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Studies on Genetic Variability for Yield and Quality Traits in Finger Millet (*Eluesine coracana* L. Gaertn)

Anusha Udamala[1*], B. Vijayalakshmi[1], N. Anuradha[2], T. S. S. K. Patro[2] and V. Sekhar[3]

[1]Department of Genetics and Plant Breeding, Agriculture college, Bapatla, Guntur-522001, A.P, India
[2]Agricultural Research Station, Vizianagaram, 535 001, A.P., India
[3]Department of Statistics, College of Horticulture, Dr. Y.S.R. Horticultural University, West Godavari, A.P – 534101

**Corresponding author*

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A B S T R A C T

Thirty blast resistant lines of finger millet were evaluated in a field study to assess the magnitude of genetic variability, heritability and genetic advance for yield and quality attributing traits. The analysis of variance revealed that there were significant differences among the entries for all the traits studied. The genetic parameters revealed that moderate to high variability coupled with high heritability and high genetic advance as per cent of mean for agronomic traits *viz.*, days to 50% flowering, days to maturity, fingers per ear head, finger width, test weight, productive tillers per plant and quality traits like calcium content, iron content, zinc content, protein content and anti-oxidant activity suggesting the predominance of additive type of gene action in controlling these traits and improvement of these characters is possible through simple selection.

Introduction

Eleusine coracana (L). Gaertnis one of the important sustenance millets grown extensively in various regions of Africa and South Asia.It is widely adapted to grow even at higher altitude regions where other crops fail to grow hence it serves as a food security crop having high nutritive and culture value. It is also known to be one of the most efficient utilizer of nitrogen (Gupta *et al.*, 2014). Globally, it stands fourth in production among millets after sorghum, bajra and foxtail millet (Upadhyaya *et al.*, 2017). In India the overall cultivated area under this crop is 10.16 lakh hectares with 13.85 lakh tonnes production and 1363 kg ha^{-1} productivity (www.indiastat.com 2016-17), whereas in Andhra Pradesh, it is grown in 0.35 lakh hectares with 0.44 lakh tonnes production and productivity of 1277 Kg ha^{-1} (Agricultural statistics at a glance 2017-18). Finger millet is considered to be one of the nutritious millet as grains are nutritionally superior by providing fair amount of proteins, minerals and vitamins in abundance to the consumers. Finger millet contains 8-10 times more calcium content than that of rice or wheat. The carbohydrate present in ragi has a unique property of slower digestibility and therefore considered as food for long subsistence. It is highly valued as a substitute food in the times of drought. Demand for millets is increasing day by day and keeping in view of the future demand, there is a continues need to evolve new varieties which should exceed the yield of existing varieties in both yield and quality.

The crop improvement depends mainly on basic information on the existence of genetic variability and diversity in population and the relationship between different traits. Presence of high variability offers much scope for its improvement (Poehlman, 1987). Success of hybridization and selection of desirable segregants can be possible by choosing of diverse parents with maximum magnitude of genetic variability for different traits. Estimation of genetic variability alone does not provide clear cut indication of possible advancement that can be achieved through selection and it should be coupled with heritability and genetic advance (Venkatesan *et al.,* 2004). Heritability and genetic advance are important selection parameters when considered together help the breeders in determining the traits having better corresponding between phenotypes and genotypes and are expected to give better response to selection (Binse *et al.,* 2006). Hence, an attempt was made to determine the performance of30 finger millet genotypes to assess the variability, phenotypic coefficient of variation (PCV), genotypic coefficient of variation (GCV), heritability and genetic advance among sixteen traits which would contribute to formulation of suitable selection indices for improvement.

Materials and Methods

The present investigation was carried out at Agriculture Research Station, Vizianagaram, Andhra Pradesh, located at an altitude of 63 m above mean sea level, latitude of 18.12 ^{0}N and longitude of 83.40^{0} E with sandy loamy soil having pH 7.3.The experimental material comprised of 30 genotypes consisting of 11 varieties released i.e. five from Agricultural Research Station (ARS), Vizianagaram, one each from Agricultural Research Station, Peddapuram and Agricultural Research Station, Perumallapalli and two from Bangalore and two from Almora, Uttarakhand apart from 11 advanced breeding lines and eight exotic germplasm lines collected from ICRISAT, Hyderabad (Table 1). The genotypes were evaluated in a Randomized Block Design with three replications during *kharif*, 2019. Each plot consisted of four rows of 4 meters length with a spacing of 30 × 10 cm.

