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Morphological Characterization of Fingermillet [*Eleusine coracana* (L.) Gaertn] Germplasm

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Genetic variability and correlation coefficients analyses were carried out in 305 fingermillet genotypes between 13 grain yield and yield related traits. Highly significant mean sum of squares due to genotypes and wide range of variability were noticed among the genotypes for all the characters studied. High values for phenotypic and genotypic coefficients were recorded for grain yield per plant and flag leaf blade length, indicating that more variability is present in the germplasm for these characters. All the characters recorded high heritability in the present study indicated that these characters were relatively less influenced by environmental factors and phenotypic selection would be effective for the improvement of these characters. High estimates of variability together with high heritability and high genetic advance were observed for flag leaf sheath width, flag leaf blade width and 1000 grain weight, which indicated that these characters were governed by additive genes and selection would be effective for improvement of such characters. Highly significant positive correlation observed for the characters like days to 50 per cent flowering, productive tillers per plant, plant height, 1000 grain weight, flag leaf sheath length, days to maturity, flag leaf blade length and finger width with grain yield per plant, indicated the possibility of simultaneous improvement of these characters by selection.

Key words: Fingermillet, Genetic variability, Correlation coefficient, Selection

Fingermillet (*Eleusine coracana* (L.) Gaertn) is an important traditional food crop in India as well as many parts of the world. The crop is grown mainly by subsistence farmers and serves as a food security crop because of its high nutritional value and excellent storage qualities (Dida *et al*., 2007). It is also a good source of micronutrients like calcium, iron, phosphorus, zinc and potassium. The fingermillet area is being replaced by other crops such as maize and soybean. Considering the increased demand for fingermillet for food purposes and decreasing area under this crop due to competing crops, there is an immediate need for genetic enhancement of fingermillet productivity.

Improvement in any crop usually involves exploitation of genetic variability for specific traits. Genetic improvement through conventional breeding approaches depends mainly on the availability of diverse germplasm and presence of enormous genetic variability. The evaluation and characterization are the important pre-requisites for effective utilization of germplasm and also to identify sources of useful genes. An insight into the nature and magnitude of genetic variability present in the gene pool is of immense value for starting any systematic breeding programme, because the presence of considerable genetic variability in the base material ensures better chances of evolving desirable plant type. Heritability is of interest to plant breeders primarily as a measure of value of selection for a particular character as an index of inheritance. In general, genetic variability, heritability and genetic advance are pre-requisites for breeding program and provide opportunity to plant breeder for selecting high yielding genotypes or to combine or transfer genes having desirable traits. Information on correlation between yield and its component characters may be helpful in selection of suitable plant type. Hence, the present investigation was undertaken to characterize the germplasm accessions, to assess the variability and to determine the interrelationship among yield and its contributing characters in fingermillet.

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Materials and Methods

Experimental material consisted of 305 fingermillet germplasm accessions maintained at Department of Millets, Centre for Plant Breeding and Genetics, Tamil Nadu Agricultural University, Coimbatore. This is situated at about 11°N latitude and 77°E longitude at an altitude of 427 m above MSL and the average annual rainfall is around 700mm. These accessions were evaluated in augmented block design during winter 2011. The germplasm accessions were evaluated into 12 blocks, each consisted of 25 accessions and five check varieties *viz.*, CO (Ra) 14, CO 9, GPU 28, TRY 1 and Paiyur 2. Each accession was grown in single row of 3 metre length with a spacing of 30 cm x 10 cm. Observations were recorded from five randomly selected competitive plants in each accession for all the quantitative characters except days to 50 per cent flowering, and days to 50 per cent

