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A study on character association, genetic variability and yield components of finger millet (*Eleusine coracana* L.)

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ABSTRACT

A study was conducted to assess the genetic variability in base germplasm (1000 accessions) of finger millet for eleven quantitative characters including grain yield per plant. Highly significant differences were observed among all the finger millet genotypes for different characters. Close relationship found between GCV and PCV for most of the characters. High heritability was expressed by plant height, finger length and days to 50 per cent flowering. Genetic advance as per cent of mean was observed maximum for finger length, number of productive tillers per plant, grain yield per plant, ear weight per plant and plant height. Character association studies revealed that, grain yield per plant had highly positive and significant association with plant height, days to 50 per cent flowering, days to maturity and ear weight per plant. Path analysis revealed that number of productive tillers per plant, days to maturity and ear weight per plant had direct positive effect on grain yield.

***Key words*:** Character association, genetic advance, variability, heritability

Finger millet (*Eleusine coracana* L.) is an important food crop in the arid areas of Africa and South Asia. It occupies third place among millets after sorghum and pearl millet both in area and production (Nadini *et al*., 2011). It is a good source of quality protein, plentiful minerals, dietary fibres, phyto-chemicals and vitamins. The crop provides food grain as well as straw, which is valued animal feed in rainfed areas. The progress in breeding for yield and yield contributing characters of any crop is genetically controlled, environmentally influenced and determined by the magnitude and nature of their genetic variability (Wright, 1935 and Fisher, 1981). Study of genetic variability and association of characters are pre-requisites for improvement of any crop including finger millet for selection of superior genotypes and improvement of any character. In a study it is reported that limited use of germplasm accessions it is leading to a narrow genetic base in crop plants (Upadhyay *et al.*, 2010).

It is very difficult to judge whether observed variability is heritable or due to environment alone. Moreover, knowledge of heritability is essential for selection based improvement as it indicates the extent of transmissibility of a character in future generations. Knowledge of correlation between yield and its contributing characters are basic and for most endeavour to find out guide-lines for plant selection. Partitioning of total correlation into direct and indirect effect by path coefficients analysis helps in making the selection move effective. Keeping in view the above facts, the present investigation was undertaken to know genetic variability, correlation and path coefficient among yield and its contributing characters in 1000 accessions of finger millet germplasm.

MATERIALS AND METHODS

The field experiment was comprised of one thousand germplasm of finger millet which includes extensive collections from various parts of Africa and Asian countries (Fig.1). The experiment was carried out at experimental plots, AICSMIP, GKVK, Bangalore, representing the eastern dry zone which is located at the latitude of 12^{o} 58' north and longitude 77^{o} 35' East and altitude of 930 meters above mean sea level (MSL). The accessions were grown in an augmented RBD (Federer, 1966) for evaluation. Each accession was grown in one row of 3m length. The inter-row distance was kept at 22.5cm and intra-row distance was kept at 10cm. Data on 11 quantitative characters *viz*., plant height , peduncle length, finger length , finger width , culm thickness, number of productive tillers per plant, finger number per ear, days to 50 per cent flowering, days to maturity, ear weight per plant and grain yield per plant were recorded on randomly selected five plants in each accession. The variability for different quantitative characters was estimated as per procedure for analysis of variance suggested by Sapra and Agarwal (1991), GCV and PCV by Burton and De Vane (1953) and heritability and genetic advance by Johnson *et al*., (1955). Correlation coefficient was worked out as per Al-Jibouri *et al*., (1958) and path coefficients of various characters were calculated by the formula given by Dewey and Lu, (1959).

RESULTS AND DISCUSSION

Analysis of variance revealed highly significant differences among entries for all the characters studied. The mean sums of squares of all the 11 quantitative characters are presented in table 1.

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Table 1: Analysis of variance (mean sum of squares) for quantitative characters of finger millet germplasms (n = 1000)

Source of variation	df	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}
Blocks	36	125.50	8.38	1.13	0.01	0.01	2.38	0.86	3.00	5.10	150.81	104.72
Checks	2	1678.50**	113.77**	5.64**	0.02	0.03	7.98**	7.20**	1875.72**	2385.38**	466.27**	344.06**
Genotypes (unreplicated)	999	383.52**	9.19**	3.04**	0.02**	0.02**	2.63**	0.95**	59.20**	63.82**	59.21**	43.97**
Genotypes v/s Checks	1	288.65*	0.00	129.68**	0.48**	1.37**	33.70**	120.86**	7.94**	21.10*	11004.54**	8828.92**
Error	72	68.83	5.69	0.95	0.01	0.01	1.18	0.50	2.08	4.11	73.25	55.95

Note: and ** are significant at 5 and 1 per cent level, respectively.*

Table 2: Estimates of mean, range, variance, coefficient of variation, heritability and genetic advance for different agronomic characters in finger millet germplasms (n = 1000)

