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Studies on Genetic Variability, Heritability and Genetic Advances for Quantitative Characters in Finger millet (*Eleusine coracana* (L.) Gaertn.)

C. K. Sindhuja*, S. Marker and S. Ramavamsi

Department of Genetics and Plant Breeding, SHUATS, Prayagraj, U.P., India

**Corresponding author*

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A B S T R A C T

The present investigation was carried out to study the genetic variability, heritability and genetic advance among 137 finger millet genotypes for fifteen characters during *Kharif* 2018. Analysis of Variance showed significant differences for all the characters under study except for leaf width, number of panicle per plant and test weight indicating the presence of a substantial amount of genetic variability thus revealed that these genotypes have been developed from the different genetic background. On the basis of *per se* performance for different quantitative traits, genotype IE4734 was found to be the best genotype in Allahabad agro-climatic conditions. High estimates of GCV and PCV were observed for harvest index. High heritability coupled with high genetic advance was recorded for leaf width followed by test weight and grain yield per plant indicating the predominance of additive gene effects and the possibilities of effective selection for the improvement of these characters.

Introduction

Finger millet is an important staple food crop widely grown in Africa and South Asia. Among the millets, finger millet has a high amount of calcium, methionine, tryptophan, fiber, and sulfur-containing amino acids.

In addition, it has C_4 photosynthetic carbon assimilation mechanism, which helps to utilize water and nitrogen efficiently under hot and arid conditions without severely affecting yield Hittalmani (2017).

Finger millet is highly nutritious as its grain contains high-quality protein (7-10%). It is the richest source of calcium (344mg/100g), iron (3.9mg/100g) and other minerals. It is also rich in phosphorus (283mg/100g) and potassium (408mg/100g). The cereal has low-fat content (1.3%) and contains mainly unsaturated fat 100 g of finger millet has roughly on an average of 336 Kcal of energy. The higher fiber content of finger millet helps in many ways as it prevents constipation, high cholesterol formation, and intestinal cancer. Hence, people suffering from diabetes are advised to eat finger millet and other small millets instead of rice Hadimani and Malleshi, (1993).

Assessment of genetic variability is a basic step in the crop improvement program. Yield is being a complex character it is influenced by a number of yield contributing characters controlled by polygenes and also influenced by the environment. Genotypic and phenotypic association reveals the degree of association between different characters and thus, aids in selection to improve the yield and yield attributing characters. Heritability measures the relative amount of the heritable portion of variation while the genetic advance helps to measure the amount of progress that could be expected with selection in a character.

Materials and Methods

The experimental material consisted of 137 finger millet genotypes collected from ICRISAT, Hyderabad and NBPGR, New Delhi (Table 1). The experiment was conducted in randomized block design with three replications during *Kharif*-2018 at Field Experimentation Centre of the Department of Genetics and Plant Breeding, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj (Allahabad) U.P. All the recommended agronomic and cultural practices were followed for raising a healthy crop. Data were recorded on five randomly taken plants per replication of each genotype for fifteen characters viz., days to 50% flowering, days to maturity, plant height (cm), leaf length (cm),leaf width (cm),leaf area index, number of panicles per plant, number of fingers per panicle, finger length (cm),finger width (cm),stem girth (cm), biological yield/plant (g), grain yield/plant (g), harvest index, seed index. The analysis of variance was done as suggested by Punse and Sukhatme (1985). The genotypic and phenotypic coefficient of variation was calculated by the formulae as suggested by Burton (1952), heritability as per formulae suggested by Burton and Devane (1953) and genetic advance (Johnson *et al*., 1955).

Results and Discussion

The analysis of variance showed a wide range of variation and significant differences for all the characters under study except for leaf width, number of panicles per plant and test weight. This indicates that there was ample scope for selection of promising lines from the present gene pool for yield and its components in finger millet(Table 2).

Estimation of genotypic variance (σ^2g) and phenotypic variance (σ^2p) was obtained for different characters and wide range of variance were observed for all the characters. The highest genotypic variance (σ^2g) and phenotypic variance (σ^2p) were recorded for plant height (124.74 and 176.25) followed by days to 50% flowering (90.06 and 94.13), days to maturity (90.06 and 94.13), leaf area index (54.63 and 63.38), leaf length (33.29 and 51.02), biological yield per plant (23.81 and 24.87). While moderate genotypic variance (σ^2g) and phenotypic variance (σ^2p) were recorded for harvest index (16.20 and 17.15).

