

~~Estimation of Genetic variability, direct and indirect effects of yield contributing traits on grain yield in finger millet [*Eleusinecoracana* (L)]~~

Title needs modification. May be as follows:

Genetic variability, heritability, genetic advance and association of traits of finger millet [*Eleusinecoracana* (L)]

ABSTRACT

The present investigation was carried out to assess the genetic variability parameters, correlation and path analysis in 20 finger millet genotypes for 13 quantitative traits in *Kharif* 2021 in Randomized Block Design replicated thrice. Analysis of variance revealed that treatment differences were highly significant under study at 1% level. Genotypes FIN 5117 and FIN 5111 depicted highest grain yield. Both high Genotypic and Phenotypic coefficient of variation were recorded for number of tillers per plant. High heritability coupled with high genetic advance as percent of mean was observed for number of fingers per ear, grain yield per plant, days to fifty percent flowering indicating that these traits are most probably under the control of additive gene action and hence these traits can be fixed by proper selection. Correlation coefficient analysis revealed that days to maturity, number of tillers per plant, number of fingers per ear, biological yield emerged as most important attributing associates of grain yield per plant in finger millet. Days to maturity, number of fingers per plant, number of tillers per plant had positively direct effect on grain yield per plant. Therefore, effective selection must be attempted for these traits which would help in improvement of grain yield in Finger millet genotypes.

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Key Words: Finger millet, Heritability, Genetic advance, Correlation coefficient analysis, Path coefficient analysis

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1. Introduction

Finger millet (*Eleusinecoracana*L.), belongs to family *Poaceae*(*Gramineae*), subfamily *Chloridoideae*, and genus *Eleusine*, and it is highly self-fertilized allotetraploid ($2n = 36$) derived from the wild tetraploid progenitor *E. coracana*subsp. *Africana**Africana* (Reference).

Finger millet was domesticated around 5000 years ago in Eastern Africa (possibly Ethiopia) and introduced into India, 3000 years ago (Hiluet *et al.* 1979). The cultivated *E. coracana*is a tetraploid ($2n=4X=36$) and exhibits morphological similarity to both *E. indica*($2n=18$) and *E. africana*($2n=36$). It was earlier thought that cultivated *E. coracana*originated from *E. indica*, of which the distribution is quite wide, from Africa eastwards to Java. *E. coracana*possibly originated from *E. africana*through selection and further mutation towards larger grains (Channaveeraiah and Hiremath, 1974., Hiluet *et al.* 1979).

In world, finger millet ranks fourth in importance among millets after sorghum, pearl millet and foxtail millet. It is estimated that some 10 per cent of the world's 30 million tonnes of millet produced is finger millet (Chandra *et al.* 2016). In India, the crop is grown in an area of 1.01 million hectares with a production of 1.38 million tonnes and productivity of 1.36 tonnes ha⁻¹. 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 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. Its cultivation is concentrated mostly in the districts of Bangalore, Kolar, Tumkur, Chitradurga, Hassan, Mysore and Mandya (Anonymous, 2016).

Finger millet is commonly called as "Nutritious millet" as its grains are nutritionally superior over other cereals. It stands out as the richest source of calcium (380-450 mg/100g) among all the cereals (Reference). It has three times more calcium than milk and 10-fold higher calcium than brown rice, wheat or maize. Besides calcium, finger millet is also very rich source of crude fibre (3.6 mg/100g), iron (3.39 mg/100g), zinc (1.5 mg/100g), essential amino acids, leucine (594 mg/100g of protein) and valine (413 mg/100g of protein), slowly digestible starch and phytochemicals like polyphenols. It is a gluten-free, low fat cereal which is non-allergic and easily digestible. For these characteristics, it is often termed as a "Super cereal" (Ref.). Apart from its nutritional attributes, finger millet has excellent environmental sustainability credentials. It can easily withstand harsh climatic conditions, low soil fertility, requires very little inputs with a short growing season. It has excellent storage quality traits and can be valuable in areas where farmers suffer losses due to dearth of post-harvest management (Kumar *et al.* 2016):

Comments:

- The background information and uses of the crop is good but lacks research problem and justification why the experiment was conducted.
- No proposed solution

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-No any literature describing why studying genetic variability and yield influencing traits is needed

