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Correlation studies in traditional varieties of finger millet (*Eleusine coracana* (L.) Gaertn.)

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Abstract
An experiment was conducted with 21 genotypes to study the association of traits with single plant yield in finger millet. The genotypes were evaluated in Randomized Block Design with three replications during *kharif* 2022. The main objective of this study is to estimate the direct and indirect effects of yield contributing traits to single plant yield. The Analysis of Variance indicated significant difference among the 21 genotypes studied for all the characters. GCV ranged from 3.03 for number of fingers per head to 19.50 for single plant yield. Highest PCV was observed in phosphorus content and lowest for days to 50% heading. Non-significant correlation of plant height with grain yield shows that there is scope for developing dwarf types without any reduction in grain yield. High heritability coupled with high genetic advance as percent mean observed for single plant yield indicates the role of additive genes in the inheritance of these traits and hence these characters could be improved through simple phenotypic selection.

Keywords: Ragi, finger millet, correlation, association analysis

Introduction

Finger millet, *Eleusine coracana* L., belongs to poaceae family with chromosome number 2n=4x=36. As compared to other grains, millets are using still as major food in the modern life style for the production of different type of food commodities for human to put on market. In olden day millets are notified primarily as the food for poor man and animals. Gains are enriched with minerals and having a better source of calcium which are taken for the preparing products such as baby foods, snack foods, baked product, flakes and pops, dietary food, pudding, sweets. Finger millet have a crucial for controlling blood sugar so diabetes patients are adding this as for maintaining good health. Mostly it is cultivated in the areas which having a high range of potential for periodical adaptation according to climate and soil requirements. It grows extensively through the year due to the presence of enough moisture content temperatures remains as above 15 °C. Finger millet is commonly known as ‘Ragi’ is one of the important food crops and widely grows in Southern parts of India. The major producers are India, China, Nepal and Uganda. Huge scale of production is in Karnataka, Tamil Nadu, Andhra Pradesh, Orissa, Bihar, Gujrat and Maharashtra and in the hilly regions of Uttar Pradesh and Himachal Pradesh, with a total area of 2.5 million hectares and 2.2 million tons of production.

The consumption of millets may be in numerous manner of way of preparation victimization flour and malt of the grains. From millet there are lot of foods prepared including cooked products, porridges, fermented breads, boiled rice products, alcoholic and non- alcoholic beverages and snacks. (Murty & Kumar, 1995). Millet is gluten-free also; therefore, an excellent option for people suffering from celiac diseases often initiated by the gluten content of wheat. According to (Makharia *et al.*, 2011), 1 out of every 96 person in north Indian community is suffering from celiac disease. Celiac disease is an allergy to gluten protein. Moreover, Millet retains its alkaline property after cooking which is good for wheat allergy people (Vanisha *et al.*, 2011). This study was initiated

- to bring back the traditional varieties that are in near extinction for cultivation
- to exploit the genetic potential of these underutilized crops and
- to explore the possibilities of using these traditional varieties in crop improvement programmes. The effective selection for grain yield depends solely on the analysis of associations between the characters and with grain yield.

Different yield components' direct and indirect contributions significantly change the genetic architecture of a complex feature like yield. The examination of the interdependencies between various characters offers a realistic basis for assigning the proper weightage to each of these traits and for developing an effective technique for the genetic enhancement of complicated features. As a result, the current experiment was carried out to investigate the phenotypic and genotypic relationships between the traits that contribute to yield, coupled with path analysis to create adequate selection criteria for increasing yield in finger millet.

Materials and Methods

The experimental materials consisting of 22 diverse finger millet accessions (**Table.1**.) which were collected from different millet growing areas of Tamil Nadu and Karnataka and evaluated in Randomized Block Design (RBD) with three replications at South Farm, Karunya Institute of Technology and Sciences, Coimbatore during *kharif* 2022. Each entry was grown in 1.5 m row with a spacing of 10cm within the plants and 30cm between the rows. In each row, a homogeneous plant population was kept in order to compare genotypes objectively. To record observations on yield and yield attributing traits, ten randomly selected plants from each genotype in each replication were used. The observations on Days of 50% heading (DFH), Days of 80% maturity (DEM), Ear exertion(EE)(cm), (PH) (cm), Number of fingers per head (NFH), Finger length (cm)(FL), (FW), Length of flag leaf (cm)(LFL and Yield per plants. Crude Protein content, Calcium content, Phosphorus content and Potassium content were also estimated from grain.