flowering was noted on single row basis. In addition, the characters namely, plant height (cm), productive tillers per plant, flag leaf sheath length (cm), flag leaf sheath width (cm), flag leaf blade length (cm), flag leaf blade width (cm), finger number per panicle, finger length (cm), finger width (mm), days to maturity, 1000 grain weight (g) and grain yield per plant (g) were recorded as per descriptors for *Eleusine coracana* (IBPGR, 1985). The data collected for all quantitative characters were subjected to analysis of variance for augmented block design according to the method suggested by Federer and Raghavarao (1975). Phenotypic and genotypic variances were estimated according to the formula given by Lush (1940). Phenotypic and genotypic coefficients of variability were computed according to the method suggested by Burton (1952). Heritability in broad sense was calculated as per the formula given by Allard (1960). Genetic advance was expressed as per cent of mean by using the formula suggested by Johnson *et al.* (1955). Traits were classified as having high, moderate or low genetic advance as per the method suggested by Johnson *et al.* (1955). Correlation coefficients were worked out using the formula as suggested by Falconer (1960).

Results and Discussion

The analysis of variance (Table 1) showed that there existed variation and significant differences for all the characters under study, indicating the presence of adequate variability for further improvement. It was highly significant for all quantitative traits,

Table 1. Analysis of variance for 13 characters of 305 fingermillet genotypes

Character	Mean sum of squares			
	Treatment (df=304)	Checks (df=4)	Genotype (df=299)	Error (df=55)
Days to 50 per cent flowering	26.419**	10.774**	26.371**	1.178
Plant height (cm)	150.958**	412.448**	146.296**	17.155
Productive tillers per plant	4.247**	8.432**	3.267**	0.232
Flag leaf sheath length (cm)	3.041**	7.354**	2.972**	0.485
Flag leaf sheath width (cm)	0.026**	0.058**	0.026**	0.005
Flag leaf blade length (cm)	52.813**	64.269**	52.519**	5.390
Flag leaf blade width (cm)	0.027**	0.059**	0.027**	0.006
Finger number per panicle	2.289**	1.439**	1.866**	0.255
Finger length (cm)	2.350**	0.128	2.271**	0.272
Finger width (mm)	1.731**	8.298**	1.563**	0.305
Days to maturity	26.380**	16.036**	26.230**	1.114
1000 grain weight (g)	0.154**	0.568**	0.148**	0.016
Grain yield per plant (g)	62.399**	98.390**	60.444**	5.357

* Significant at P =0.05 ** Significant at P =0.01

implying that the genotypes tested were highly variable. Substantial variations in fingermillet have been reported in previous studies (Naik *et al*., 1994; Prasad Rao *et al*., 1994). Regardless of the variation, the relative magnitude of the range and the mean of the genotypes generally displayed considerable differences between the minimal and maximal values for all the traits evaluated (Table 2). Flag leaf blade length exhibited the widest range (14.60 and 54.20 cm) followed by grain yield per plant (13.67 and 47.82 g), 1000 grain weight (1.52 and 3.57 g) and productive tillers per plant (6 and 14). Relatively, low ranges were recorded for days to maturity (88 and 113 days), days to 50 per cent flowering (62 and 83 days), plant height (62.67 and 114.67 cm) and finger width (7 and 13), respectively. Similar to this study, a wide range of variations for plant height and grain yield per plant (Narasamha Rao and Parathasarathi, 1968), for finger length and number (Kebede and Menkir, 1986), for plant height and productive tillers per plant (Prasada Rao *et al*., 1994) were reported earlier.

High phenotypic and genotypic variances were shown by plant height (130.11 and 109.52), flag leaf blade length (67.78 and 60.48) and grain yield per plant (60.78 and 53.20) whereas, the lowest ones were found for flag leaf blade width (0.02 and 0.01) and flag leaf sheath width (0.02 and 0.01) (Table 2). This indicated the existence of immense inherent variability that remained unaltered by environmental conditions among the genotypes, which in turn was more useful for exploitation in hybridization and/or selection.

