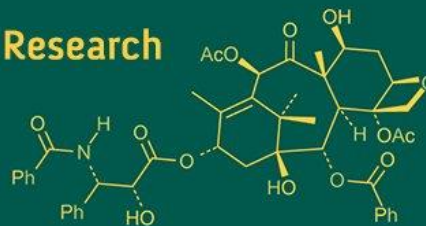


International Journal of Advanced Biochemistry Research



ISSN Print: 2617-4693
ISSN Online: 2617-4707
NAAS Rating (2026): 5.29
IJABR 2026; SP-10(7): 2019-2024
www.biochemjournal.com
Received: 22-04-2026
Accepted: 25-05-2026

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Character association and direct/indirect effects of component traits on grain yield in finger millet [*Eleusine coracana* (L.) Gaertn.]

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DOI: <https://www.doi.org/10.33545/26174693.2026.v10.i7Sx.9355>

Abstract

Finger millet serves as a vital climate-resilient famine reserve crop, yet its productivity remains constrained by a lack of high-yielding cultivars. To formulate effective direct selection strategies, this investigation evaluated character associations and direct/indirect path effects among sixteen agro-morphological and grain quality parameters using 35 diverse finger millet genotypes. Correlation analysis indicated that grain yield per plant was positively and significantly associated with plant height, finger length, finger width, number of fingers per earhead, 1000-grain weight, fodder yield per plant, harvest index, and iron and zinc contents at both the genotypic and phenotypic levels. Path coefficient analysis revealed that fodder yield per plant had the greatest positive direct influence on grain yield, followed by harvest index, number of fingers per earhead, finger length, main earhead length, productive tillers per plant, finger width, plant height, and protein, iron, and calcium contents. These findings suggest that simultaneous selection for these yield-contributing and nutritionally important traits would be an effective strategy for improving grain yield in finger millet. Leveraging these positive trait associations through strategic hybridization and rigorous selection in segregating generations offers a viable pathway for developing superior, high-yielding, and biofortified finger millet varieties.

Keywords: Finger millet, correlation, path analysis, grain yield, direct and indirect effect

Introduction

Finger millet is an annual grass species of the *Poaceae* family that holds a versatile place in agriculture as a primary source of food, fodder, and livestock feed. Characterized by its remarkable capacity to thrive on marginal, nutrient-poor lands and endure harsh environmental stresses, millet cultivation has been sustained across various regions for over 5,000 years (Gowda *et al.*, 2006) [13]. A strictly self-pollinating species, finger millet is an allotetraploid possessing a chromosome count of ($2n = 4X = 36$). Among small millets, it carries the highest economic significance, although related species such as foxtail, proso, barnyard, kodo and little millet remain indispensable to the subsistence of tribal farming communities (Patil *et al.*, 2018) [28].

In India, finger millet is cultivated predominantly under rainfed regimes. Frequently termed a "poor person's crop", it serves as a staple for resource-limited smallholders managing water-constrained agro-ecosystems across the semi-arid regions of South Asia and Sub-Saharan Africa (Vasisth *et al.*, 2022) [36]. Historical accounts place its introduction to the Indian subcontinent more than three millennia ago. Beyond its agronomic resilience, the grain exhibits exceptional post-harvest storability without vulnerability to storage pests, making it a critical security buffer during periods of famine. Nutritionally, its grain profile is exceptionally rich, containing roughly 8 to 10 times more calcium than traditional staple cereals such as wheat and rice (Sharma *et al.*, 2022) [32].

