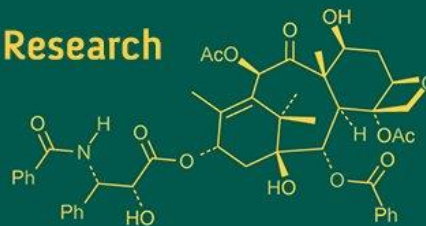


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Correlation and path coefficient studies on yield components in summer season barnyard millet genotypes

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Abstract

The initial step in improving grain yield in barnyard millet through genetic enhancement involves indirect selection of yield-related traits. An evaluation of 35 barnyard millet germplasm accessions revealed that traits such as flag leaf blade width (0.737), 1000-grain weight (0.620), flag leaf blade length (0.549), days to physiological maturity (0.542), peduncle length (0.539), panicle length (0.311), plant height (0.298), days to 50 per cent flowering (0.256) and basal tiller number (0.214) showed a strong and significant positive genotypic correlation with grain yield per plant. A positive association suggests that an increase in any one of these traits would likely lead to higher grain yield. Path coefficient analysis further demonstrated that flag leaf blade width (0.8813) contributed the greatest positive direct effect on grain yield, followed by peduncle length (0.6669), days to 50 per cent flowering (0.6081), basal tiller number (0.5193), flag leaf blade length (0.3089) and panicle length (0.2836). Conversely, traits such as days to physiological maturity (-0.777), plant height (-0.4533) and 1000-grain weight (-0.4479) exerted negative direct effects on grain yield per plant.

Keywords: Barnyard millet, correlation, path analysis, yield components

Introduction

Barnyard millet (*Echinochloa frumentacea*), a minor but valuable crop, belongs to the genus *Echinochloa* (family Poaceae, sub family Panicoideae) and is primarily self-pollinated (Clayton and Renvoize, 2006) [8]. The genus includes about 250 species distributed across tropical and temperate regions (Bajwa *et al.*, 2015) [6] and has a chromosome number of $2n = 4x = 36$.

India ranks first globally in terms of area and production of barnyard millet, with an average productivity of 1034 kg ha⁻¹ (IIMR, 2018) [14]. Barnyard millet is widely cultivated in countries such as India, China, Japan and Korea, where it serves both as a staple food and as fodder for livestock (Upadhyaya *et al.*, 2014) [25]. It is also cultivated on the hills under double cut production system with better yield (Bandyopadhyay 2009) [7]. The crop is particularly valued for its ability to withstand drought, short growth period, (Dwivedi *et al.*, 2012) [12] and exceptional nutritional properties (Saleh *et al.*, 2013) [20].

Barnyard millet is a highly nutritious grain, containing about protein (12%) with digestibility (81%) (Arya *et al.*, 2018) [4]. It is rich in dietary fiber (13%), comprising both soluble (4%) and insoluble (8%) types and has a relatively low carbohydrate content (58%), with 25 per cent being slowly digestible. These traits make it beneficial for a healthy diet, especially for individuals with diabetes (Ugare, 2014) [24]. It also provides moderate levels of minerals like calcium (25 mg/100 g) and iron (1.40 mg/100 g) (Veena, 2003) [26]. Despite its nutritional value, barnyard millet remains an underutilized crop with limited genetic improvement efforts. Its genetic diversity is rapidly declining and cultivation areas are shrinking in several states (Gupta *et al.*, 2009) [13]. However, ongoing initiatives aim to collect and characterize barnyard millet genotypes (Gupta *et al.*, 2009) [13].

To achieve this objective, an experiment was carried out to identify the traits contributing to higher yield in barnyard millet. Understanding how yield is related to its component traits is crucial for developing effective selection strategies and identifying superior genotypes. In kodo millet improvement, it is important to determine those traits that not only show a

significant positive correlation with grain yield but also exert both direct and indirect effects on it. For this, correlation and path coefficient analyses are essential tools. Correlation analysis provides information on the degree of association among traits, while path analysis helps to clarify whether a trait influences yield directly or indirectly through other characters. Based on these considerations, the present investigation was undertaken.