The magnitude of phenotypic coefficient of variation (PCV) was higher than that of genotypic coefficient of variation (GCV) for all the characters under study which indicated that apparent variation is not only due to genotypes but also due to the influence of environment (Table 3). The narrow differences between PCV and GCV indicated little influence of environment on the expression of these characters and variability was due to genetic components only. This implied that phenotypic variability is a reliable measure of genotypic variability. Similar reports were earlier reported by Kebere Bezaweletaw *et al*. (2006). For all 13 traits, the phenotypic coefficient of variation ranged from 5.24 to 23.69 per cent for days to maturity and single plant grain yield, respectively. The genotypic coefficient of variation ranged from 5.03 to 22.30 for days to maturity and flag leaf blade length, respectively. Genotypic coefficients of variation followed the similar trend as that of phenotypic coefficients of variation.

The genotypic and phenotypic coefficients of variation levels were high for flag leaf blade length (22.30 and 23.61 per cent) and grain yield per plant (22.16 and 23.69 per cent) indicating that these characters are more variable in the germplasm. There is a great scope for improvement of these characters by direct selection among the genotypes. Similar reports were made by Dagnachew Lule *et al*. (2012), Nirmalakumari *et al*. (2010) and Kebere Bezaweletaw *et al*. (2006). Productive tillers per plant (16.37 and 17.55 per cent), flag leaf sheath length (15.16 and 16.78 per cent), 1000 grain weight (14.64 and 15.48 per cent), finger length (13.20 and 14.40 per cent), flag leaf blade width (11.70 and 13.36 per cent), flag leaf sheath width (11.47 and 13.47 per cent) and plant height (10.90 and 11.88 per cent) showed medium GCV and PCV, which indicated variation for these characters were moderate among these genotypes.

These observations are in agreement with the earlier reports of Dagnachew Lule *et al*. (2012), Ganapathy *et al*. (2011) and Kebere Bezaweletaw *et al*. (2006). Low GCV and PCV estimates were observed for finger width (8.45 and 9.71 per cent), days to 50 per cent flowering (6.61 and 6.98 per cent) and days to maturity (5.03 and 5.24 per cent) indicating that these characters were less variable among these genotypes. These results are in accordance with Dagnachew Lule *et al*. (2012), Ganapathy *et al*. (2011) and Kebere Bezaweletaw *et al*. (2006). Finger number per panicle (9.85 and 10.94 per cent) recorded low to moderate variability of this character indicated the need for improvement of base population. However, for majority of the traits, the environmental coefficients of variation (ECV) estimates were lower than both genotypic and phenotypic coefficients of variations. This implied that the environmental role was less for the expression of such characters (Singh and Narayanan, 1993).

Table 2. Range, mean and variance for 13 characters in 305 fingermillet genotypes.

Characters	Range		Mean	Phenotypic variance ($\sigma^2$2p)	Genotypic variance ($\sigma^2$2g)	Error variance ($\sigma^2$2e)
	Minimum	Maximum				
Days to 50 per cent flowering	62.00	83.00	70.94	25.67	23.00	2.66
Plant height (cm)	62.67	114.67	91.16	130.11	109.52	20.59
Productive tillers per plant	6.00	14.00	9.26	3.03	2.64	0.40
Flag leaf sheath length (cm)	7.00	14.70	10.14	3.37	2.75	0.62
Flag leaf sheath width (cm)	0.68	1.36	1.02	0.02	0.01	0.01
Flag leaf blade length (cm)	14.60	54.20	30.16	67.78	60.48	7.30
Flag leaf blade width (cm)	0.70	1.46	1.02	0.02	0.01	0.00
Finger number per panicle	6.00	12.67	8.62	0.87	0.70	0.16
Finger length (cm)	6.12	12.57	8.78	1.48	1.24	0.24
Finger width (mm)	7.00	13.00	10.12	1.10	0.84	0.27
Days to maturity	88.00	113.00	100.67	29.06	26.80	2.27
1000 grain weight (g)	1.52	3.57	2.47	0.16	0.14	0.02
Grain yield per plant (g)	13.67	47.82	29.43	60.78	53.20	7.58

Table 3. Estimates of variability for yield and yield contributing characters in 305 fingermillet genotypes.