While finger millet is primarily grown for human grain consumption, its crop residues serve as a crucial source of dry matter for livestock, particularly during dry seasons when green forage is scarce. Finger millet straw is highly valued as livestock fodder due to its superior nutritional quality, containing up to 61% digestible nutrients. Although enhancing grain yield is the primary objective of breeding programmes, yield is a complex quantitative trait

governed by multiple genes and strongly influenced by environmental factors, making direct selection less effective. Correlation analysis is an important statistical approach for understanding the relationships between grain yield and its component traits, thereby facilitating the identification of promising genotypes. Furthermore, path coefficient analysis separates correlation coefficients into direct and indirect effects, providing a more precise understanding of the contribution of individual traits to grain yield. This information enables breeders to identify key traits for effective selection. Therefore, the present study was undertaken to investigate the association among yield and its related traits through correlation and path coefficient analyses in 35 finger millet genotypes.

Materials and Methods

During *Kharif-2024*, 35 finger millet genotypes were evaluated in a Randomized Block Design with three replications across four SDAU research stations: Centre for Millets Research, Deesa; Agronomy Instructional Farm, Sardarkrushinagar; Maize Research Station, Bhiloda; and Agricultural Research Station, Ladol. Entries were grown in three-meter single row plots at 30 cm × 10 cm spacing following standard package of practices. Days to 50% flowering and days to maturity were monitored on a plot basis, whereas quantitative traits were recorded from five randomly sampled, non-border plants per replication. The following estimates of covariances were worked out as reviewed by Panse and Sukhatme (1978) [25].

$$\sigma_{p_i p_j} = \sigma_{g_i g_j} + \sigma_{e_i e_j}$$

$\sigma_{p_i p_j}$ = Phenotypic covariance between i^{th} and j^{th} character

$\sigma_{g_i g_j}$ = Genotypic covariance between i^{th} and j^{th} character

$\sigma_{e_i e_j}$ = Environmental covariance between i^{th} and j^{th} character

Genotypic correlations primarily reflect the effects of pleiotropy and genetic linkage, whereas phenotypic correlations represent the combined influence of genetic and environmental factors. Genotypic and phenotypic correlation coefficients were computed using the procedure described by Hazel (1943) [14]. The significance of the correlation coefficients was tested for $n - 2$ degrees of freedom by calculating the t -value according to the method of Panse and Sukhatme (1985) [26]. Path coefficient analysis was performed following the approach proposed by Wright (1921) [39] and later adapted by Dewey and Lu (1959) [7]. Genotypic correlation coefficients of the 15 component traits with grain yield per plant were used to partition the correlations into direct and indirect effects, thereby assessing the contribution of each trait to grain yield.

Results and Discussion

Assessment of trait associations is an important approach in plant breeding, as it facilitates indirect selection for yield improvement by identifying traits closely related to grain yield. Correlation analysis helps determine the magnitude and direction of relationships among yield and its component traits, thereby supporting the selection of superior genotypes. In the present study, genotypic correlation coefficients were generally higher than the corresponding phenotypic coefficients, indicating that genetic factors contributed more strongly to trait associations than environmental effects. The genotypic (r_g) and phenotypic (r_p) correlation coefficients of sixteen characters were presented in Table 1.

Trait productive tillers per plant was found to be in positive and significant phenotypic correlation with harvest index ($r_p = 0.19$) and negative and significant genotypic correlation with plant height ($r_g = -0.61$), number of finger per earhead ($r_g = -0.36$) and fodder yield per plant ($r_g = -0.46$). Abhilash *et al.* (2020) reported negative and significant results for days to 50% flowering. At both the genotypic and phenotypic levels, the number of fingers per earhead was significantly positively correlated with the plant height ($r_g = 0.36$ and $r_p = 0.27$), 1000 grain weight ($r_g = 0.63$ and $r_p = 0.68$), grain yield per plant ($r_g = 0.79$ and $r_p = 0.80$), fodder yield per plant ($r_g = 0.55$ and $r_p = 0.59$), harvest index ($r_g = 0.46$ and $r_p = 0.51$), iron content ($r_g = 0.44$ and $r_p = 0.26$) and zinc content ($r_g = 0.40$ and $r_p = 0.24$). It showed negative and significant correlation with days to maturity ($r_g = -0.43$, $r_p = -0.22$) at both genotypic and phenotypic levels, indicates the contrasting association between these traits, while productive tiller per plant ($r_g = -0.36$) showed negative and significant genotypic correlation with number of fingers per earhead. Sapkal *et al.* (2019) [31], Abhilash *et al.* (2020) [1], Chavan *et al.* (2020) [4], Rajabhau *et al.* (2020), Vidhate *et al.* (2020) [37], Gayathri *et al.* (2022) [10], Hema *et al.* (2022) [185], Nikunj *et al.* (2023) [24] and Sul *et al.* (2025) [33] posted same results with grain yield per plant.