-The objectives of the study was not included

2. Materials and methods

Study site: The experiment was carried out at Field Experimentation Centre of Department of Genetics and Plant Breeding, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj (Uttar Pradesh) during *Kharif* -2021. The experimental field which was located on the left side of Prayagraj -Rewa (National Highway) new bridge road. It is about 2 km away from Prayagraj. Prayagraj is situated between the parallels of 25.4358° N latitude and 81.8463° E longitude. The climate of this area is tropical characterized by fairly hot summer, moderately cold winter with humid and warm monsoon. The rainfall of this region is heavy and normally received from June to September. Most of the precipitation is received through south-west monsoon, concentrating in the months of July and October. The soil of experimental site was loamy mixed with pH ranging from 7.3 to 7.6. The land was prepared by two harrowing followed by planking.

Planting materials and experimental design

The experiment material for present investigation comprised of 20 genotypes of finger millet obtained from Department of Genetics and Plant Breeding, Prayagraj. The experiment was conducted in Randomized Block Design (RBD) with three replications. The genotypes were sowing on 5 Aug 2021 and harvested on 30th Nov, 2021 at the shuats college Research Station, Prayagraj. The seedlings were sowing at 20×10 cm² spacing. The crop was fertilized with 40 Kg N₂ and 20 Kg P₂O₅ per hectare. The nitrogen was applied in two splits, one at the time of transplanting and other at 25 days after transplanting. Entire Phosphorus was applied as basal dose. All recommended practices were followed and timely plant protection measures were taken to avoid damage through insect-pests and diseases. The genotypes were sown on 5 Aug 2021 and harvested on 30th Nov, 2021 at the shuats college Research Station, Prayagraj.

Comments:

—The plot size of each plot, path between each plots, between blocks should be clearly indicated.

- Method of data collection should be incorporated
- Method of data analysis must be included

2.1 Experimental Materials

The experiment material for present investigation comprised of 20 genotypes of finger millet obtained from Department of Genetics and Plant Breeding, Prayagraj.

Source: Indian Institute of Millets Research (IIMR), Hyderabad.

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Table 1: Analysis of Variance (ANOVA) for 20 genotypes of 13 quantitative traits

Mean Sum of Squares				
S. No	Characters	Replication (d.f=2)	Treatment (d.f=19)	Error (d.f=38)
1	Days to fifty percent flowering	52.550	26.568	26.568
2	Days to maturity	118.950	52.722	52.722
3	Plant height	53.310	26.656	26.656
4	Number of leaves	5.4210	3.911	3.911
5	Number of fingers per plant	0.2590	0.167	0.167
6	Finger length	0.0380	0.246	0.246
7	Finger width	0.0020	0.007	0.007
8	Ear head length	0.6060	0.346	0.346
9	Number of tillers	0.0650	0.051	0.051
10	Biological yield	16.3990	11.262	11.262
11	1000 grain weight	0.0070	0.027	0.027
12	Grain yield per plant	0.2170	0.377	0.377
13	Harvest index	28.2580	160.60310.614	

****Indicates significant at 0.0020% level**

- It is not clear why the authors used the 0.0020% probability level. The author didn't determine any significance for means. It was incorrect. For field experiments, it is recommended to use 5% probability level and if well under well controlled environment 1% probability level can be used to test its significance.

Therefore, the author is suggested to use the correct probability level to determine the significance of mean squares.

Table 2: ~~Grand mean~~ Genetic variability, phenotypic variability, heritability and genetic advance for yield contributing ~~Characters~~ characters in 20 finger millet genotypes

Sl. No.	Traits	GCV	PCV	h ² (Broad sense)	Genetic Advancement	Gen. Adv as % of Mean
1	Days to fifty percent flowering	9.903	11.932	68.89	13.114	16.933
2	Days to maturity	6.614	9.634	47.127	9.694	9.353
3	Plant height	4.996	8.469	34.8	4.584	6.071
4	Number of leaves	14.203	16.282	76.093	6.34	25.523
5	Number of fingers per plant	24.162	24.798	94.94	3.548	48.499
6	Finger length	13.421	15.466	75.308	1.549	23.992
7	Finger width	12.14	14.569	69.435	0.215	20.839
8	Ear head length	9.879	12.024	67.505	1.436	16.72

