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ASSESSMENT OF GENETIC VARIABILITY, CORRELATION AND PATH ANALYSIS INFINGER MILLET (*ELEUSINE CORACANA* L. GAERTN.) GENOTYPES

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ABSTRACT

The study aimed to assess genetic variability, heritability, and genetic advance for seventeen quantitative traits. ANOVA indicated highly significant differences among the genotypes for all quantitative traits studied. The field experiment was carried out during *Kharif* 2023 and 2024 at the Student Research Farm, Bihar Agriculture University, Sabour, Bihar, India using 22 finger millet genotypes. Significant phenotypic and genotypic coefficients of variation were recorded for culm thickness, biological yield, sheath width, and flag leaf blade width. High heritability coupled with high genetic advance was observed for number of fingers per plant, finger length, number of sterile spikelet per panicle, spikelet fertility percentage, test weight, 1000 seed weight, ear head weight per plant, harvest index and grain yield per plant, suggesting the possibility of selection-based improvement. There was a strong positive and highly significant correlation between grain yield per plant and ear head weight per plant ($r = 0.624$, $P < 0.01$), followed by number of fingers per plant ($r = 0.572$, $P < 0.01$), number of productive tillers per plant ($r = 0.414$, $P < 0.01$), ear head length per plant ($r = 0.454$, $P < 0.05$), finger length ($r = 0.285$, $P < 0.05$), and 1000 seed weight ($r = 0.286$, $P < 0.05$). The highest positive and substantial direct effects on seed yield per plant were exerted by EHLPP (5.253), followed by SW (0.8092), NFPP (0.1402), NPTPP (0.1569), NTPP (0.0559), PH (0.0459) and DFF (0.0057). The outcomes emphasize the potential of exploiting genetic variability in finger millet to strengthen breeding pipelines aimed at producing cultivars with enhanced productivity and adaptability under diverse growing conditions

***Key words*:** Correlation; finger millet; genetic advance; heritability; path analysis and variability.

Introduction

Finger millet (*Eleusine coracana* L. Gaertn), also known as Bird foot millet, ragi, or African millet (*Eleusine coracana* L. Gaertn). This crop is indigenous to Africa (Abyssinian, currently known as Ethiopia's origin). It is a self-pollinated (allopolyploid) crop with 2n=4x=36 chromosomes that arose from a hybrid between two diploid species, Eleusine indica (AA) and de Wet, 1976). It belongs to the family Poaceae and is commonly farmed in the world's arid and semi-arid regions. Eleusine is derived from Eleusis, an ancient epic city consecrated to Demeter, the Greek goddess of agriculture. Coracana is derived from kurukkan, the grain's singhali name. (Chennaveeraiah and Hiremath, 1974, Hilu and de Wet, 1976) The major finger millet growing states are Karnataka, Uttarakhand, Maharashtra, Tamil Nadu, Odisha, Andhra Pradesh and Jharkhand. Karnataka, Uttarakhand and Tamil Nadu are the major contributors

Table 1: List of 22 finger millet genotypes along with their sources.

S.No	Genotype	Source
1.	IE5249	ICRISAT
2.	ICFV221002	ICRISAT
3.	ICFV221029	ICRISAT
4.	ICFV221034	ICRISAT
5.	IE 2606	ICRISAT
6.	ICFV221011	ICRISAT
7.	IE 6326	ICRISAT
8.	GPU67	IIMRHyderabad
9.	IE 4570	ICRISAT
10.	S-1	BAUSabour
11.	S-2	BAUSabour
12.	S-3	BAUSabour
13.	S-4	BAUSabour
14.	PR202	IIMRHyderabad
15.	ICFV221009	ICRISAT
16.	ICFV221040	ICRISAT
17.	ICFV221038	ICRISAT
18.	ICFV221024	ICRISAT
19.	IE 5963	ICRISAT
20.	VL376	IIMRHyderabad
21.	KMR316(check)	IIMRHyderabad
22.	RAU8(check)	RPCAUPusa

accounting for more than 80 per cent of the total production. In Karnataka, it occupies an area of 0.59 million hectares with a production of 0.85 million tonnes and productivity of 1.43 tonnes ha^{-1}. In Bihar the area and production of Finger millet are 22.03 (lakh ha), 2.58 (thousand tone) and 7.03 (thousand/ha) respectively (pib.gov.in) 2022-23.

In India, finger millet serves as a staple food, particularly among low-income communities. On a global scale, it ranks as the fourth most important millet after sorghum, pearl millet, and foxtail millet. Often referred to as the "Nutritious millet," it is recognized for its superior nutritional profile compared to other cereals. Being gluten-free, low in fat, non- allergenic, and easily digestible, it is also termed a "Super cereal". Finger millet is notable for its exceptional calcium (344 mg%) and potassium (408 mg%) content, the highest among all grains and millets. It is also rich in dietary fibre, minerals, and essential amino acids, including sulphur, surpassing white rice in nutritional value.