Test weight or 1000 grain weight showed positive significant genotypic and phenotypic correlation with traits finger width ($r_g = 0.41$ and $r_p = 0.31$), number of fingers per earhead ($r_g = 0.63$ and $r_p = 0.68$), grain yield per plant ($r_g = 0.70$ and $r_p = 0.71$), fodder yield per plant ($r_g = 0.60$ and $r_p = 0.50$), harvest index ($r_g = 0.40$ and $r_p = 0.35$), iron content ($r_g = 0.44$ and $r_p = 0.43$) and zinc content ($r_g = 0.43$ and $r_p = 0.42$), while it showed positive significant phenotypic correlation with plant height ($r_p = 0.22$). The favorable association among these traits proved advantageous in formulating effective genetic improvement programme. In contrast, days to maturity ($r_g = -0.39$ and $r_p = -0.29$) had a significant negative correlation with 1000 grain weight at both levels and significant negative phenotypic correlation with main earhead length ($r_p = -0.21$). Lule *et al.* (2012) [20], Suman *et al.* (2018) [34], Chavan *et al.* (2020) [4], Rajabhau *et al.* (2020), Aruna *et al.* (2023) [3], Patel *et al.* (2023) [27], Poola (2024) [29] and Ujjainkar *et al.* (2025) [35] reported similar results for grain yield per plant.

Grain yield per plant, being the primary economic trait, exhibited significant positive genotypic and phenotypic correlations with several yield-contributing characters, including plant height ($r_g = 0.40$ and $r_p = 0.31$), finger length ($r_g = 0.51$ and $r_p = 0.62$), finger width ($r_g = 0.53$ and $r_p = 0.62$), number of fingers per earhead ($r_g = 0.79$ and $r_p = 0.80$), 1000 grain weight ($r_g = 0.70$ and $r_p = 0.71$), fodder yield per plant ($r_g = 0.58$ and $r_p = 0.63$), harvest index ($r_g = 0.45$ and $r_p = 0.54$), iron content ($r_g = 0.45$ and $r_p = 0.29$) and zinc content ($r_g = 0.36$ and $r_p = 0.23$). These results indicate a favorable association among these traits, which could be advantageous for crop improvement, particularly for increasing grain yield in the future. Trait main earhead length ($r_g = 0.32$) had positive genotypic correlation with same trait.

On the other hand, there was a notable inverse genotypic and phenotypic relationship between this trait and days to maturity ($r_g = -0.41$ and $r_p = -0.24$), while a negative genotypic correlation was also recorded with productive tillers per plant ($r_g = -0.36$). The positive association of grain yield with plant height observed in the present investigation is consistent with the findings of Wolie and Dessalegn (2011) [38], Jayshree and Nagarajaiah (2013) [17], Jadhav *et al.* (2015) [16], Chavan *et al.* (2020) [4], Giddaluri *et*