Characters	PCV (%)	GCV (%)	ECV (%)	h^2 (BS) (%)	GA as % of mean
Days to 50 per cent flowering	6.98	6.61	2.30	89.62	3.25
Plant height (cm)	11.88	10.90	4.61	84.18	3.85
Productive tillers per plant	17.55	16.37	7.25	86.95	14.32
Flag leaf sheath length (cm)	16.78	15.16	8.59	81.63	13.63
Flag leaf sheath width (cm)	13.47	11.47	7.03	72.44	40.55
Flag leaf blade length (cm)	23.61	22.30	9.11	89.23	8.66
Flag leaf blade width (cm)	13.36	11.70	7.04	76.75	40.66
Finger number per panicle	10.94	9.85	5.22	81.07	12.49
Finger length (cm)	14.40	13.20	6.07	83.93	14.29
Finger width (mm)	9.71	8.45	5.83	75.67	10.37
Days to maturity	5.24	5.03	1.49	92.21	9.95
1000 grain weight (g)	15.48	14.64	5.19	89.41	25.69
Grain yield per plant (g)	23.69	22.16	9.40	87.53	9.09

In the present study, the estimates of heritability were found to be high for all the characters under study and it ranged from 72.44 (flag leaf sheath width) to 92.21 per cent (days to maturity). Heritability was more than 85 per cent observed for days to maturity (92.21 per cent), days to 50 per cent flowering (89.62 per cent), 1000 grain weight (89.41 per cent), flag leaf blade length (89.23 per cent), grain yield per plant (87.53 per cent) and productive tillers per plant (86.95 per cent), which indicated that these characters were less influenced by environmental conditions and selection would be effective on the basis of phenotype alone with high probability of success. Similarly, high heritability for all the characters studied was reported by Ganapathy *et al*. (2011), Dagnachew Lule *et al.* (2012), Dhagate *et al,* (1972) and Abraham *et al.* (1989). Heritability portion of phenotypic variance is a good index of transmission of characters from parents to offspring (Falconer, 1960). The estimates of heritability help the plant breeder in selection of elite genotypes from divergent population. But heritability itself does not provide any indication towards the amount of genetic progress that would result in selecting best individual; rather it depends upon the amount of genetic advance. Genetic advance as per cent of mean ranged from 3.25 (days to 50 per cent flowering) to 40.66 (flag leaf blade width). High genetic advance as per cent of mean was observed for flag leaf blade width (40.66), flag leaf sheath width (40.55) and 1000 grain weight (25.69). High genetic advance indicated that these characters are governed by additive genes and selection will be rewarding for improvement of these traits. Medium genetic advance as per cent of mean was observed for productive tillers per plant (14.32), finger length (14.29), flag leaf sheath length (13.63), finger number per panicle (12.49) and finger width (10.37) indicated that these characters are governed by non additive genes. High heritability coupled with high genetic

advance was observed for flag leaf sheath width, flag leaf blade width and 1000 grain weight. This indicated that the heritability is due to additive gene effects and can be improved by simple selection. High heritability coupled with medium genetic advance for productive tillers, flag leaf sheath length, finger number, finger length and finger width indicated non additive gene action and high genotype x environment interaction.