Whereas, finger length (1.94 and 2.04), number of fingers per panicle (0.85 and 0.89), grain yield per plant (0.52 and 0.53), finger width (0.03 and 0.04), stem girth (0.02 and 0.03), number of panicle per plant (0.00 and 0.01) showed genotypic variance (σ^2g) and phenotypic variance (σ^2p). The phenotypic variance was higher than the genotypic variance for all the yield and yield attributing characters indicates that the influence of environmental factors on these traits. Less difference in the estimates of genotypic and phenotypic variance for all the characters suggested that the variability present among the genotypes were mainly due to genetic reason with minimum influence of environment and hence heritable. The genotypic estimates of variability (Vg) being the most important, helps in the measurement of a particular character and gives a clue to compare the genetic variability for different characters. Similar results have been reported by John (2006), Ganapathy *et al.,* (2011)and Karad and Patil (2013).

Phenotypic coefficient of variation ranged from 8.70 (days to maturity) to 41.45 (harvest index). Highest PCV was recorded for harvest index (41.45), whereas the lowest was recorded for days to maturity (8.70). Genotypic coefficient of variation ranged from 4.80 (number of panicles per plant) to 40.30 (harvest index). Highest GCV was recorded for Harvest index (40.30), whereas the lowest was recorded for a number of panicles per plant (4.80).

The coefficient of variation at phenotypic and genotypic levels was high for harvest index, grain yield per plant, biological yield per plant, leaf area index, test weight, finger width and finger length. Similar results were also obtained by Kumari and Singh (2015) for Harvest index and leaf area index, Patil(2013) for Grain yield per plant, finger length and test weight. Moderate for the traits like leaf width, number of fingers per panicle, plant height, stem girth, leaf length. Similar results were also obtained by Ulaganathan and Nirmalakumari (2011) for leaf length, leaf width and number of fingers per panicle, Ganapathy *et al.*,(2011) for plant height. Low PCV and GCV were observed for days to maturity. Similar results were obtained by Ganapathy *et al.,*(2011)for days to maturity. The magnitude of high GCV and PCV suggests that enough genetic variability is present among the finger millet genotypes for traits where PCV and GCV are moderate to low, the scope of selection for suitable characters is limited.

In present study, high heritability was recorded for leaf width, test weight, grain yield per plant, biological yield per plant, number of panicles per plant, days to flowering, days to maturity, finger length, harvest index, finger width, leaf area index, plant height, stem girth and leaf length. The maximum value was recorded for leaf width (99%) and the minimum was recorded for number of panicles per plant (21%). High heritability coupled with high genetic advance as percent mean in the present set of genotypes were recorded for leaf width (99% and 37.59%) followed by test weight (97% and 47.34%),grain yield per plant (97% and 77.41%), days to 50% flowering (96% and 22.11%), number of fingers per panicle (96% and 32.87), biological yield per plant (96% and 50.34%), finger length (95% and 44.22%), finger width (94% and 46.12%), harvest index (94% and 80.67%), leaf area index (86% and 47.15%), plant height (71% and 25.24%), stem girth (69% and 22.64%) and leaf length (65% and 21.38%) indicating a predominance of additive gene effects and the possibilities of effective selection for the improvement of these characters. Similar results were also obtained by John 2006 for Test weight and harvest index, Ganapathy *et al.*,(2011)for grain yield per plant, finger length and plant height, Kumari and Singh (2015) for leaf area index and days to 50% flowering, Ulaganathan and Nirmalakumari (2011) for leaf length. High heritability coupled with moderate genetic advance was recorded for days to maturity (96% and 17.5%), suggesting the greater role of both additive and non-additive gene action in their inheritance.