The mean on ten plants were statistically analysed to estimate phenotypic and genotypic correlation coefficients using the correlation coefficient method developed by Singh and Ch audhary (1995) and the path analysis method developed by Dewey and Lu (1959). R packa

Table 1: List of local landraces and traditional varieties and their site of collection

S. No.	Name of landraces / traditional varieties	Site of collection	Seed colour
1	Gai ragi	Seengampathi, Coimbatore	Brown
2	Ney ragi	Sembukkarai, Coimbatore	Brown
3	Chadivayal ragi	Chadivayalpathi, Coimbatore	Brown
4	Mullangadu ragi	Mullangadu, Coimbatore	Brown
5	Kovilpatti Local	Kovilpatti, Tuticorin	Brownish Red
6	Aruppukottai Local	Aruppukkottai, Virudhunagar	Brownish Red
7	Thangachimadam sivappu ragi	Thangachimadam, Ramanathapuram	Red
8	Thiruchuzhi keppai	Thiruchuzhi, Virudhunagar	White
9	Palavanatham Local	Palavanatham, Virudhunagar	Brownish Red
10	Kariapatti kezhvaragu	Kariapatti, Virudhunagar	Red
11	Kollimala ragi	Jamunamarathur, Thiruvannamalai	Red
12	Paramakudi Local	Paramakudi, Ramanathapuram	Brown
13	Edagu ragi	Mandya, Karnataka	Red
14	Sharavathi ragi	Mandya, Karnataka	Brown
15	Ragalli	Mandya, Karnataka	Brown
16	Shivalli ragi	Mandya, Karnataka	Brown
17	Bonda ragi	Mandya, Karnataka	Brown
18	Kempu ragi	Mandya, Karnataka	Brown
19	Billigada ragi	Mandya, Karnataka	Brown
20	Bennemudde ragi	Mandya, Karnataka	Brown
21	Hasirukaddi ragi	Mandya, Karnataka	Brown

Table 2: Mean table of traits

Genotype	DFH	DEM	EE	PH	NF/H	FL	FW	LFL	SPY	Protein	Calcium	Phosphorus	Potassium
Gai ragi	60.67	120.33	6.90	85.67	6.68	84.67	41.00	13.51	8.25	6.37	9.42	4.57	8.16
Ney ragi	62.67	128.00	7.15	96.67	5.40	92.67	52.33	10.17	7.95	6.53	6.53	3.82	7.90
Chadivayal ragi	62.00	144.67	7.83	92.00	6.59	57.67	71.67	8.79	11.33	7.00	9.28	3.37	7.27
Mullangadu ragi	67.67	135.00	7.34	100.00	6.68	107.67	63.33	13.31	8.46	6.30	8.83	4.63	6.63
Kovilpatti Local	68.00	120.40	6.55	93.00	6.70	67.33	65.67	9.57	14.68	6.47	9.38	6.22	8.40
Aruppukkaottai Local	69.33	130.20	7.54	87.00	6.82	87.00	56.33	10.23	10.31	6.03	7.93	4.23	7.33
Thangachimadam sivappu ragi	65.00	135.58	8.54	107.00	5.15	82.67	56.00	8.88	7.83	7.10	5.44	5.07	6.80
Thiruchuzhi keppai	70.00	144.01	6.35	111.00	6.38	74.63	43.00	14.07	8.30	6.47	6.36	3.93	8.60
Palavanatham Local	71.33	139.00	5.86	108.67	5.60	86.48	69.00	11.17	11.37	6.20	7.23	6.47	5.90
Kariyapatti kezhvaragu	62.00	140.33	7.86	106.00	6.88	47.00	57.33	12.98	8.86	6.57	8.59	6.07	6.83
Kollimala ragi	65.33	129.00	7.64	89.00	6.48	55.33	32.00	9.96	9.37	6.33	7.68	4.50	8.90
Paramakudi Local	63.33	132.33	7.54	90.00	5.80	57.85	58.67	10.97	12.43	6.37	6.10	3.87	7.73
Edagu ragi	69.33	142.33	7.27	93.67	6.46	67.33	67.33	14.14	7.53	6.83	6.05	6.20	8.63
Sharavathi ragi	70.00	147.33	5.75	108.33	8.28	76.82	75.67	13.52	8.93	7.00	6.88	5.53	6.77
Ragalli	68.67	126.33	6.37	112.00	6.50	85.50	57.33	13.25	9.87	6.17	7.05	4.80	8.73
Shivalli ragi	69.33	133.00	5.27	95.67	5.76	83.67	66.00	11.53	11.21	6.77	8.91	5.73	8.43