Selection is predicated on the availability of genetic variability, breeders can design effective selection procedures with the help of genetic variability knowledge. There is a wide range of genetic variability in the segregating population, which is mostly caused by the genetic variance across genotypes. Additionally, since selection makes use of the heritable fraction of the diversity that already exists, understanding heritability is crucial to crop development procedures. Planning an appropriate breeding approach for genetic progress requires first evaluating variability for yield and yield-attributing traits. To determine the degree of variability present in the germplasm, phenotypic and genotypic coefficients of variation are crucial. High genetic advancement combined with heritability would be a more useful instrument. Correlation studies provide knowledge of association among different characters and grain yield. The study of association among various traits is useful for breeders in selecting genotypes possessing groups of desired traits. The path coefficient analysis provides a more realistic picture of the relationship as it considers direct as well as indirect effects of the variables by partitioning the Correlation. The path coefficient analysis provides a more realistic picture of the relationship as it considers direct as well as indirect effects of the variables by partitioning the correlation coefficients. All plant breeding projects have one purpose in mind: to maximize economic output. Keeping in mind the expanding population and global climate change, we need to breed varieties with improved yield and quality characteristics to suit the needs of the future population.

Materials and Methods

Experimental Site and Material

The study was conducted during the Rabi season of 2023–24 at the Finger Millet Research Block of Bihar Agricultural University, Sabour, Bhagalpur, Bihar, India. The experimental material comprised 22 diverse finger millet genotypes, including improved varieties and advanced breeding lines obtained from ICRISAT, IIMR, and BAU, Sabour (Table 1).

Experimental Design and Observations

The trial was laid out in a Randomized Block Design (RBD) with three replications. Each genotype was sown

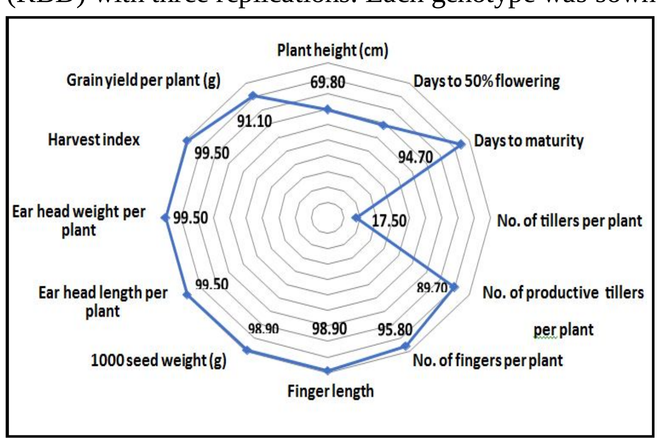

Fig. 1: Illustrates the direct and indirect effects.

Table 2: Estimates of parametersof geneticvariability.

Characters	Range		Genotypic variance	GCV	Phenotypic variance	PCV	h^2 (Broad Sense)	Gen. Adv as 5% of Mean
	Lowest	Highest						
Plant height (cm)	83.17	130.93	101.96	9.18	146.10	10.99	69.80	15.80
Days to 50% flowering	95.00	121.00	65.27	7.49	94.76	9.02	68.90	12.80
Days to maturity	118.00	162.00	191.06	9.90	201.70	10.18	94.70	19.86
No. of tillers per plant	6.00	8.00	0.06	3.71	0.37	8.89	17.50	3.20
No. of productive tillers per plant	4.00	6.00	0.16	7.93	0.18	8.38	89.70	15.48
No. of fingers per plant	5.00	8.00	0.69	13.38	0.72	13.67	95.80	**26.99**
Finger length	4.86	10.30	2.77	21.42	2.80	21.53	98.90	**43.89**
1000 seed weight(g)	4.87	10.30	2.77	21.41	2.80	21.53	98.90	**43.86**
Ear head length per plant (cm)	12.03	18.57	3.04	11.32	3.05	11.35	99.50	**23.27**
Ear head weight per plant (g)	2.01	3.12	0.10	12.38	0.10	12.41	99.50	**25.43**
Harvest index	17.76	37.31	19.36	16.78	19.46	16.83	99.50	**34.48**
Grain yield per plant (g)	4.20	8.50	1.21	17.21	1.33	18.03	91.10	**33.83**

in a 4m long two-row plot with a spacing of 25 cm × 10 cm. Recommended agronomic practices were followed to ensure healthy crop growth. Observations were recorded on five randomly selected competitive plants from each replication for twelve quantitative traits: plant height (cm), days to 50% flowering, days to maturity, number of tillers per plant, number of productive tillers per plant, number of fingers per plant, finger length (cm), ear head length per plant (cm), ear head weight per plant (g), 1000-seed weight (g), harvest index (%), and grain yield per plant (g).