Table.1 List of finger millet genotypes used in the present investigation

S. No	Designation	Source	S. No	Designation	Source	S. No	Designation	Source	S. No	Designation	Source	S. No	Designation	Source
1	IE3978	ICRISAT, Hyderabad	29	IE4121	ICRISAT, Hyderabad	57	IE3104	ICRISAT, Hyderabad	85	GE4	NBPGR, New Delhi	113	GE61	NBPGR, New Delhi
2	IE2043	ICRISAT, Hyderabad	30	IE4734	ICRISAT, Hyderabad	58	IE3391	ICRISAT, Hyderabad	86	GE62	NBPGR, New Delhi	114	FMWC 1	Farmer
3	IE4797	ICRISAT, Hyderabad	31	IE5066	ICRISAT, Hyderabad	59	IE3614	ICRISAT, Hyderabad	87	GE236	NBPGR, New Delhi	115	FMWC 2	Farmer
4	IE5106	ICRISAT, Hyderabad	32	GE86	NBPGR, New Delhi	60	IE4565	ICRISAT, Hyderabad	88	GE51	NBPGR, New Delhi	116	FMWC 3	Farmer
5	GE229	NBPGR, New Delhi	33	GE237	NBPGR, New Delhi	61	IE6240	ICRISAT, Hyderabad	89	GE21	NBPGR, New Delhi	117	FMWC 4	Farmer
6	GE93	NBPGR, New Delhi	34	GE228	NBPGR, New Delhi	62	GE238	NBPGR, New Delhi	90	GE196	NBPGR, New Delhi	118	FMWC 5	Farmer
7	GE82	NBPGR, New Delhi	35	GE52	NBPGR, New Delhi	63	GE87	NBPGR, New Delhi	91	GE76	NBPGR, New Delhi	119	FMWC 6	Farmer
8	GE83	NBPGR, New Delhi	36	GE200	NBPGR, New Delhi	64	GE81	NBPGR, New Delhi	92	GE80	NBPGR, New Delhi	120	FMWC 7	Farmer
9	GE231	NBPGR, New Delhi	37	GE235	NBPGR, New Delhi	65	GE213	NBPGR, New Delhi	93	GE224	NBPGR, New Delhi	121	FMWC 8	Farmer
10	GE13	NBPGR, New Delhi	38	GE276	NBPGR, New Delhi	66	GE191	NBPGR, New Delhi	94	GE207	NBPGR, New Delhi	122	FMWC 9	Farmer
11	GE277	NBPGR, New Delhi	39	IE3470	ICRISAT, Hyderabad	67	GE44	NBPGR, New Delhi	95	GE274	NBPGR, New Delhi	123	FMWC 10	Farmer
12	GE193	NBPGR, New Delhi	40	GE245	NBPGR, New Delhi	68	GE76	NBPGR, New Delhi	96	GE223	NBPGR, New Delhi	124	FMWC 11	Farmer
13	GE271	NBPGR, New Delhi	41	GE2	NBPGR, New Delhi	69	GE85	NBPGR, New Delhi	97	IE4671	ICRISAT, Hyderabad	125	FMWC 12	Farmer
14	GE278	NBPGR, New Delhi	42	GE86	NBPGR, New Delhi	70	GE55	NBPGR, New Delhi	98	IE4673	ICRISAT, Hyderabad	126	FMWC 13	Farmer
15	GE202	NBPGR, New Delhi	43	GE77	NBPGR, New Delhi	71	GE79	NBPGR, New Delhi	99	IE4757	ICRISAT, Hyderabad	127	FMWC 14	Farmer
16	GE199	NBPGR, New Delhi	44	GE227	NBPGR, New Delhi	72	GE60	NBPGR, New Delhi	100	IE2872	ICRISAT, Hyderabad	128	FMWC 15	Farmer
17	GE234	NBPGR, New Delhi	45	GE228	NBPGR, New Delhi	73	GE203	NBPGR, New Delhi	101	GE12	NBPGR, New Delhi	129	FMWC 16	Farmer
18	GE53	NBPGR, New Delhi	46	GE214	NBPGR, New Delhi	74	GE243	NBPGR, New Delhi	102	GE19	NBPGR, New Delhi	130	FMWC 17	Farmer
19	GE63	NBPGR, New Delhi	47	IE6154	ICRISAT, Hyderabad	75	IE2072	ICRISAT, Hyderabad	103	IE2437	ICRISAT, Hyderabad	131	FMWC 18	Farmer
20	GE197	NBPGR, New Delhi	48	GE19	NBPGR, New Delhi	76	IE2790	ICRISAT, Hyderabad	104	IE6294	ICRISAT, Hyderabad	132	FMWC 19	Farmer
21	GE233	NBPGR, New Delhi	49	GE50	NBPGR, New Delhi	77	IE3475	ICRISAT, Hyderabad	105	IE5817	ICRISAT, Hyderabad	133	FMWC 20	Farmer
22	GE87	NBPGR, New Delhi	50	GE239	NBPGR, New Delhi	78	IE3945	ICRISAT, Hyderabad	106	IE3045	ICRISAT, Hyderabad	134	FMWC 21	Farmer
23	GE198	NBPGR, New Delhi	51	GE205	NBPGR, New Delhi	79	IE4073	ICRISAT, Hyderabad	107	IE5537	ICRISAT, Hyderabad	135	FMWC BULK 22	Farmer
24	GE85	NBPGR, New Delhi	52	GE219	NBPGR, New Delhi	80	IE4570	ICRISAT, Hyderabad	108	IE7079	ICRISAT, Hyderabad	136	IE3618 (Check)	ICRISAT, Hyderabad
25	GE275	NBPGR, New Delhi	53	GE79	NBPGR, New Delhi	81	IE5091	ICRISAT, Hyderabad	109	GE68	NBPGR, New Delhi	137	IE2217 (Check)	ICRISAT, Hyderabad
26	GE76	NBPGR, New Delhi	54	GE279	NBPGR, New Delhi	82	IE5367	ICRISAT, Hyderabad	110	GE240	NBPGR, New Delhi			
27	IE518	ICRISAT, Hyderabad	55	IE1055	ICRISAT, Hyderabad	83	IE5367	ICRISAT, Hyderabad	111	GE195	NBPGR, New Delhi			
28	IE4028	ICRISAT, Hyderabad	56	IE1055	ICRISAT, Hyderabad	84	GE273	NBPGR, New Delhi	112	GE210	NBPGR, New Delhi			