Grain yield is a complex character and its expression depends on the interplay of a number of component characters. An insight into the association between grain yield and other traits helps to improve the efficiency of selection. Correlation coefficient measures the mutual relationship between various plant characters and determines the component characters on which selection can be relied upon for genetic improvement of yield. Grain yield per plant had significant positive correlation with days to 50 per cent flowering (0.93), productive tillers per plant (0.92), plant height (0.91), 1000 grain weight (0.90), flag leaf sheath length (0.85), days to maturity (0.83), flag leaf blade length (0.78) and finger width (0.30) (Table 4). Significant positive correlation of most of the characters on grain yield per plant indicated that all these characters can be simultaneously improved, and it also suggested that increase in any one of them would lead to improvement of other character. Grain yield per plant had positive and significant relation with days to 50 per cent flowering, plant height and productive tillers, which confirmed the report by Bedis *et al.* (2006) in fingermillet. Significant negative correlation was observed for flag leaf sheath width (-0.75), flag leaf blade width (-0.70), finger number per panicle (-0.55) and finger length (-0.49) with grain yield per plant, which indicated that increase in one character will lead to decrease in another character.

Table 4. Phenotypic correlation coefficients for different traits in fingermillet genotypes.

Characters	DF	PH	PT	FLSL	FLSW	FLBL	FLBW	FN	FL	FW	DM	TGW	SPY
DF	1.00	0.84**	0.85**	0.81**	-0.70**	0.76**	-0.66**	-0.47**	-0.42**	0.26**	0.91**	0.84**	0.93**
PH		1.00	0.85**	0.92**	-0.82**	0.85**	-0.79**	-0.51**	-0.45**	0.28**	0.74**	0.83**	0.91**
PT			1.00	0.78**	-0.71**	0.70**	-0.65**	-0.49**	-0.44**	0.25**	0.75**	0.84**	0.92**
FLSL				1.00	-0.76**	0.86**	-0.70**	-0.44**	-0.39**	0.20**	0.71**	0.75**	0.85**
FLSW					1.00	-0.71**	0.82**	0.45**	0.37**	-0.24**	-0.63**	-0.70**	-0.75**
FLBL						1.00	-0.64**	-0.37**	-0.31**	0.18**	0.70**	0.69**	0.78**
FLBW							1.00	0.43**	0.32**	-0.19**	-0.58**	-0.66**	-0.70**
FN								1.00	0.69**	-0.42**	-0.43**	-0.60**	-0.55**
FL									1.00	-0.35**	-0.39**	-0.55**	-0.49**
FW										1.00	0.25**	0.28**	0.30**
DM											1.00	0.75**	0.83**
TGW												1.00	0.90**
SPY													1.00

* Significant at P =0.05 ** Significant at P =0.01

DF	Days to 50 per cent flowering	FN	Finger number per panicle
PH	Plant height (cm)	FL	Finger length (cm)
PT	Productive tillers per plant	FW	Finger width (mm)
FLSL	Flag leaf sheath length (cm)	DM	Days to maturity
FLSW	Flag leaf sheath width (cm)	TGW	1000 grain weight (g)
FLBL	Flag leaf blade length (cm)	SPY	Grain yield per plant (g)
FLBW	Flag leaf blade width (cm)		

Conclusion

Genetic variability present in the population is mainly used for varietal improvement of future breeding programmes. High coefficients of variation was observed for grain yield per plant indicating that this character is more variable in the germplasm. There is a great scope for improvement of this character by direct selection among the genotypes. High heritability coupled with high genetic advance was observed for flag leaf sheath width, productive tillers per plant and 1000 grain weight, which suggested that these characters may be successfully used as selection criteria in improving grain yield. The characters such as days to 50 per cent flowering, productive tillers per plant, plant height, 1000 grain weight, flag leaf sheath length, days to maturity, flag leaf blade length and finger width showed significant positive correlation with grain yield per plant. This positive association suggested that increase in one character will increase the other also.

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References

Abraham, M.J., Gupta, A.S. and Savma, B.K. 1989. Genetic variability and character association of yield and its components in finger millet (*Eleusine coracana*) in acidic soils of Meghalaya. *Indian J. Agri. Sci*. **59:** 579-581.

Allard, R.W. 1960. Principles of plant breeding. John Wiley and Sons Inc., U.S.A.