All the recommended agronomic packages of practices were followed during the entire crop period. In each replication, five random plants were chosen and observations were recorded on eleven yield viz., days to 50% flowering, days to maturity, plant height, number of productive tillers per plant, number of fingers per ear, finger length, finger width, test weight, harvesting index, fodder yield and grain yield and five quality traits viz., protein content, calcium content, iron content, zinc content and anti-oxidant activity.

The mean values were subjected to statistical analysis and the genetic parameters such as phenotypic coefficient of variation (PCV), genotypic coefficient of variation (GCV), heritability and Genetic advance as per cent of mean were established as per Burton *et al.,*

(1952) and Johnson *et al.,* (1955) to assess the genetic variability of yield and quality traits.

Results and Discussion

Analysis of variance revealed highly significant differences among genotypes for the characters studied indicating presence of sufficient amount of variability in the studied material (Table 1). Thus, there is ample scope for selection of different quantitative characters for finger millet improvement. The mean, range, variability, heritability and genetic advance as per cent mean for sixteen traits were presented in Table 2. The range varied for calcium content 228.3 mg/100g (VR 1101) to 626.7 mg/100g (VL 352) with the mean value of 408.05 mg/100g, plant height varied from 89.5 cm (EG 24) to 120.1 cm (VR 1179) with the mean value of 110.55 cm and days to 50 percent flowering ranged from 50 days (VR 1125) to 83 days (EG 31) with a mean value of 69 days. The genotypic coefficient of variation for all the characters studied were lesser than phenotypic coefficient of variation indicate modifying effect of the environment in association with the characters at genotypic level. High PCV coupled with high GCV and was observed for high GCV for characters zinc content (36.52 and 36.02), iron content (24.56 and 22.87), calcium content (23.40 and 22.97) and protein content (22.21 and 20.97). Similar findings are in conformity with Banu *et al.,* (2017) and Vaibhav Sharma (2018) for iron content. Padmaja (2006) and Sarala (2007) for calcium content and Maloo *et al.,* (1998) for protein content. High PCV coupled with moderate GCV was recorded for the productive tillers per plant (21.79 and 19.79).

These findings are earlier reported by Jyothsna *et al.,* (2016), Anuradha *et al.,* (2017).When coefficient of variation is higher, the population has greater variability and scope for improvement of high yielding genotypes with diverse genotypes. Moderate PCV and GCV was recorded for test weight (17.98 and 17.08), days to 50% flowering (16.28 and 16.15), grain yield per plot (16.28 and 13.47), anti-oxidant activity (15.28 and 12.67) fingers per ear head (15.14 and 14.36), finger width (14.09 and 13.19) and days to maturity (11.68 and 11.44) was observed. These findings are in conformity with Keerthana *et al.,* (2019) for days to 50% flowering, grain yield per plot and fingers per ear head. While moderate PCV with low GCV for harvesting index (11.97 and 9.94) and finger length (11.43 and 8.37). Low PCV and GCV was exhibited for plant height (6.08 and 3.85). Indicating narrow range of variability among the tested genotypes. Similar results were reported by Devaliya *et al.,* (2018) for plant height.

Heritability which is the heritable portion of phenotypic variance is a good index of transmission of characters from parents to offspring (Falconer, 1981). Assessment of heritability helps to get an idea to know about how intensity of the character under genetic control and has a close bearing on response to selection. Heritability estimates along with the genetic advance mean are more useful in predicting gain under selection than heritability estimate alone.

High broad sense heritability with high genetic advance as percent of mean was recorded for traits *viz.,* days to 50% flowering (98.00 and 33.01), zinc content (97.00 and 73.19), days to maturity (96.00 and 23.01), calcium content (96.00 and 46.43), fingers per ear head (90.00 and 28.08), test weight (90.00 and 33.43),protein content (89.00 and 40.79), finger width (88.00 and 25.41), iron content (87.00 and 43.87), and anti-oxidant activity (69.00 and 21.63) and grain yield per plot (68.00 and 22.95) indicating that these traits were less influenced by environment and governs by additive gene action which may be exploited through simple selection procedures.