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9	Number of tillers	40.004	40.404	98.028	3.239	81.592
10	Biological yield	20.851	22.91	82.837	13.823	39.094
11	1000 grain weight	25.914	26.951	92.452	1.14	51.328
12	Harvest index	20.857	21.989	89.967	3.594	40.753
13	Grain yield per plant	27.183	29.93	82.488	13.229	50.859

PCV: Phenotypic Coefficient of Variation, GCV: Genotypic Coefficient of Variation, h^2 (bs): Heritability (broad sense), GA: Genetic Advance, GAM: Genetic Advance as Percent Mean

[The author is also suggested to incorporate phenotypic and genotypic variances for the 13 characters in table 2.](#)

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Table 3: Genotypic (above) and phenotypic (below) correlations of among all quantitative characters grain yield per plant with other characters studied in 20 Finger millet genotypes of Finger millet.

Traits	Genotypic/phenotypic	Days to fifty percent flowering	Days to maturity	Plant height	Number of leaves	Number of fingers per ear	Finger length	Finger width	Ear head length	Number of tillers	Biological yield	1000 grain weight	Harvest Index	Grain yield per plant
Days to fifty percent flowering	G	1.0000	0.825	0.546*	0.1534	-	-	0.40	0.027	-0.317*	-0.0034	-	-	-
	P	1.0000	**	*	0.0737	0.1544	0.1784	3*	2	-0.263*	0.0056	0.11	0.218	0.257
Days to maturity	G	1.0000	0.660	0.290*	-	-	0.25	-	-	-	-	0.28	0.04	*
	P	1.0000	**	**	0.1038	0.054	7*	0.023	4	-	-	0.10	0.173	0.193
Plant height	G	1.0000	0.825	0.546*	0.1534	-	-	0.40	0.027	-0.317*	-0.0034	-	-	-
	P	1.0000	**	*	0.0737	0.1544	0.1784	3*	2	-0.263*	0.0056	0.11	0.218	0.257
Number of leaves	G	1.0000	0.660	0.290*	-	-	0.25	-	-	-	-	0.28	0.04	*
	P	1.0000	**	**	0.1038	0.054	7*	0.023	4	-	-	0.10	0.173	0.193
Number of fingers per ear	G	1.0000	0.825	0.546*	0.1534	-	-	0.40	0.027	-0.317*	-0.0034	-	-	-
	P	1.0000	**	*	0.0737	0.1544	0.1784	3*	2	-0.263*	0.0056	0.11	0.218	0.257
Finger length	G	1.0000	0.660	0.290*	-	-	0.25	-	-	-	-	0.28	0.04	*
	P	1.0000	**	**	0.1038	0.054	7*	0.023	4	-	-	0.10	0.173	0.193
Finger width	G	1.0000	0.825	0.546*	0.1534	-	-	0.40	0.027	-0.317*	-0.0034	-	-	-
	P	1.0000	**	*	0.0737	0.1544	0.1784	3*	2	-0.263*	0.0056	0.11	0.218	0.257
Ear head length	G	1.0000	0.660	0.290*	-	-	0.25	-	-	-	-	0.28	0.04	*
	P	1.0000	**	**	0.1038	0.054	7*	0.023	4	-	-	0.10	0.173	0.193
Number of tillers	G	1.0000	0.825	0.546*	0.1534	-	-	0.40	0.027	-0.317*	-0.0034	-	-	-
	P	1.0000	**	*	0.0737	0.1544	0.1784	3*	2	-0.263*	0.0056	0.11	0.218	0.257
1000 grain weight	G	1.0000	0.660	0.290*	-	-	0.25	-	-	-	-	0.28	0.04	*
	P	1.0000	**	**	0.1038	0.054	7*	0.023	4	-	-	0.10	0.173	0.193

Biological yield	G				**
	P	1.00	0.485	0.938	00 ** **
Harvest Index	G	1.00	0.420	0.878	00 ** **
	P		1.000	0.582	0 **
Grain yield per plant	G				1.000
	P				0 1.0000

- [The title or caption of Table 3 requires modification](#)

[The Table 3 data is lengthy and not attractive. Therefore author is suggested to write the genotypic correlation result on the above diagonal while write below diagonal for the corresponding phenotypic correlation result. But be careful not mix up.](#)

- [The author is suggested to take Table1, 2, 3 under Results and discussion section.](#)

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3. RESULTS AND DISCUSSION

3.1 Analysis of Variance for Quantitative Characters of Finger millet (*Eleusine coracana* L.)

Analysis of variance for different characters is presented in Table 1. The mean sum-of-squares for 13 different characters of 20 genotypes showed highly significant differences ($\alpha=0.01$) for all characters indicating the presence of substantial amount of genetic variability among the Finger millet genotypes.