Materials and Methods

The experimental material for variability analysis consisted of 35 barnyard millet genotypes along with two checks, Phule Barti-1 and DHBM-9303, as shown in Table 1. These materials were procured from the AICRP on Small Millets, Zonal Agricultural Research Station, Shenda Park, Kolhapur (MS). The field trial was conducted at RSJRS, Kolhapur Centre during Summer of 2024, using a randomized block design with three replications. Genotypic correlation coefficients were estimated following the method of Singh and Chaudhary (1977) [22], while path coefficient analysis was carried out using the procedure outlined by Dewey and Lu (1959) [10].

Results and Discussion

Developing effective selection strategies for identifying desirable genotypes largely depends on understanding the relationship between yield and its contributing traits. In this context, the genotypic correlation coefficients of yield with its associated characters were estimated and are presented in Table 2. Path coefficient analysis further illustrates the direct and indirect contributions of each trait to other characters. The results of these direct and indirect effects on grain yield per earhead are summarized in Table 3.

A. Genotypic correlation

Correlation of grain yield per plant with its components

Grain yield per plant showed a highly significant and positive genotypic correlation with several traits, including flag leaf blade width (0.737), 1000-grain weight (0.620), flag leaf blade length (0.549), days to physiological maturity (0.542), peduncle length (0.539), panicle length (0.311), plant height (0.298), days to 50 per cent flowering (0.256) and basal tiller number (0.214). This positive correlation indicates that an increase in any of these traits is likely to contribute to an increase in grain yield per plant. On the other hand, protein content showed a negative but non-significant correlation (-0.125), while crude fiber content exhibited a positive but non-significant correlation (0.065). Nehru *et al.* (2024) [17] reported that basal tiller number, peduncle length and 1000-seed weight had a significant and positive association with grain yield per plant. These findings are in agreement with earlier reports of Amarnath *et al.* (2018) [1] and Joshi *et al.* (2015) [15] for 1000-seed weight and by Amarnath *et al.* (2018) [1] for peduncle length. Consistent results were also noted by Deepak *et al.* (2023) [9], who observed that grain yield per plant was positively and significantly correlated with days to 50 per cent flowering, days to physiological maturity, flag leaf blade length, flag leaf blade width and panicle length. Similarly, Ayesha Md *et al.* (2019) [5] reported a strong and positive genotypic correlation between grain yield per plant and traits such as plant height and panicle length in foxtail millet. Dhanalakshmi *et al.* (2019) [11] also observed similar trends, where grain yield per plant showed significant

positive genotypic associations with plant height, days to 50 per cent flowering, days to physiological maturity and 1000-seed weight. Vikram *et al.* (2020) [27] reported that grain yield per plant shows a positive and significant correlation with basal tiller number, panicle length, flag leaf length and plant height.

The findings further revealed that grain yield per plant exhibited highly significant positive correlations with 1000-grain weight, days to 50 per cent flowering and days to maturity, highlighting the critical role of these traits in enhancing yield potential in barnyard millet. These results are in line with previous studies conducted by Arunachalam *et al.* (2012) [2], Gupta *et al.* (2009) [13], Upadhyaya *et al.* (2014) [25], Sood *et al.* (2015) [23], Joshi *et al.* (2015) [15] and Arya *et al.* (2017) [3]. days to 50 per cent flowering and days to physiological maturity were positively associated with plant height, peduncle length and flag leaf blade traits. The strong positive correlation among flowering, maturity and plant height agrees with the findings of Monika *et al.* (2021) [16] and Nehru *et al.* (2024) [17]. Among morphological traits peduncle length and panicle length had significant positive correlations with yield-related traits such as 1000-grain weight Nehru *et al.* (2024) [17] also reported similar associations of plant height and peduncle length with maturity and leaf blade width. Leaf traits, particularly flag leaf blade length and width, showed highly significant positive associations with grain yield and 1000-grain weight, with width showing the strongest correlation (0.737) with grain yield. These results are in line with Deepak *et al.* (2023) [9] and Dhanalakshmi *et al.* (2019) [11], who also observed strong positive associations between leaf traits and yield components. Basal tiller number had positive correlations with yield and grain weight, consistent with the findings of Nehru *et al.* (2024) [17]. Overall, yield in barnyard millet was mainly governed by flag leaf blade width, grain weight and peduncle length.