Table.1 Analysis of variance for yield and yield components and quality traits among 30 genotypes of Finger millet (*Eluesine coracana L.* Gaertn)

Source	Replications	Treatments	Error
Degree of freedom	**2**	**29**	**58**
Mean Sum of Squares			
Days to 50% flowering	0.90	375.87**	**5.80**
Plant height (cm)	35.97	135.71**	**81.35**
Finger length	0.49	1.41**	**0.65**
Finger width	0.01	0.03**	**0.00**
No.of productive tillers/plant	0.29	1.22**	**0.21**
Days to maturity	8.14	394.50**	**15.91**
Fingers per ear head	0.45	4.05**	**0.40**
Grain yield/plot	6.69	60.94**	**19.23**
Fodder yield	42.58	217.25**	**58.95**
Harvesting index	0.00	0.00	**0.00**
Test weight	0.00	0.67**	**0.06**
Calcium content	1180.28	27353.50*	**1008.15**
Iron content	0.12	1.58**	**0.21**
Zinc content	0.01	0.90**	**0.02**
Protein content	0.28	150.31**	**32.69**
Anti-oxidant activity	**99.60**	**440.01****	**137.59**

(**significance at 1 percent level)

Table.2 Mean, Variability, Heritability and Genetic advance as per cent of mean for yield and yield attributing and quality traits of Finger millet (*Eluesine coracana* L. Gaertn)

Character	Mean	Coefficient of variation		Heritability (%) (broad sense)	Genetic advance as percent of mean (5% level)
		PCV%	GCV%		
Days to 50% Flowering (days)	68.77	16.28	16.15	98.00	**33.01**
Plant height (cm)	110.55	6.08	3.85	40.00	**5.02**
Finger length (cm)	6.00	11.43	8.37	54.00	**12.62**
Finger width (cm)	0.76	14.09	13.19	88.00	**25.41**
Productive tillers per plant	2.92	21.79	19.79	82.00	**1.08**
Days to maturity (days)	98.19	11.68	11.44	96.00	**23.09**
Fingers per ear head	7.67	15.14	14.36	90.00	**28.08**
Grain yield/plot (g)	27.99	16.28	13.47	68.00	**22.95**
Fodder yield (g)	67.59	12.59	10.75	73.00	**18.90**
Harvesting index (%)	0.28	11.97	9.94	69.00	**16.99**
Test weight (g)	2.62	17.98	17.08	90.00	**33.43**
Calcium content (mg/100g)	408.05	23.40	22.97	96.00	**46.43**
Iron content (mg/100g)	2.96	24.56	22.87	87.00	**43.87**
Zinc content (mg/100g)	1.50	36.52	36.02	97.00	**73.19**
Protein content (per cent)	5.92	22.21	20.97	89.00	**40.79**
Anti-oxidant activity (mg/100g)	**79.26**	**15.28**	**12.67**	**69.00**	**21.63**

PCV = Phenotypic coefficient of variation GCV = Genotypic coefficient of variation

Table.3 Mean performance of genotypes studied for grain yield, yield attributes and quality traits in finger millet