The characters under investigation were analyzed for genotypic variance (c^2), phenotypic variance (σ^2_p), genotypic coefficient of variation (GCV), phenotypic coefficient variation (PCV), heritability (Broad sense), genetic advance and expected genetic advance as percent of mean (EGA) and are presented in Table 2.

3.2 Genotypic coefficient of variation

High magnitude of GCV was observed in traits such as no. number of tillers (40.004) followed by grain yield (27.18), 1000 GM weight (25.91), number of fingers per ear (24.16) and biological yield (20.85), harvest index (10.95). While moderate GCV was observed in traits number leaves per plant (14.20), number of finger length (13.42), finger width (12.14), ear head length (9.87) and days to 50% flowering (6.61) and Lowest GCV was observed in traits plant height (4.96).

3.3. Phenotypic coefficient variation

Phenotypic coefficient of variation was observing greater than genotypic coefficient of variation for all the traits. Highest PCV was observed

in the traits no of tillers (40.40) followed by grain yield (29.93), 1000 GM weight (26.95), no of fingers per ear (24.79) and biological yield (22.91), harvest index (21.98). While moderate PCV was observed in traits number leaves per plant (16.28), number of finger length (15.46), finger width (14.56), ear head length (12.02) and days to 50% flowering (9.61) and Lowest GCV was observed in traits plant height (8.46).

3.4. Heritability

The high heritability estimates were observed in the traits no of tillers (98.02) followed by no of fingers per ear (94.94), 1000 GM weight (92.45), harvest index (82.48), grain yield (82.48) and biological yield (82.21). While moderate heritability was observed in traits number leaves per plant (76.09), number of finger length (75.30), finger width (69.43), ear head length (67.50) and days to 50% flowering (68.89) and Lowest GCV was observed in traits plant height (34.8). Showed moderate heritability.

3.5. Genetic advance (5%)

The highest GA (%) was observed in character biological yield per ha (13.82) followed by grain yield per plant (13.22), days to 50 percent flowering (13.11), days to maturity (9.69), no of leaves (6.34), harvest index (3.59) showed moderate genetic advance as percent of mean. While 1000GM weight yield (1.14), finger width (0.215) and plant height showed low genetic advance as percent.

3.6 Genetic advance as % of mean 5%

Genetic advance of 5% mean of variation was observing. Highest genetic advance value was observed in the traits no of tillers (81.59) followed by 1000

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Comment [D6]: Not included in Table 2.

GM weight (51.32), grain yield per plant (50.85), no of fingers per ear (48.49), moderate genetic advance mean value was observed in traits number leaves per plant (25.52), number of finger length (23.99), finger width (20.83), ear head length (16.72) and days to 50% flowering (16.93) and Lowest GCV was observed in traits plant height (9.3).

[Comment: There was no any explanation, discussion and future direction indicated based on the results. No any description on genotypic and phenotypic correlation result of Table 3.](#)

CONCLUSION

From the present investigation it is concluded that among 20 genotypes of finger millet on the basis of mean performance 4 genotypes viz FIN 5117, FIN 5111, FIN 5113, FIN 7051 and possessed maximum grain yield per plant over the check variety GPU-48. It is concluded from experimental results that significant variation can be exploited further for the improvement of the finger millet. High GCV, PCV, heritability and genetic advance for all characters implies selection will be effective in this studied population. Number of tillers per plant exhibited high estimates of GCV and PCV. The grain yield per plant exhibited a significant positive phenotypic correlation with number of number of tillers, ear head length, 1000 grain weight, biological yield and harvest index, paves the way of indirect selection of the traits. For grain yield improvement. Harvest index showed high direct effect on grain yield, hence should be given utmost important during selection.