Characters	Mean ± SE	Range		Variance		Co-efficient of variability		h^2 (broad Sense) (%)	GA as per cent of mean
		Lowest	Highest	PV	GV	PCV (%)	GCV (%)		
X_1	95.6 ± 0.62	45.6	157.2	407.31	338.91	21.11	19.24	83.11	36.14
X_2	13.6 ± 0.09	4.4	22.0	11.82	6.13	25.30	18.20	51.86	27.00
X_3	6.0 ± 0.05	3.5	13.8	3.80	2.85	32.33	28.13	75.00	50.19
X_4	0.9 ± 0.00	0.5	1.4	0.02	0.01	13.55	7.70	33.33	8.37
X_5	0.9 ± 0.00	0.4	1.6	0.02	0.01	13.55	7.70	33.33	8.37
X_6	5.7 ± 0.05	1.1	13.4	3.56	2.38	32.98	27.08	66.89	45.44
X_7	6.6 ± 0.03	3.8	11.5	1.21	0.71	16.66	12.71	58.50	20.08
X_8	69.8 ± 0.24	47.0	89.0	10.58	8.50	4.65	4.16	80.34	7.70
X_9	109.2 ± 0.25	84.0	128.0	4.81	0.67	2.00	0.01	13.91	0.57
X_{10}	23.8 ± 0.24	8.0	62.0	119.95	4.67	46.00	28.69	38.93	36.89
X_{11}	19.7 ± 0.21	5.0	51.0	90.65	34.70	48.32	29.89	38.27	38.09

X_1 - Plant height (cm) X_5 - Culm thickness (cm) X_9 - Days to maturity
X_2 - Peduncle length (cm) X_6 - No. of productive tillers / plant X_{10} - Ear weight / plant (g)
X_3 - Finger length (cm) X_7 - Finger number / ear X_{11} - Grain yield / plant (g)
X_4 - Finger width (cm) X_8 - Days to 50 per cent flowering

Genetic variability, heritability and genetic advance

The extent of variability present in the 1000 accessions of finger millet was measured in terms of range, mean, phenotypic variance, phenotypic coefficient of variation, genotypic variance, genotypic coefficient of variation, heritability (broad sense) and genetic advance and are presented in table 2.

All the genotypes differed significantly with respect to the different characters studied, with a wide range of variation. Plant height range varied from 45.6cm (GE 6058) to 157.2cm (GE 4735), peduncle length varied from 4.4cm (GE 6350) to 22.0cm (GE 5936), finger length varied from 3.5cm (GE 6288) to 13.8cm (GE 4715), finger width *varied* from 0.5cm (GE 6288) to 1.4cm (GE 4868), culm thickness ranged from 0.4cm (GE 5852) to 1.6cm (GE 4865), number of productive tillers per plant ranged from 1.1 (GE 5983) to 13.4 (GE 6240), finger number per ear ranged from 3.8 (GE 5953) to 11.5 (GE 5078), days to 50 per cent flowering ranged from 47 days (GE 5946) to 89 days (GE 6410), days to maturity varied from 84 days (GE 5943) to 128 days (GE 5006), ear weight per plant ranged from 8 g (GE 4776) to 62 g (GE 4786 and GE 4972) and grain yield per plant ranged from 5 g (GE 4776) to 51 g (GE 4786 and GE 4972).

Close relationship found between GCV and PCV for most of the characters but few PCV values were greater than GCV values, revealing influence of environment for their expression.

High heritability was observed for the characters *viz.*, plant height, finger length and days to 50 per cent flowering which indicated that these characters were governed by less environmental factors. High heritability along with high genetic advance was observed for plant height, peduncle length, finger length and days to 50 per cent flowering. Genetic advance as per cent of mean was observed maximum for finger length, number of productive tillers per plant, grain yield per plant, ear weight per plant and plant height. If heritability were mainly due to additive gene action, it would be associated with high genetic advance and if it is due to

non-additive gene action, genetic gain would be low (Panse, 1957).

In present investigation, the characters like plant height, finger length, number of productive tillers per plant and days to 50 per cent flowering had high values of GCV, heritability and genetic advance indicated additive gene action and these could be effectively used in selection, as suggested by Johnson *et al.* (1955). Similar results were also reported by Kempanna *et al*. (1971), Chunilal *et al*. (1996) and Bandopadhyay (1999).

Table 3: Estimates of phenotypic correlation coefficients for 11 quantitative characters in finger millet germplasm (n = 1000)

Traits	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}
X_1	0.5082**	0.4793**	-0.0804	0.2006*	0.1733*	0.1379	0.5345**	0.5241**	0.4332**	0.4197**
X_2		0.3583**	-0.0951	-0.0243	0.0368	0.0839	0.2628**	0.2568**	0.2481**	0.2284**
X_3			-0.0920	0.1187	0.0536	0.0375	0.3196**	0.3093**	0.3463**	0.3303**
X_4				0.2184*	-0.1089	-0.0688	0.0081	0.0223	0.0703	0.0816
X_5					-0.0926	0.0794	0.0749	0.0735	0.1642	0.1550
X_6						-0.0488	0.3019**	0.2926**	0.3376**	0.3546**
X_7							-0.0153	-0.0228	0.1298	0.1205
X_8								0.9861**	0.4121**	0.4135**
X_9									0.3981**	0.4000**
X_{10}										0.9802**