Statistical Analysis

The mean data were subjected to variability, correlation and path analysis using R software (version 4.4.3) to test the significance of genotypic differences. The data was analysed where genotype was considered as the main factor. The coefficient of variation (CV %) was calculated to evaluate the extent of variability present within the dataset. The GCV and phenotypic PCV, broad-sense heritability (h^2bs), genetic advance (GA) and genetic gain (GG) were further computed as per standard methods (Tripathi PC, Johnson HW), using INDOSTAT software (Indostat Service, Hyderabad, India). The genotypic and phenotypic correlations were calculated using the formulae suggested by Fisher and Yates (1967), while the direct and indirect contribution of each character for grain yield was estimated by path co-efficient analysis suggested by Wright (1921).

Results and Discussion

Information on mean, range, PCV, GCV, heritability, genetic advance and genetic advance in per cent of mean for yield and yield component traits are furnished in Table 2. A high phenotypic coefficient of variance (PCV) (>20%) was exhibited by finger length and 1000 seed weight moderate PCV (10-20%) exhibited by plant height, days to maturity, number of fingers per plant, ear head length per plant, ear head weight per plant, harvest index and grain yield per plant low pcv (<10%) was seen for days to 50 % flowering, number of productive tiller and number of tiller per plant. High phenotypic coefficient of variance (PCV) (>20%) was exhibited by finger length and 1000 seed weight moderate PCV (10-20%) exhibited by number of fingers per plant, ear head length per plant, ear head weight per plant, harvest index and grain yield per plant low pcv (<10%) was seen for days to 50 % flowering, plant height, days to maturity, number of productive tiller and number of tiller per plant. The PCV was higher than GCV for all traits, as noted by Reddy *et al*., (2013), indicating environmental influence on trait expression.

The broad-sense heritability (h^2bs) estimates for all the characters were estimated (Table 2). The highest was recorded for days to 50 % flowering (68.90%), plant height (69.80 %), days to maturity (94.70%), number of productive tiller (89.70%), number of fingers per plant (95.80%), finger length (98.90 %), 1000 seed weight (98.90%), ear head length per plant (99.50%), ear head weight per plant (99.50%), harvest index (99.50%) and grain yield per plant (99.50%). Grain yield in finger millet is a complex quantitative trait with low heritability," as also observed by Demissie and Engida (2025). Traits with high heritability indicate a strong association between phenotype and genotype, suggesting greater genetic control and stable inheritance for such traits (Raghava M *et al*., 2008). High broad-sense heritability (H^2) for grain yield and related traits (with high genetic advance) suggests additive gene action, consistent with findings by Dhanpati *et al*., (2026) This indicates that selection will be effective for selecting genotypes having such traits with high heritability (Mahla J.S. *et al*., 2022). High heritability along with high genetic advance as % of mean

Table 3: Estimates of phenotypic correlation coefficient in finger millets.

	PH	D50F	DM	NTPP	NPTPP	NFPP	FL	S W	EHLPP	EHWPP	HI	GYPP
PH		0.2751*	0.1635	-0.1714	-0.2606 *	0.0298	0.2546*	0.2588*	0.1641	0.0028	-0.2212	-0.0795
D50F			0.648**	-0.1452	-0.1871	-0.2314	0.039	0.0365	-0.2094	-0.1977	-0.2021	-0.450**
DM				-0.117	-0.2198	-0.457**	-0.0187	-0.0206	-0.1946	-0.2159	-0.2482 *	-0.593**
NTPP					0.302**	0.511**	0.3135 *	0.3116*	0.2632 *	0.1965	0.0361	0.290*
NPTPP						0.663**	0.458**	0.456**	0.397**	0.3012 *	0.0617	0.414**
NFPP							0.457**	0.456**	0.464**	0.427**	0.2259	0.572**
FL							0.397**	1.000**	0.625**	0.455**	-0.2284	0.285*
S W									0.623**	0.452**	-0.232	0.286*
EHLPP										0.504**	0.2132	0.454**
EHWPP											0.423**	0.624**
HI												0.2246

were exhibited by number of fingers per plant, finger length, 1000 seed weight, ear head length per plant, ear head weight per plant, harvest index and grain yield per plant.Consistent with our results, Farooqkhan *et al*., (2025) found high H² and GA for grain yield in finger millet, indicating strong genetic control and selection potentia.

The correlation analysis revealed that grain yield per plant (GYPP) in finger millet is positively and significantly associated with several important yield components, indicating their direct influence on productivity. The highest correlation was observed with ear head weight per plant(0.624**), followed by number of fingers per plant (0.572**), number of productive tillers per plant (0.414**), ear head length per plant (0.454*), finger length (0.285*), and 1000 seed weight (0.286*). Grain yield showed significant positive correlations with productive tillers and finger number, as also observed by Bharathi *et al*., (2013) and (in pearl millet) by Kour *et al*., (2025) On the other hand, grain yield showed a significant negative correlation with days to 50% flowering (-0.450**) and days to maturity (-0.593**). The correlation with plant height (-0.0795) and harvest index (0.2246) was non-significant, suggesting the setraits playa minor or indirect role in determining grain yield in this study.