S. No.	Genotype	Days to 50% flowering	Plant height (cm)	Finger length (cm)	Finger width (cm)	No. of productive tillers per plant	Days to maturity	No. of fingers per ear head	Grain yield per plot plot	Fodder yield per plot	Harvest index	Test weight (g)	Calcium content (mg/100g)	Iron content (mg/100g)	Zinc content (mg/100g)	Protein content (%)	Anti-oxidant activity (mg/100 g)
1	Sri Chaitanya	78	114.0	5.7	0.9	2.8	106.3	7.3	29.8	70.3	0.3	3.2	423.3	3.2	1.5	7.3	99.7
2	Bharathi	80.7	113.9	5.9	0.9	3.1	110.3	7.3	28.1	67.5	0.3	3.4	405.0	2.9	1.5	7.3	78.6
3	Champavathi	50.7	103.3	5.3	0.6	2.9	79.0	6.9	21.7	53.5	0.3	2.8	366.7	2.4	1.6	5.8	91.0
4	Vegavathi	75.7	115.1	6.4	0.9	3.1	105.0	8.5	31.9	78.4	0.3	3.0	318.3	4.0	1.1	3.3	83.7
5	VR 1101	64	116.4	5.9	0.8	3.8	93.0	8.6	34.8	74.7	0.3	2.6	228.3	2.2	1.2	6.2	92.0
6	VR 1110	76.3	114.8	6.2	0.8	3.5	105.3	6.9	33.8	72.4	0.3	2.8	458.3	2.2	1.6	7.5	81.4
7	VR 1151	61.3	114.0	5.4	0.8	3.1	92.3	8.5	32.1	69.1	0.3	2.6	430.0	2.6	1.6	5.9	98.7
8	VR 1131	65.3	110.4	5.9	0.6	3.1	94.0	9.1	31.8	51.5	0.4	2.8	616.7	4.2	1.1	6.2	79.9
9	VR 1125	50.3	110.0	6.2	0.8	3.4	79.3	8.6	31.6	72.7	0.3	2.6	471.7	3.0	1.3	5.3	83.3
10	VR 1112	81.0	117.1	6.1	0.8	4.4	110.0	7.2	35.3	80.0	0.3	3.1	446.7	2.0	1.2	7.2	75.6
11	VR 1117	55.0	107.4	5.9	0.9	2.7	83.7	8.8	29.0	61.4	0.3	2.7	438.3	4.0	0.9	5.1	86.7
12	VL 352	52.7	108.3	6.7	0.7	2.1	83.3	8.3	28.5	67.8	0.3	3.0	626.7	1.9	1.5	6.3	79.6
13	GPU 67	80.0	111.3	6.4	0.9	3.2	110.0	9.3	29.8	75.7	0.3	3.2	318.3	3.8	1.0	4.8	73.1
14	PR 202	78.7	109.1	5.5	0.8	3.1	111.0	8.1	30.4	71.3	0.3	3.2	256.7	2.2	1.2	6.7	75.9
15	Vakula	58.3	108.4	6.3	0.9	2.4	86.7	8.9	26.3	60.3	0.3	2.9	493.3	2.2	1.4	5.5	81.6
16	EG 4	59.7	112.8	6.4	0.8	2.5	89.3	7.6	23.1	65.9	0.3	2.2	418.3	3.2	1.4	4.9	69.2
17	EG 16	62.7	110.3	5.5	0.9	2.3	92.0	7.6	29.2	76.4	0.3	2.3	403.3	3.6	1.2	5.7	72.8
18	EG 17	81.7	109.5	5.8	0.5	1.9	111.0	7.4	27.9	56.8	0.3	2.7	483.3	3.3	1.5	5.2	98.6
19	EG 18	80.3	114.1	7.9	0.7	3.9	110.7	7.3	23.5	74.5	0.2	2.0	545.0	2.5	3.5	6.5	54.4
20	EG 21	59.7	104.3	6.4	0.8	1.7	88.7	5.8	24.0	64.0	0.3	2.1	391.7	2.7	1.4	7.4	97.2
21	EG 24	78.3	89.5	4.1	0.6	3.5	106.7	6.4	29.9	69.4	0.3	2.0	321.7	3.1	1.3	5.7	86.7
22	EG 31	82.7	118.6	7.0	0.7	3.6	111.7	7.2	25.7	64.6	0.3	2.2	365.0	2.6	1.3	5.5	81.1
23	VR 1179	60.0	120.1	5.6	0.7	1.8	89.7	4.8	13.5	54.5	0.2	2.3	426.7	2.9	1.5	9.2	71.8
24	VR 1174	77.0	90.7	6.1	0.6	2.3	107.7	5.2	23.1	73.4	0.2	2.1	398.3	4.2	2.8	5.5	76.2
25	EG 48	76.3	109.9	5.5	0.8	2.9	108.7	7.8	24.9	60.3	0.3	2.1	336.7	2.1	1.2	6.2	67.0
26	VR 1171	62.7	114.4	5.5	0.8	2.8	91.0	7.7	23.4	63.6	0.3	2.1	268.3	3.2	2.5	7.0	62.1

