining substantial proportion of the variation in grain yield.

Table 1: Genotypic correlation coefficients of 10 characters in 40 genotypes of Barnyard millet

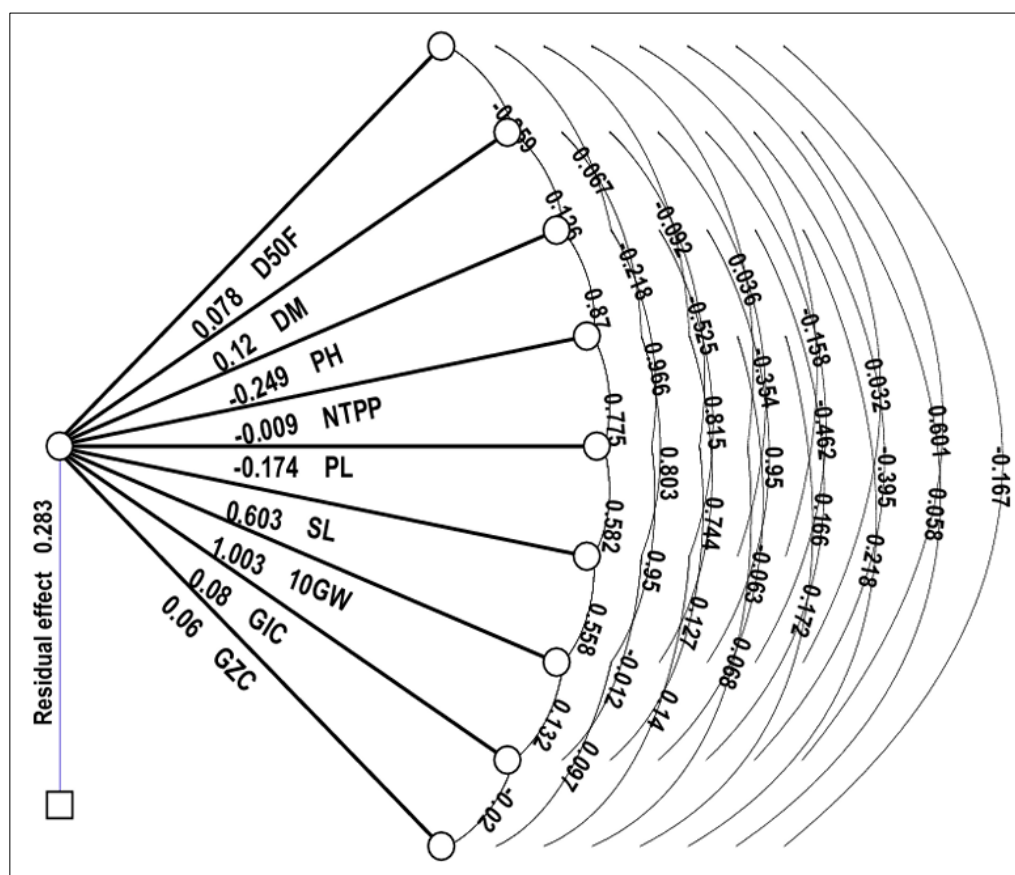
Sr. No.	Days to 50 per cent flowering (No.)	Days to maturity (No.)	Plant Height (cm)	Numbers of tillers per plant (No.)	Panicle length (cm)	Spikelet length (cm)	1000-grain weight (g)	Grain Iron content (mg)	Grain Zinc content (mg)	Grain yield per plant (g)
	1	2	3	4	5	6	7	8	9	10
1.	1	-0.2594	0.0671	-0.0916	0.0355	-0.1584	0.0323	0.6007 **	-0.1667	-0.0001
2.		1	0.1256	-0.2175	-0.5249 **	-0.3538	-0.4618 **	-0.3946*	0.0576	-0.5436 **
3.			1	0.8698 **	0.9661 **	0.8147 **	0.9498 **	0.1665	0.2180	0.9528 **
4.				1	0.7748 **	0.8029 **	0.7440 **	-0.0631	0.1718	0.8427 **
5.					1	0.5822 **	0.9504 **	0.1273	0.0681	0.8374 **
6.						1	0.5576 **	-0.0120	0.1404	0.8040 **
7.							1	0.1318	0.0971	0.8947 **
8.								1	-0.0202	0.1403
9.									1	0.1671
10										1

* and ** denote significance at the 5% and 1% levels, respectively.

Table 2: Direct and indirect (below and above diagonal) path effects of different characters towards grain yield at genotypic level in Barnyard millet

Sr. No.	Days to 50 per cent flowering (No.)	Days to maturity (No.)	Plant height (cm)	Numbers of tillers per plant (No.)	Panicle length (cm)	Spikelet length (cm)	1000-grain weight (g)	Grain Iron content (mg)	Grain Zinc content (mg)	Grain yield per plant (g)
	1	2	3	4	5	6	7	8	9	10
1.	0.0784	-0.0203	0.0053	-0.0072	0.0028	-0.0124	0.0025	0.0471	-0.0131	-0.0001
2.	-0.0311	0.1198	0.0151	-0.0261	-0.0629	-0.0424	-0.0553	-0.0473	0.0069	-0.5436 **
3.	-0.0167	-0.0313	-0.2494	-0.2169	-0.2409	-0.2032	-0.2368	-0.0415	-0.0544	0.9528 **
4.	0.0008	0.0019	-0.0077	-0.0089	-0.0069	-0.0071	-0.0066	0.0006	-0.0015	0.8427 **
5.	-0.0062	0.0911	-0.1678	-0.1345	-0.1737	-0.1011	-0.1650	-0.0221	-0.0118	0.8374 **
6.	-0.0956	-0.2135	0.4916	0.4845	0.3513	0.6034	0.3364	-0.0073	0.0847	0.8040 **
7.	0.0324	-0.4633	0.9528	0.7464	0.9534	0.5593	1.0032	0.1323	0.0974	0.8947 **
8.	0.0479	-0.0315	0.0133	-0.0050	0.0102	-0.0010	0.0105	0.0798	-0.0016	0.1403
9.	-0.0101	0.0035	0.0132	0.0104	0.0041	0.0085	0.0059	-0.0012	0.0605	0.1671

(Residual effect = 0.2828) * and ** denote significance at the 5% and 1% levels, respectively.

**Fig 1:** Genotypical path diagram for grain yield per plant in Barnyard Millet

Conclusion

The grain yield recorded high significant and positive correlation with plant height, numbers of tillers per plant, panicle length, spikelet length, 1000-grain weight. Negative but significant correlation showed by days to maturity with grain yield per plant. The highest positive direct effect was observed by 1000-grain weight. Based on the path analysis the main yield contributing traits are 1000-grain weight, spikelet length, days to maturity. Thus, for crop improvement one must select plant with more 1000-grain weight, spikelet length and days to maturity.

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