al. (2022) [11], Aruna *et al.* (2023) [3], Patel *et al.* (2023) [27], and Ujjainkar *et al.* (2025) [35]. Similar positive relationships for main earhead length were reported by Devaliya *et al.* (2017) [6], Keerthana *et al.* (2019) [18], Sapkal *et al.* (2019) [31], and Gayathri *et al.* (2022) [10]. The positive correlation of grain yield with finger length agrees with the reports of Wolie and Dessalegn (2011) [38], Ganapathy *et al.* (2011) [9], Lule *et al.* (2012) [20], Das *et al.* (2013) [5], Jadhav *et al.* (2015) [16], and Keerthana *et al.* (2019) [18]. Similar findings for finger width were documented by Das *et al.* (2013) [5], Eric *et al.* (2016) [8], Vidhate *et al.* (2020) [37], Hema *et al.* (2022) [15], Nikunj *et al.* (2023) [24], Patel *et al.* (2023) [27], and Poola (2024) [29]. The significant positive association between grain yield and 1000-grain weight corroborates the observations of Lule *et al.* (2012) [20], Suman *et al.* (2018) [34], Vidhate *et al.* (2020) [37], Aruna *et al.* (2023) [3], Patel *et al.* (2023) [27], and Ujjainkar *et al.* (2025) [35]. Likewise, the positive correlation of grain yield with fodder yield per plant is in agreement with the findings of Wolie and Dessalegn (2011) [38], Anuradha *et al.* (2013) [2], Gohel and Chaudhari (2018) [12], Suman *et al.* (2018) [34], Keerthana *et al.* (2019) [18], Madhavalatha *et al.* (2021) [21], Gayathri *et al.* (2022) [10], and Nikunj *et al.* (2023) [24]. A comparable positive association between grain yield and harvest index has also been reported by Wolie and Dessalegn (2011) [38], Devaliya *et al.* (2017) [6], Gohel and Chaudhari (2018) [12], Suman *et al.* (2018) [34], Abhilash *et al.* (2020) [1], Gayathri *et al.* (2022) [10], and Nikunj *et al.* (2023) [24]. Furthermore, the positive relationship between grain yield and iron content is in accordance with the findings of Devaliya *et al.* (2017) [6]. Fodder yield per plant had significant positive genotypic and phenotypic correlation with finger width ($r_g = 0.35$ and $r_p = 0.26$), number of fingers per earhead ($r_g = 0.55$ and $r_p = 0.59$), 1000 grain weight ($r_g = 0.60$ and $r_p = 0.50$), grain yield per plant ($r_g = 0.58$ and $r_p = 0.63$), iron content ($r_g = 0.64$ and $r_p = 0.50$) and zinc content ($r_g = 0.35$ and $r_p = 0.28$), while significant positive phenotypic correlation was also recorded with plant height ($r_p = 0.20$). At the genotypic and phenotypic levels, there was a significant negative correlation found between the days to maturity ($r_g = -0.50$ and $r_p = -0.34$) and harvest index ($r_g = -0.45$ and $r_p = -0.29$), while significant negative genotypic correlation was also recorded with productive tillers per plant ($r_g = -0.46$). Wolie and Dessalegn (2011) [38], Anuradha *et al.* (2017) [2], Gohel and Chaudhari (2018) [12], Suman *et al.* (2018) [34], Keerthana *et al.* (2019) [18], Madhavalatha *et al.* (2021) [21], Gayathri *et al.* (2022) [10], Nikunj *et al.* (2023) [24], Poola (2024) [29] and Sul *et al.* (2025) [33] reported significant positive correlation of grain yield with fodder yield per plant.

In the present study, grain yield per plant exhibited significant positive correlations with plant height, finger length, finger width, number of fingers per earhead, 1000-grain weight, fodder yield per plant, harvest index, and iron and zinc contents at both the genotypic and phenotypic levels. These strong positive associations indicate that these traits play a major role in determining grain yield in finger millet. Therefore, improvement of these component traits through indirect selection is expected to result in a corresponding increase in grain yield, even without direct selection for yield itself. Consequently, these characters may serve as reliable selection criteria for the development of high-yielding finger millet genotypes.

Path coefficient analysis provides a more precise evaluation of the relationships among traits by partitioning correlation coefficients into their direct and indirect effects on grain yield. In the present study, grain yield per plant was

considered the dependent variable, while the remaining fifteen traits were treated as independent variables to assess their individual contributions. The direct and indirect effects of these traits on grain yield, estimated from genotypic correlation coefficients, are presented in Table 2 and illustrated in Figure 1.