S. No.	Genotype	Days to 50% flowering	Plant height (cm)	Finger length (cm)	Finger width (cm)	Productive tillers per plant	Days to maturity	Fingers per ear head	Grain yield per plot	Fodder yield per plot	Harvesting index	Test weight (g)	Calcium content (mg/100g)	Iron content (mg/100g)	Zinc content (mg/100g)	Protein content (%)	Anti-oxidant activity (mg/100g)
27	VR1165	80.0	114.1	6.7	0.8	3.4	109.3	7.0	25.8	86.4	0.2	2.2	273.3	2.2	1.5	2.6	73.3
28	VR1163	60.0	110.8	5.6	0.7	3.3	89.0	7.7	26.8	73.4	0.3	1.9	391.7	2.6	1.2	4.4	65.7
29	GPU 45	80.7	113.1	5.2	0.7	2.9	109.0	8.7	28.1	61.4	0.3	3.4	453.3	4.1	1.6	6.6	53.2
30	VL 376	53.7	110.8	6.7	0.7	2.4	82.0	9.7	26.9	56.3	0.3	3.2	466.7	4.0	1.3	4.5	87.6
	Mean	68.77	110.55	6.00	0.76	2.93	98.19	7.67	27.69	67.59	0.29	2.62	408.06	2.96	1.50	5.92	79.26
	Maximum	82.7	120.1	7.9	0.9	4.4	111.7	9.7	35.3	86.4	0.4	3.4	626.7	4.2	3.5	9.2	79.26
	Minimum	50.3	89.5	4.1	0.5	1.7	79.0	4.8	13.5	51.5	0.2	1.9	228.3	1.9	0.9	2.6	53.2
	C.V.	3.50	8.16	13.48	8.61	15.82	4.06	8.28	15.84	11.36	11.57	9.72	7.78	15.50	10.44	12.69	14.80
	C.D. 5%	3.93	14.74	1.32	0.11	0.76	6.52	1.04	7.17	12.55	0.05	0.42	51.89	0.75	0.26	1.23	19.17

These results were in accordance with Shinde *et al.,* (2014), Jyothsna *et al.,* (2016) for days to 50% flowering and days to maturity. Prashantha *et al.,* (2018) and Keerthana *et al.,* (2019) for fingers per ear head and grain yield per plot. High heritability with low genetic advance as percent of mean was observed for productive tillers per plant (82.00 and 1.08). These findings are in conformity with Bharathi *et al.,* (2013). While moderate heritability with moderate genetic advance was observed for finger length (54.00 and 12.62). These findings are in uniformity with Patil and Mane (2013) and Reddy *et al.,* (2013). Moderate heritability with low genetic advance was exhibited by plant height (40.00 and 5.02). Similar results are reported by Sao *et al.,* (2016). However, it is not necessary that a character showing high heritability will also exhibit high genetic advance (Johnson *et al.,* 1955). Such conditions were most likely caused by additive gene action, thereby, reflecting the efficiency of selection for the improvement of these traits. According to Panse (1957), if the heritability is mainly owing to non-additive gene effect, the expected genetic advance would be low and if there is additive gene effect, a high genetic advance may be expected.

The present experimental study revealed that there exists an adequate amount of variability in the genotypes studied. The estimates of phenotypic coefficients of variation was slightly higher than the estimates of genotypic coefficients of variation for all traits under study implying that besides genetic factors some environmental factors are having their role in expression of characters. The genetic parameters revealed that moderate to high GCV, PCV coupled with high heritability and high genetic advance as percent of mean were observed for days to 50% flowering, days to maturity, fingers per ear head, finger width, test weight, productive tillers per plant, calcium content, iron content, zinc content, protein content and anti-oxidant activity. These results indicate the operation of additive gene action in the inheritance of these traits and improvement of these traits are possible through simple selection. In the present investigation, the genotype VL 376 recorded maximum mean performance for more number of characters i.e. days to 50% flowering, days to maturity, fingers per ear head, test weight, iron content and anti-oxidant activity which also exhibiting high PCV to moderate GCV along with high heritability with high genetic advance. Further the genotypes namely, Vegavathi, VR1131, VR 1117, VL 352 and VL 376 are identified as promising varieties for utilization in hybridization programme aimed at developing varieties with high yield and quality traits.

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