B. Path Analysis

Direct effect of component characters on grain yield per plant. In present study the character flag leaf blade width (0.8813) reported highest positive direct effect on grain yield per plant followed by peduncle length (0.6669), days to 50 per cent flowering (0.6081), basal tiller number (0.5193), flag leaf blade length (0.3089) and panicle length (0.2836). It showed that there was a real connection between these traits and the grain yield per plant. Thus, in a program to enhance yield, direct selection for these qualities will be advantageous.

Sehrawat *et al.* (2024) [21] reported a significant positive direct effect of flag leaf blade width and peduncle length on grain yield, while days to maturity, plant height and thousand-grain weight had negative effects. In foxtail millet, Amarnath *et al.* (2018) [1] found positive direct effects of panicle length, peduncle length and flag leaf blade length, whereas thousand-grain weight was negative. Dhanalakshmi *et al.* (2019) [11] also reported positive effects of days to flowering and leaf blade length, but negative effects of maturity and plant height. Arya *et al.* (2017) [3] also noted a positive direct effect of peduncle length and negative effects of plant height and 1000-seed weight on grain yield per plant. Nehru *et al.* (2024) [17] further confirmed favorable effects of flag leaf blade length, width and panicle length, but negative impacts of plant height on grain yield per plant, with similar results for panicle length reported by

Nirmalakumari and Vetriventhan (2010) ^[18] and Vikram *et al.* (2020) ^[27].

Days to 50 per cent flowering exhibited a positive indirect influence on grain yield per plant through traits such as flag leaf blade width (0.3371), peduncle length (0.265), protein content (0.0754), flag leaf blade length (0.0332) and basal tiller number (0.0003). The findings of Dhanalakshmi *et al.* (2019) ^[11] revealed an indirect effect of days to 50 per cent flowering on grain yield per plant through flag leaf blade length and flag leaf blade width.

Plant height exerted a positive indirect effect on the grain yield per plant through flag leaf blade width (0.4073), days

to 50 per cent flowering (0.3438), peduncle length (0.2125), protein content (0.0617), basal tiller number (0.0576), flag leaf blade length (0.0172) and crude fiber content (0.006). Jhansi Rani *et al.* (2022) also observed an positive indirect effect of plant height on grain yield per plant through days to 50 per cent flowering

The residual value of 0.5008 observed in the present study indicates that additional traits such as number of productive tillers per plant, number of panicles per plant and harvest index should be considered in future analysis to gain a more comprehensive understanding of yield components.

Table 1: List of barnyard millet genotypes included in the study:

Sr. No.	Genotypes	Sr. No.	Genotypes
1.	KOPBM-23-03	19.	KOPBM-23-35
2.	KOPBM-23-05	20.	KOPBM-23-36
3.	KOPBM-23-06	21.	KOPBM-23-37
4.	KOPBM-23-07	22.	KOPBM-23-38
5.	KOPBM-23-10	23.	KOPBM-23-39
6.	KOPBM-23-11	24.	KOPBM-23-40
7.	KOPBM-23-12	25.	KOPBM-23-42
8.	KOPBM-23-14	26.	KOPBM-23-43
9.	KOPBM-23-18	27.	KOPBM-23-44
10.	KOPBM-23-19	28.	KOPBM-23-45
11.	KOPBM-23-22	29.	KOPBM-23-46
12.	KOPBM-23-24	30.	KOPBM-23-47
13.	KOPBM-23-25	31.	KOPBM-23-48
14.	KOPBM-23-26	32.	KOPBM-23-49
15.	KOPBM-23-28	33.	KOPBM-23-50
16.	KOPBM-23-29	34.	Phule barti-1 (C)
17.	KOPBM-23-31	35.	DHBM-93-03 (C)
18.	KOPBM-23-34		

Table 2: Genotypic correlation among grain yield and its attributing characters in barnyard millet