Table.2 Analysis of Variance for different quantitative parameters in finger millet

S. No.	Parameters	Mean Sum of Squares		
		Replications (d.f = 2)	**Treatments (d.f = 136)**	**Error(d.f = 272)**
1	Days to 50% flowering	5.70	274.25**	4.06
2	Days to maturity	5.70	274.25**	4.06
3	Plant height	140.73	425.73**	51.51
4	Leaf length	44.97	117.59**	17.73
5	Leaf width	0.00	0.08	0.00
6	Leaf area index	19.08	172.64**	8.76
7	Finger length	0.21	5.92**	0.10
8	Finger width	0.01	0.10**	0.00
9	No. of panicle per plant	0.00	0.02	0.01
10	No. of fingers per panicle	0.04	2.59**	0.03
11	Stem girth	0.02	0.06**	0.01
12	Biological yield per plant	1.54	72.48**	1.06
13	Harvest Index	0.25	49.54**	0.95
14	Test weight	0.00	0.01	0.00
15	Grain yield per plant	0.02	1.57**	0.02

****** indicates 1% level of significance

Table.3 Genetic parameters for 15 quantitative characters in 137 finger millet genotypes.

Parameters	Genotypic variance	Phenotypic variance	Coefficient of variance (%)		Heritability (%)	Genetic advance at 5%	Genetic advance as a percent of mean
			GCV	PCV			
Days to 50% flowerin1g	90.06	94.13	10.97	11.22	96.00	19.12	22.11
Days to maturity	90.06	94.13	8.51	8.70	96.00	19.12	17.15
Plant height	124.74	176.25	14.56	17.31	71.00	19.36	25.24
Leaf length	33.29	51.02	12.85	15.91	65.00	9.60	21.38
Leaf width	0.03	0.03	18.32	18.39	99.00	0.33	37.59
Leaf area index	54.63	63.38	24.65	26.55	86.00	14.14	47.15
Finger length	1.94	2.04	22.02	22.60	95.00	2.96	44.22
Finger width	0.03	0.04	23.09	23.82	94.00	0.36	46.12
No. of panicle per plant	0.00	0.01	4.80	10.55	21.00	0.05	4.50
No. of fingers per panicle	0.85	0.89	16.26	16.61	96.00	1.86	32.87
Stem girth	0.02	0.03	13.25	15.98	69.00	0.23	22.64
Biological yield per plant	23.81	24.87	24.97	25.52	96.00	9.84	50.34
Harvest Index	16.20	17.15	40.30	41.45	94.00	8.07	80.67
Test weight	0.00	0.00	23.29	23.29	97.00	0.12	47.34
Grain yield per plant	0.52	0.53	38.18	38.18	97.00	1.46	77.41

Similar findings were reported by Ulaganathan and Nirmalakumari (2011) andKarad and Patil (2013).Low heritability coupled with low genetic advance was recorded for number of panicles per plant (21% and 4.50%). It is indicative of non-additive gene action. The low heritability is being exhibited due to the favorable influence of environment rather than genotype and selection for such traits may not be rewarding(Table 3).

In the present study, the characters, leaf width followed by test weight and grain yield per plant had high heritability coupled with high genetic advance as percent means indicating the predominance of additive gene effects and the possibilities of effective selection for the improvement of these characters.

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