Bedis, M.R., Patil, H.S., Jangle, G.D. and Patil, V.S. 2006. Correlation and path analysis in finger millet (Eleusine coracana Gaertn.). *Crop Res.,* 31(2): 261-266.

Burton, G.W. 1952. Quantitative inheritance in grasses. In: Proc. of the 6th International Grassland Congress, pp 277-283.

Dagnachew Lule, Kassahun Tesfaye, Masresha Fetene and Santie De Villiers. 2012. Inheritance and Association of Quantitative Traits in Finger Millet (*Eleusine coracana* Subsp. *Coracana*) Landraces Collected from Eastern and South Eastern Africa. *Int. J. Genet.*, **2(2):** 12-21.

Dhagate, N.K., Patidar, G.L., Shrivastava, P.S. and Joshi, R.C. 1972. Correlation and genetic variability study in ragi [*Eleusine coracana* (L.) Gaertn]. *JNKVV Research J.* **6:** 121-124.

Dida, M.M., Srinivasachary, Ramakrishnan, S., Bennetzen, J.L., Gale, M.D. and Devos, K.M. 2007. The genetic map of finger millet, Eleusine coracana. *Theoretical Appl. Genet*., **114:** 321-332.

Falconer, D.S. (1960). Introduction to Quantitative Genetics 2nd ed., Longman, New York.

Federer, W.T. and Raghavarao, D. 1975. On Augmented Designs. *Biometrics*. **31:** 29-35.

Ganapathy, S., Nirmalakumari, A. and Muthiah, A.R. 2011. Genetic Variability and Interrealtionship Analyses for Economic Traits in Finger Millet Germplasm. *World J. Agric. Sci.* **7(2):** 185-188.

IBPGR (International Board for Plant Genetic Resources), 1985. Descriptors for Finger Millet. IBPGR Secretariat, Rome, pp: 20.

Johnson, H.W., Robinson, H.F. and Comstock, R.E. 1955. Estimates of genetic and environmental variability in soybean. *Agron. J.* **47:** 314-318.

Kebede, Y. and Menkir, A. 1986. Improvement of finger millet in Ethiopia, pp. 173-176. In Seetheram, A., Rilley, K.W. and Harinaryyana, G (eds.). Small Millet in Global Agriculture: Proceeding of the First International Small Millet Workshop. October 29-November 2, 1986. Bangalore, India.

Kebere Bezaweletaw, Prapa Sripichitt, Wasana Wongyai and Vipa Hongtrakul. 2006. Genetic Variation, Heritability and Path-Analysis in Ethiopian Finger Millet [Eleusine coracana (L.) Gaertn] Landraces. *Kasetsart J. (Nat. Sci.)* **40**: 322-334.

Lush, J.L. 1940. Intra – sire correlation and regression of offspring on dams as a method of estimating heritability of characters. In: Proc. of "American Society of Animal Production" **33:** 293-301.

Naik, B.J., Shankare Gounda, B.T. and Seetharam, A. 1994. Pattern of variability in relation to domestication of finger millet in Africa and India. In K.E. Riley: pp.347-363.

Narasamha Rao, D.V. and Parathasarathi, A.V. 1968. Studies on genetic variability of certain phenotypic variations, genetic advance and heritability of certain quantitative characters. *Madras Agric. J.* **55:** 392-397.

Nirmalakumari, A., Salini, K. and Veerabadhiran, P. 2010. Morphological Characterization and Evaluation of Little millet (Panicum sumatrense Roth. ex. Roem. and Schultz.) Germplasm. *Elect. J. Plant Breed*., **1(2):** 148-155.

Prasado Rao, K.E., de Wet, J.M.J., Gopal Reddy, V. and Mengesha, M.H. 1994. Diversity in the small millets collection at ICRISAT. In K.E. Riley pp.331-345.

Singh, P. and Narayanan, S.S. 1993. Biometrical Techniques in Plant Breeding. Kalyani Publishers, New Delhi.

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