Path coefficient analysis indicated that fodder yield per plant exerted the highest positive direct effect on grain yield per plant (0.646), followed by harvest index (0.626), number of fingers per earhead (0.299), finger length (0.128), main earhead length (0.099), productive tillers per plant (0.090), finger width (0.072), iron content (0.046), protein content (0.023), plant height (0.014), and calcium content (0.004). The positive direct effects of these traits suggest that their association with grain yield is primarily due to their inherent contribution rather than indirect influences through other characters. Therefore, these traits can be considered reliable selection criteria and should be given priority in breeding programmes aimed at improving grain yield in finger millet. The present findings are consistent with the reports of Priyadarshini *et al.* (2011) [30] and Negi *et al.* (2017) [23], who also observed a high positive direct effect of harvest index on grain yield. A similar positive direct contribution of fodder yield per plant was documented by Devaliya *et al.* (2017) [6] and Negi *et al.* (2017) [23]. The positive direct influence of number of fingers per earhead on grain yield corroborates the findings of Sapkal *et al.* (2019) [31], Abhilash *et al.* (2020) [1], and Lad *et al.* (2020) [19]. Likewise, the positive direct effect of finger length agrees with the observations of Priyadarshini *et al.* (2011) [30], Mahanthesha *et al.* (2018) [22], and Vidhate *et al.* (2020) [37]. Comparable positive direct effects for iron and calcium contents were also reported by Vidhate *et al.* (2020) [37].

Several traits contributed positively to grain yield through their indirect effects *via* harvest index. The highest positive indirect effect through harvest index was observed for number of fingers per earhead (0.139), followed by main earhead length (0.027), days to 50% flowering (0.015), 1000-grain weight (0.011), plant height (0.003), productive tillers per plant (0.003), protein content (0.001), and zinc content (0.0001). Likewise, fodder yield per plant exerted favourable indirect effects on grain yield through number of fingers per earhead (0.166), days to maturity (0.041), iron content (0.029), finger width (0.026), 1000-grain weight (0.016), finger length (0.010), plant height (0.004), and calcium content (0.001). These positive indirect contributions indicate that the influence of these traits on grain yield is also mediated through harvest index and fodder yield per plant, emphasizing their importance in selection strategies for yield improvement.

The indirect contribution of 1000-grain weight to grain yield through fodder yield per plant (0.281) was the highest, followed by number of fingers per earhead (0.208), harvest index (0.150), days to maturity (0.032), iron content (0.020), finger width (0.018), finger length (0.009), plant height (0.003), and protein content (0.0005). Similarly, number of fingers per earhead exerted favourable indirect effects on grain yield through fodder yield per plant (0.254), harvest index (0.191), days to maturity (0.035), 1000-grain weight (0.028), iron content (0.020), finger width (0.008), plant height (0.005), and main earhead length (0.004). These findings indicate that the positive influence of 1000-grain weight and number of fingers per earhead on grain yield is also mediated through other important yield-contributing traits, particularly fodder yield per plant and harvest index.

Productive tillers per plant exerted positive indirect effects on grain yield through finger length (0.099), harvest index

(0.093), zinc content (0.008), and protein content (0.0001). In contrast, days to maturity (-0.082) and zinc content (-0.045) exhibited negative direct effects on grain yield per plant. These negative direct effects are likely attributable to their unfavourable indirect influences through other associated traits. Therefore, a multi-trait selection strategy that emphasizes traits with favourable direct and indirect

effects would be more effective for improving grain yield than selection based on a single character. Such an approach enables breeders to exploit beneficial trait interactions while minimizing the adverse influence of traits with negative direct effects. The negative direct effect of days to maturity on grain yield observed in the present study is in agreement with the findings of Patel *et al.* (2023)^[27].