[Conclusion needs correction](#)

harvest index (40.75) and biological yield (39.09). While

REFERENCES

1. Anuradha, n., patro, t. s. s. k., divya, m., sandhya r. y. and triveni, u., 2017, Genetic variability, heritability and association in advanced breeding lines of finger millet [*Eleusinecoracana*(L.) Gaertn]. *Int. J. Chem. Stud.*, **5**(5):1042-1044.
2. Abraham, M.J., Gupta, A.S. and Sharma, B.K. 1989. Genetic variability and character association of yield and its components\ in finger millet (*Eleusinecoracana*L.) in acidic soils of Meghalaya. *Indian J. Agri. Sci.*, **59**: 579-581.
3. Anantharaju, P. and Meenakshiganesan, N. 2005. Studies on correlation and path coefficient analysis of yield and yield contributing characters in finger millet (*Eleusinecoracana*L. Gaertn.). *Crop Res. Hisar*, **30** (2): 227-230.
4. Bedis, M.R., Ganvirand, B.N. and Patil, P.P. 2006. Genetic variability in finger millet. *Journal of Maharashtra Agricultural Universities*, **31** (3): 369-370.
5. Burton, G. W. 1952. Quantitative inheritance in grasses. Proceedings of 6th International Grassland Congress, 1: 277-283.
6. Barbeau W.E. and Hilu, K.W. 1993. Protein, calcium, iron and amino acid content of selected wild and domesticated cultivars of Finger millet. *Plant Foods Hum. Nutr.*, **43**:97-104

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7. Dewey, D. and Lu, K.H. 1959. A correlation and path coefficient analysis of components of crested wheat grass seed production. *Agronomy Journal*. **51**: 515-518.
8. Dida, M.M., Wanyera, N., Harrison, M.L. Dunn, J.L., Bennetzen, and Devos., K.M. 2008. Population structure and diversity in finger millet (*Eleusinecora-cana*) germplasm. *Trop. Plant Biol.*, 1: 131-141. doi:10.1007/s12042-008-9012-3.
9. Ganapathy, S. Nirmalakumari A. and Muthiah, A.R. 2011. Genetic variability and interrelationship analysis for economic traits in finger millet germplasm. *World Journal of Agricultural Sciences*, **7**(2):185-188.
10. Goulden, C.H. 1952. Methods of Statistical Analysis. 1st Edn. John Wiley and Sons, Inc., New York, USA. Goron, T.L., and Raizada, M.N. 2015. Genetic diversity and genomic resources available for the small millet crops to accelerate a New Green Revolution. *Front. Plant Sci.* **6**:157. doi: 10.3389/fpls.2015.00157.
11. Gowda, J. Shet, R. and Suvarna, Somu M. 2008. Genetic variability, correlation studies in interspecific crosses of finger millet (*Eleusinecoracana*(L.) Gaertn.). *Crop Research*. **31** (2): 264- 266.
12. Hilu, K.W., and J.M.J. De Wet. 1976. Domestication of *Eleusinecoracana*. *Econ Bot* **30**: 199-208.
13. Fisher RA. The correlation between relative on the supposition of Mendalian Inheritance. Vol. 52. Edinburg: *Trance Royal Society*; 1918. p. 399-403.
14. Priyadharshini, C., Nirmalakumari, A., John., Joel. and Raveendran, M. (2021). Genetic variability and trait relationships in finger millet (*Eleusinecoracana*(L.) Gaertn.) Hybrids. *Madras Agriculture Journal*, **98**(1-3): 18-21.
15. Singamsetti, A., Patro, T. S. S. K., Anuradha, N. and Divya, M. (2018). Studies on Genetic Variability for Yield and Yield Attributing Traits in Finger millet (*Eluesinecoracana*(L.) Gaertn). *International Journal of Current Microbiology and Applied Sciences*, **7**: 90-95.
16. Ulaganatham, V. and Nirmalakumari, A. (2011). Genetic variability for yield and yield related traits in finger millet [*Eleusinecoracana*(L.) Gaertn] Genotypes. Department of Millets, Centre for plant Breeding and Genetics, Tamil Nadu Agricultural University, Coimbatore, India.

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