Path co-efficient analysis provides an effective means of finding out the direct and indirect causes of association and presents a critical examination of the specific forces acting to produce a given correlation and also measures the relative importance of each causal factor. Hence, the study of direct and indirect effects of yield components on grain yield per plant was undertaken in the present investigation and the results obtained are presented in Table 4. The analysis revealed that the highest positive and substantial direct effects on seed yield per plant were exerted by EHLPP (5.253) followed by SW(0.8092), NFPP(0.1402), NPTPP(0.1569), NTPP(0.0559), PH(0.0459) and DFF(0.0057). Conversely, traits such as HI(-0.1928), EHWPP(-0.3154), DM(-0.4258) and FL(-5.355) exhibited negative direct effects on grain yield. Fig. 1 illustrates the direct and indirect effects. Ngidi *et al*., (2024) who identified shoot biomass as having a strong direct positive effect on sorghum yield Very low direct effect recorded for the characters indicating direct contribution to seed yield per plant. The residual factor effects (0.3428) were recorded positive.

Table 4: Direct (diagonal) and indirect effects of component traits attributing to grain yield(kg/ha) in finger millet at phenotypic level.

	PH	D50F	DM	NTPP	NPTPP	NFPP	FL	EHLPP	EHWPP	SW	HI	GYPP
PH	**0.0459**	0.0126	0.0075	-0.008	-0.012	0.0014	0.0117	0.0119	0.0075	0.0001	-0.01	-0.0795
D50F	0.0016	**0.0057**	0.0044	-8E-04	-0.001	-0.001	0.0002	0.0002	-0.0012	-0.0011	-0.001	-0.450**
DM	-0.07	-0.326	**-0.426**	0.0498	0.0936	0.1944	0.008	0.0088	0.0829	0.0919	0.1057	-0.593**
NTPP	-0.01	-0.008	-0.007	**0.0559**	0.0336	0.0286	0.0175	0.0174	0.0147	0.011	0.002	0.290*
NPTPP	-0.041	-0.029	-0.035	0.0944	**0.1569**	0.104	0.0719	0.0716	0.0623	0.0473	0.0097	0.414**
NFPP	0.0042	-0.033	-0.064	0.0717	0.0929	**0.1402**	0.064	0.0639	0.0651	0.0598	0.0317	0.572**
FL	-1.364	-0.209	0.1002	-1.679	-2.455	-2.446	**-5.356**	-5.3548	-3.3457	-2.434	1.223	0.285*
EHLPP	1.3595	0.1915	-0.108	1.6371	2.3975	2.3955	5.2525	**5.2532**	3.2742	2.3751	-1.219	0.286*
EHWPP	-0.052	0.066	0.0614	-0.083	-0.125	-0.147	-0.197	-0.1966	**-0.3154**	-0.2537	-0.067	0.454**
SW	0.0023	-0.16	-0.175	0.159	0.2437	0.3451	0.3678	0.3659	0.6507	**0.8092**	0.3426	0.624**
HI	0.0426	0.039	0.0479	-0.007	-0.012	-0.044	0.044	0.0447	-0.0411	-0.0816	**-0.193**	0.2246
GYPP	-0.08	-0.45	-0.593	0.2901	0.4136	0.5717	0.2852	0.2862	0.454	0.624	0.2246	-
GYPP: Phenotypic correlation with GYPP; Residual effect = 0.5457												

Conclusion

Results of the present investigation on variability, heritability and genetic advance indicated a scope for improvement of grain yield through selection. Further, studies on character association and path co-efficients revealed the importance of EHLPP (5.253) followed by SW(0.8092), NFPP(0.1402), NPTPP(0.1569), NTPP (0.0559), PH(0.0459) and DFF(0.0057) as selection criteria for effective yield improvement. The study indicated high heritability along with high genetic advance as % of mean were exhibited by number of fingers per plant, finger length, 1000 seed weight, ear head length per plant, ear head weight per plant, harvest index and grain yield per plant and the genotypes having high heretability along with high genetic advance were good for used in crop improvement programme.

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Authors' contributions

Adarsh Ranjan, Birendra Singhand Sardar Sunil Singh were responsible for conducting the field experimentation, data recording and initial data analysis. Priyanka Kumari, Brajesh Kumar, Dr. Tushar Ranjan, Mr. Awdhesh Kumarand Ashutosh Kumar contributed to the preparation, critical review, and refinement of the manuscript. All authors read and approved the final version of the manuscript

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