Table 1: Genotypic and phenotypic correlations of grain yield per plant with other characters in finger millet

	DF	DM	PH	PTP	MEHL	FL	FW	NFEH	TW	GYP	FYP	HI	PC	Ca	Fe	Zn
DF	1	0.777**	-0.182	-0.103	0.521**	0.459**	0.054	0.039	-0.092	0.049	-0.147	0.202	0.092	0.204	-0.203	-0.294
DM	0.587**	1	-0.269	0.208	0.267	0.150	-0.106	-0.429*	-0.388*	-0.412*	-0.498**	0.104	0.101	-0.017	-0.438**	-0.427*
PH	-0.113	-0.161	1	-0.610**	-0.153	-0.053	0.067	0.359*	0.253	0.398*	0.268	0.201	-0.162	-0.162	-0.014	0.095
PTP	-0.022	0.082	-0.145	1	-0.079	-0.228	-0.294	-0.358*	-0.121	-0.357*	-0.461**	0.069	0.009	-0.292	-0.156	-0.165
MEHL	0.431**	0.216*	-0.108	0.010	1	0.590**	-0.155	0.037	-0.226	0.320*	0.194	0.278	-0.106	-0.086	-0.230	-0.109
FL	0.334**	0.109	-0.051	-0.051	0.854**	1	-0.083	0.217	-0.067	0.507**	-0.078	0.415*	-0.011	-0.106	-0.137	-0.022
FW	0.051	-0.074	0.029	-0.088	-0.141	-0.032	1	0.112	0.405*	0.531**	0.353*	-0.313	-0.262	-0.034	0.192	0.322
NFEH	-0.013	-0.222**	0.267**	0.138	0.022	0.127	0.022	1	0.630**	0.786**	0.553**	0.464**	-0.056	-0.067	0.437**	0.401*
TW	-0.078	-0.285**	0.222**	-0.031	-0.206*	-0.045	0.305**	0.675**	1	0.696**	0.595**	0.399*	0.038	-0.035	0.440**	0.430*
GYP	-0.024	-0.241**	0.310**	0.138	0.014	0.615**	0.619**	0.802**	0.708**	1	0.584**	0.453**	-0.083	-0.021	0.452**	0.364**
FYP	-0.134	-0.338**	0.201*	-0.039	-0.143	-0.028	0.260**	0.586**	0.501**	0.630**	1	-0.451**	-0.174	0.204	0.641**	0.351*
HI	0.120	0.047	0.210*	0.194*	0.207*	0.208*	-0.242**	0.512**	0.351**	0.541**	-0.288**	1	0.088	-0.240	-0.228	-0.002
PC	0.079	0.080	-0.126	0.006	-0.104	-0.008	-0.230**	-0.034	0.039	-0.051	-0.133	0.068	1	0.211	0.084	-0.060
Ca	0.156	-0.016	-0.127	-0.137	-0.085	-0.096	-0.028	-0.042	-0.034	-0.013	0.162	-0.186*	0.210*	1	0.287	0.134
Fe	-0.167*	-0.346**	-0.011	-0.064	-0.220**	-0.120	0.167*	0.261**	0.432**	0.290**	0.503**	-0.176*	0.083	0.286**	1	0.678**
Zn	-0.240**	-0.335**	0.076	-0.072	-0.104	-0.019	0.281**	0.242**	0.421**	0.233**	0.276**	-0.002	-0.060	0.134	0.677**	1

* and ** significant at 5% and 1% levels of significance, respectively. Values above the diagonal bold values are genotypic correlation and below is phenotypic correlation. DF: Days to 50 % flowering, DM: Days to maturity, PH: Plant height, PTP: Productive tillers per plant, MEHL: Main earhead length,

FL: Finger Length, FW: Finger Width, NFPE: Number Of Fingers Per Earhead TW: 1000 Grain Weight, GYP: Grain Yield Per Plant, FYP: Fodder Yield Per plant, HI: Harvest Index, PC: Protein Content, Ca: Calcium Content, Fe: Iron Content, Zn: Zinc Content.