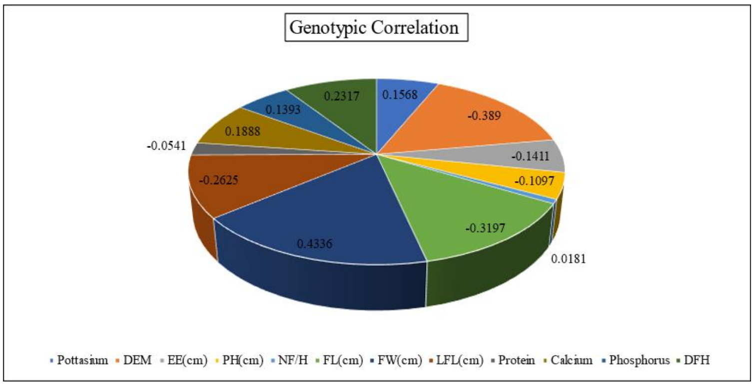
Bonda ragi	62.67	155.00	5.87	87.00	6.44	97.17	51.33	9.86	7.53	6.67	9.43	4.67	7.73
Kempu ragi	67.00	143.00	6.87	106.33	5.55	87.83	44.00	10.22	7.44	6.23	9.03	5.83	6.57
Billigada ragi	64.67	153.33	7.03	107.67	6.92	93.96	54.33	13.52	9.53	6.03	7.76	3.83	7.69
Bennemudde ragi	70.00	135.00	6.94	111.00	6.07	84.00	67.00	12.78	11.55	7.00	7.58	5.73	8.83
Hasirukaddi ragi	70.67	127.00	6.77	96.33	6.63	78.67	51.00	13.91	10.14	6.70	9.11	6.43	7.90

Note: DFH- Days to 50% heading, DEM- Days to 80% maturity, EE- Ear exertion, PH- Plant height, NF/H- Number of fingers per head, FL- Finger length, FW- Finger width, LFL- Length of flag leaf, SPY- Single plant yield.

Table 3: Estimates of genetic variability parameters

Traits	Range		GCV (%)	PCV (%)	h^2	GAM (%)
	Minimum	Maximum				
Days to 50% heading	60.00	75.00	4.96	5.34	0.86	9.51
Days to 80% maturity	119.00	158.00	7.02	7.28	0.92	13.94
Ear exertion	5.24	8.58	11.69	11.74	0.99	23.99
plant height	84.00	115.00	9.04	9.46	0.91	17.82
Number of fingers per head	3.6	8.6	3.03	18.09	0.02	1.04
Finger length	45.00	110.00	19.30	19.57	0.97	39.20
Finger width	30.00	77.00	19.27	19.62	0.96	39.00
Length of flag leaf	1.42	14.22	14.24	18.62	0.58	22.43
Single plant yield	7.30	16.68	19.50	19.92	0.95	39.32
Protein	5.90	7.20	4.84	5.38	0.81	8.99
Calcium	5.39	9.90	16.38	16.58	0.98	33.49
Phosphorus	3.04	6.80	19.39	20.16	0.92	38.45
Potassium	5.90	9.00	11.17	11.62	0.92	22.11

Note: GCV- Genotypic Coefficient of Variance, PCV- Phenotypic Coefficient of Variance, h^2-Heritability, GAM-Genetic Advance as percentage of mean



Potassium- 0.1568	FW-0.4336
DEM--0.389	LFL- -0.2625
EE- -0.1411	Protein--0.0541
PH- -0.1097	Calcium-0.1888
NF/H- 0.0181	Phosphorus-0.1393
FL- -0.3197	DFH-0.2317