X_1 - Plant height (cm) X_5 - Culm thickness (cm) X_9 - Days to maturity
X_2 - Peduncle length (cm) X_6 - No. of productive tillers / plant X_{10} - Ear weight / plant (g)
X_3 - Finger length (cm) X_7 - Finger number / ear X_{11} - Grain yield / plant (g)
X_4 - Finger width (cm) X_8- Days to 50 per cent flowering

Note: and ** are significant at 5 and 1 per cent level, respectively.*

Table 4: Estimates of direct and indirect effects of yield components on grain yield at phenotypic level in finger millet germplasm (n = 1000)

Traits	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	'r' value
X_1	**-0.0018**	-0.0072	-0.0028	-0.0006	0.0039	-0.0004	-0.0013	0.0074	0.4224	0.4196**
X_2	-0.0009	**-0.0141**	-0.0021	0.0001	0.0008	-0.0002	-0.0006	0.0036	0.2419	0.2285**
X_3	-0.0009	-0.0051	**-0.0058**	-0.0004	0.0012	-0.0001	-0.0008	0.0044	0.3377	0.3302**
X_4	-0.0004	0.0003	-0.0007	**-0.0030**	-0.0021	-0.0002	-0.0002	0.0010	0.1601	0.1548
X_5	-0.0003	-0.0005	-0.0003	0.0003	**0.0227**	0.0001	-0.0007	0.0041	0.3292	0.3546**
X_6	-0.0003	-0.0012	-0.0002	-0.0002	-0.0011	**-0.0028**	0.0000	-0.0003	0.1265	0.1204
X_7	-0.0010	-0.0037	-0.0018	-0.0002	0.0069	0.0000	**-0.0024**	0.0139	0.4018	0.4135**
X_8	-0.0010	-0.0036	-0.0018	-0.0002	0.0067	0.0001	-0.0023	**0.0141**	0.3881	0.4001**
X_9	-0.0008	-0.0035	-0.0020	-0.0005	0.0077	-0.0004	-0.0010	-0.0056	**0.9751**	0.9700**

Residual effect = 0.0382 *The main diagonal (bold) is direct effects*

X_1 - Plant height (cm) X_4 - Culm thickness (cm) X_7- Days to 50 per cent flowering
X_2 - Peduncle length (cm) X_5 - No. of productive tillers / plant X_8 - Days to maturity
X_3 - Finger length (cm) X_6 - Finger number / ear X_9 - Ear weight / plant (g)

Association among yield and yield component characters

The effect of each yield contributing characters on yield in finger millet was analysed through character association studies. Phenotypic correlation was worked out among 11 quantitative characters to know the nature of association existing among the characters. On the basis of Phenotypic correlation coefficient (Table 3) it was observed that grain yield per plant had highly positive and significant association with plant height, days to 50 per cent flowering, days to maturity and ear weight per plant. Such correlation was also reported by Basavaraj and Sheriff (1991), Mahto *et al*., (2000), Gowda *et al.*, (2007) and Sumathi *et al.* (2007). Whereas, it had positive and non-significant correlation with finger width, culm thickness and finger number per ear. Among the yield contributing characters plant height and days to 50 per cent flowering had high positive correlation with ear weight per plant and also days to 50 per cent flowering had high positive association with days to maturity. Whereas finger width showed negative association with all other characters under study.

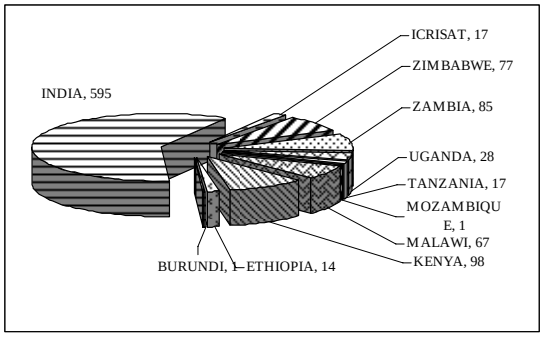

Fig1: **Pie chart representing 1000 germplasm accessions of finger millet from different parts of the world used in the current study.**

The direct and indirect effects of different characters on grain yield per plant were worked out using path coefficients analysis (Deway and Lu, 1959). Highly correlated yield contributing characters were considered for path analysis. Path analysis revealed that number of productive tillers per plant, days to maturity and ear weight per plant had positive direct effect on grain yield per plant (Table 4). Thus, selection for these traits may lead to an overall increase in grain yield per plant. These results are in close conformity with the findings of Basavaraj and Sheriff, (1990) and Naik, (1991). The highest indirect positive effect on grain yield was shown by plant height, finger length, days to 50 per cent flowering and days to maturity through ear weight per plant.

On the contrary, the characters *viz.*, plant height, peduncle length, finger length, culm thickness, finger number per ear and days to 50 per cent flowering showed high negative direct effect on grain yield. Thus, path coefficient analysis revealed the importance of characters such as number of productive tillers per plant, days to maturity and ear weight per plant in selection of superior genotypes for grain yield.

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