Table 2: Direct and indirect genotypic effects of fifteen causal variables on grain yield per plant (g)

	DF	DM	PH	PTP	MEHL	FL	FW	NFEH	TW	FYP	HI	PC	Ca	Fe	Zn	'r _g ' with GYP
DF	0.076	-0.064	-0.003	-0.004	0.051	-0.059	0.004	0.012	-0.003	-0.094	0.126	0.001	0.001	-0.009	0.013	0.049
DM	0.059	-0.082	-0.004	0.008	0.026	-0.019	-0.008	-0.128	-0.011	-0.339	0.065	0.001	-0.0001	-0.020	0.019	-0.412*
PH	-0.014	0.022	0.014	-0.024	-0.015	0.007	0.005	0.108	0.007	0.172	0.126	-0.002	-0.001	-0.001	-0.004	0.398*
PTP	-0.008	-0.017	-0.008	0.090	-0.008	0.099	-0.021	-0.107	-0.003	-0.270	0.093	0.0001	-0.001	-0.007	0.008	-0.157
MEHL	0.040	-0.022	-0.002	-0.003	0.099	-0.027	-0.001	0.110	-0.006	-0.025	0.174	-0.001	-0.0004	-0.011	0.005	0.320*
FL	0.035	-0.012	-0.001	-0.009	0.098	0.128	-0.006	0.095	-0.002	-0.050	0.237	-0.0001	-0.001	-0.006	0.001	0.507**
FW	0.004	0.009	0.001	-0.012	-0.015	0.011	0.072	0.034	0.007	0.230	0.196	-0.003	-0.0001	0.009	-0.015	0.531**
NFEH	0.003	0.035	0.005	-0.014	0.004	-0.028	0.008	0.299	0.028	0.254	0.191	-0.001	-0.0003	0.020	-0.018	0.786**
TW	-0.007	0.032	0.003	-0.005	-0.022	0.009	0.018	0.208	0.027	0.281	0.150	0.001	-0.0002	0.020	-0.019	0.696**
FYP	-0.011	0.041	0.004	-0.018	-0.019	0.010	0.026	0.166	0.016	0.646	-0.243	-0.002	0.001	0.029	-0.016	0.630**
HI	0.015	-0.009	0.003	0.003	0.027	-0.040	-0.023	0.139	0.011	-0.199	0.626	0.001	-0.001	-0.011	0.0001	0.541**
PC	0.007	-0.008	-0.002	0.0003	-0.010	0.001	-0.019	-0.017	0.001	-0.111	0.055	0.023	0.001	0.024	0.003	-0.051
Ca	0.016	0.001	-0.002	-0.012	-0.008	0.014	-0.003	-0.020	-0.001	0.130	-0.150	0.003	0.004	0.021	-0.006	-0.013
Fe	-0.015	0.036	-0.0002	-0.006	-0.023	0.018	0.014	0.079	0.012	0.410	-0.243	0.001	0.001	0.046	-0.031	0.290**
Zn	-0.022	0.035	0.001	-0.007	-0.011	0.003	0.023	0.080	0.012	0.125	-0.001	-0.001	0.001	0.031	-0.045	0.233**

Diagonal (Bold) values are direct effects, Residual factor = -0.0003, * and ** significant at 5% and 1% levels of significance, respectively.

DF: Days to 50 % flowering, DM: Days to Maturity, PH: Plant Height, PTP: Productive Tillers per Plant, MEHL: Main Earhead Length, FL: Finger Length, FW: Finger width, NFPE: Number of fingers per earhead TW: 1000 grain weight, GYP: Grain Yield per Plant, FYP: Fodder yield per plant, HI: Harvest Index, PC: Protein Content, Ca: Calcium Content, Fe: Iron Content, Zn: Zinc Content.