Trait	DFF	DPM	PH	PAL	PL	FLBL	FLBW	BTN	TW	PC	CFC	GYP
DFF	1	0.953**	0.565**	-0.056	0.397**	0.108	0.383**	0.001	0.111	-0.183	0.011	0.256**
DPM		1	0.369**	0.100	0.644**	0.251**	0.250*	0.294**	0.257**	-0.269**	-0.067	0.542**
PH			1	-0.042	0.319**	0.056	0.462**	0.111	0.125	-0.150	-0.210*	0.298**
PAL				1	0.090	0.057	0.195*	-0.148	0.434**	-0.323**	-0.325**	0.311**
PL					1	0.041	0.244*	0.210*	0.348**	-0.159	-0.112	0.539**
FLBL						1	0.383**	0.333**	0.343**	0.008	0.077	0.549**
FLBW							1	0.046	0.706**	0.028	0.201*	0.737**
BTN								1	0.200*	0.428**	0.088	0.214*
TW									1	-0.173	0.043	0.620**
PC										1	0.292**	-0.125
CFC											1	0.065
GYP												1

Where,

DFF = Days to 50 per cent flowering

PL = Peduncle length (cm)

TW = 1000 grain weight (g)

DPM = Days to physiological maturity

FLBL = Flag leaf blade length (cm)

GYP = Grain yield per plant (g)

PH = Plant height (cm)

FLBW = Flag leaf blade width (cm)

PAL = Panicle length (cm)

BTN = Basal tiller number

Table 3: Direct (diagonal) and indirect (above and below diagonal) effects of different characters towards grain yield per plant at genotypic level in barnyard millet

Trait	DFF	DPM	PH	PAL	PL	FLBL	FLBW	BTN	TW
DFF	0.6081	0.5796	0.3438	-0.0339	0.2416	0.0654	0.2326	0.0004	0.0673
DPM	-0.7407	-0.777	-0.2864	-0.0774	-0.5004	-0.1953	-0.1944	-0.2288	-0.1996
PH	-0.2563	-0.1671	-0.4533	0.0192	-0.1444	-0.0253	-0.2095	-0.0503	-0.0566
PAL	-0.0158	0.0283	-0.012	0.2836	0.0256	0.0163	0.0552	-0.0421	0.1232
PL	0.265	0.4295	0.2125	0.0602	0.6669	0.0274	0.1626	0.1402	0.2322
FLBL	0.0332	0.0776	0.0172	0.0177	0.0127	0.3089	0.1184	0.1028	0.106
FLBW	0.3371	0.2205	0.4073	0.1714	0.2149	0.3379	0.8813	0.041	0.6221
BTN	0.0003	0.1529	0.0576	-0.0771	0.1092	0.1728	0.0241	0.5193	0.1036
TW	-0.0496	-0.1151	-0.056	-0.1946	-0.1559	-0.1537	-0.3162	-0.0894	-0.4479
GYP	0.2565	0.542	0.2985	0.3114	0.5391	0.5491	0.7366	0.2143	0.6202

Residual effect = 0.5008

Where,

DFF = Days to 50 per cent flowering

PL = Peduncle length (cm)

TW = 1000 grain weight (g)

DPM = Days to physiological maturity

FLBL = Flag leaf blade length (cm)

GYP = Grain yield per plant(g)

PH = Plant height

BTN = Basal tiller number

PL = Panicle length

PC = Protein content

Conclusions

Correlation analysis revealed that flag leaf blade width and 1000-grain weight had a highly significant positive association with grain yield per plant, indicating that an increase in these traits is directly proportional to higher yield. Path coefficient analysis further divided the effects into direct and indirect contributions. Results showed that flag leaf blade width and peduncle length exerted the highest positive direct effects on grain yield, followed by other traits, whereas days to physiological maturity, plant height and 1000-grain weight exhibited negative direct effects. The residual effect value of 0.5008 suggests the presence of unexplained variation, indicating that additional traits such as number of productive tillers per plant and number of panicles per plant should be included in future studies for a more comprehensive understanding of yield components.

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