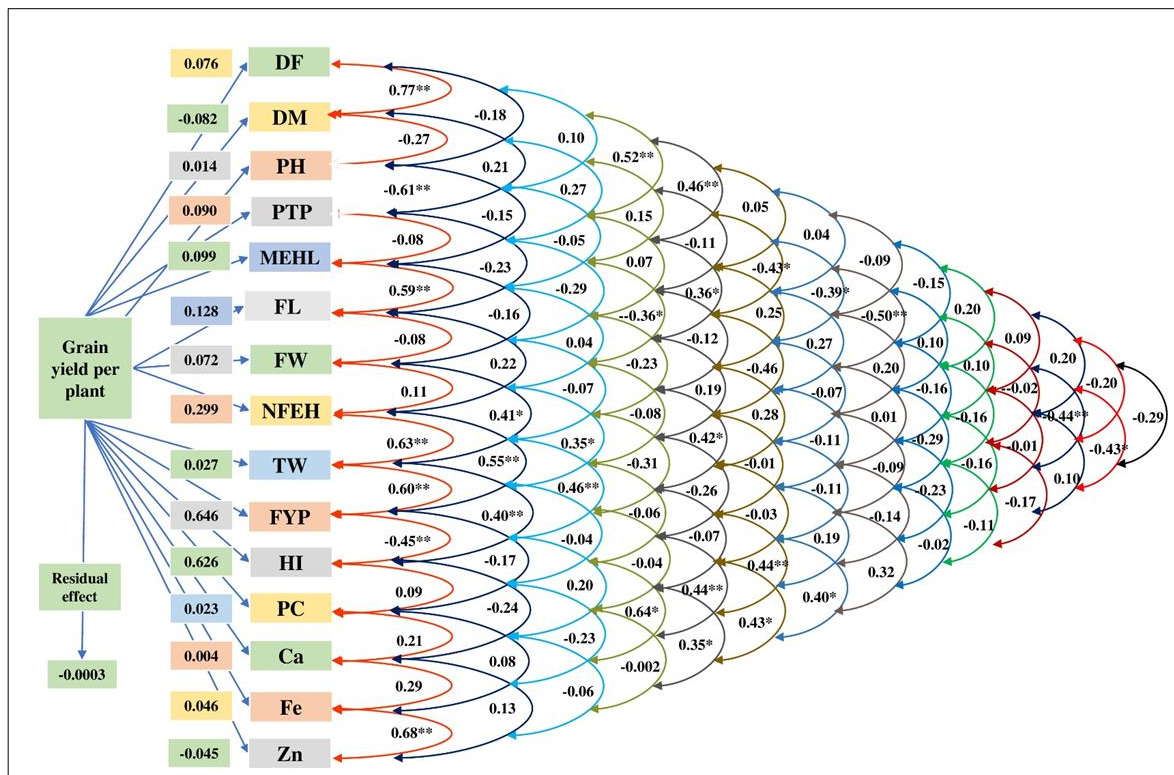


Fig 1: Path diagram depicting direct effects and genotypic correlation of yield attributes on grain yield per plant (g)

Conclusion

Overall, the combined evaluation of trait correlations and path coefficients provides a clear selection framework for finger millet enhancement. Grain yield per plant showed significant positive associations at both the genotypic and phenotypic levels with plant height, finger length, finger width, test weight, fodder yield, harvest index, iron, and zinc content, establishing their utility for indirect selection. Path analysis resolved these associations into direct causal paths, identifying fodder yield per plant and harvest index as the primary direct contributors to productivity, alongside substantial positive contributions from main earhead length, productive tillers per plant, iron, protein, and calcium content. Because these attributes display both high direct effects and strong mutual associations with yield, incorporating them into selection indices offers an efficient strategy to achieve concurrent improvements in yield potential and grain quality.

Acknowledgements

The authors express their sincere gratitude to Sardarkrushinagar Dantiwada Agricultural University (SDAU) for providing the necessary funding and research facilities. We are also deeply grateful to the Hill Millet Research Station, NAU, Waghai for generously sharing the research materials.

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