Table 4: Genotypic correlation

	DFH	DEM	EE	PH	NF/H	FL	FW	LFL	Protein	Calcium	Phosphorus	Potassium	SPY
DFH	1 **												
DEM	-0.0414 NS	1 **											
EE (cm)	-0.4761 *	-0.1396 NS	1 **										
PH (cm)	0.428 NS	0.3046 NS	-0.1543 NS	1 **									
NF/H	0.4384 *	0.7554 **	-0.6129 **	-0.0048 NS	1 **								
FL (cm)	0.2138 NS	0.1043 NS	-0.3463 NS	0.1623 NS	-0.5829 **	1 **							
FW (cm)	0.339 NS	0.1932 NS	-0.2086 NS	0.2205 NS	0.7791 **	-0.0054 NS	1 **						
LFL (cm)	0.3833 NS	0.078 NS	-0.307 NS	0.4337 *	1.8874 **	0.1335 NS	0.0322 NS	1 **					
Protein	0.0178 NS	0.191 NS	0.0626 NS	0.0703 NS	-0.1043 NS	-0.2555 NS	0.4489 *	-0.0925 NS	1 **				
Calcium	-0.1995 NS	-0.0882 NS	-0.2309 NS	-0.3843 NS	0.9798 **	0.104 NS	-0.0834 NS	-0.1162 NS	-0.1429 NS	1 **			

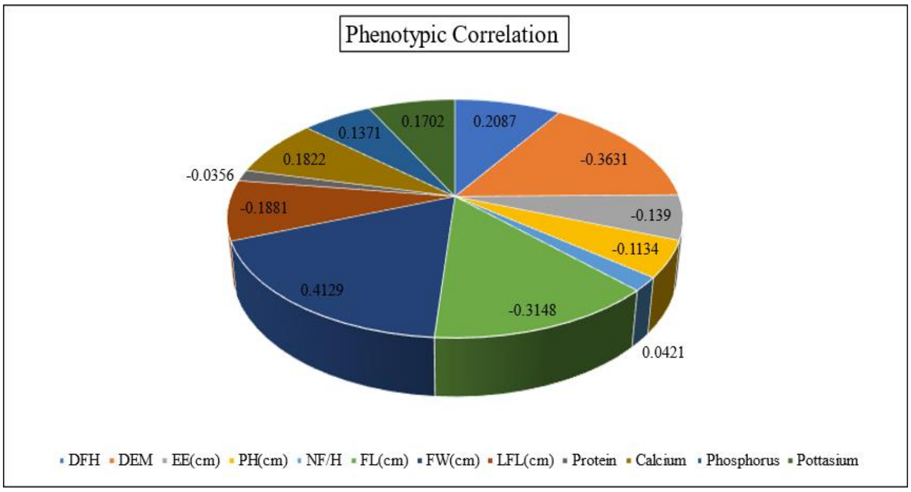
Phosphorus	0.5523 **	-0.132 NS	-0.3177 NS	0.2523 NS	-0.0382 NS	-0.0793 NS	0.294 NS	0.273 NS	0.2224 NS	0.1491 NS	1 **		
Potassium	0.0583 NS	-0.3521 NS	-0.1183 NS	-0.2266 NS	0.2027 NS	-0.1931 NS	-0.287 NS	0.2347 NS	0.0756 NS	-0.0577 NS	-0.1355 NS	1 **	
Single plant yield	0.2317 NS	-0.389 NS	-0.1411 NS	-0.1097 NS	0.0181 NS	-0.3197 NS	0.4336 *	-0.2625 NS	-0.0541 NS	0.1888 NS	0.1393 NS	0.1568 NS	1 **

Note: DFH- Days to 50% heading, DEM- Days to 80% maturity, EE- Ear exertion, PH- Plant height, NF/H- Number of fingers per head, FL-Finger

Table 5: Phenotypic correlation

	DFH	DEM	EE	PH	NF/H	FL	FW	LFL	Protein	Calcium	Phosphorus	Potassium	SPY
DFH	1 **												
DEM	-0.0497 NS	1 **											
EE (cm)	-0.4401 **	-0.131 NS	1 **										
PH (cm)	0.4143 **	0.2826 *	-0.1446 NS	1 **									
NF/H	0.0241 NS	0.0749 NS	-0.1167 NS	-0.0729 NS	1 **								
FL (cm)	0.1911 NS	0.0991 NS	-0.34 **	0.1551 NS	-0.0682 NS	1 **							
FW (cm)	0.3088 *	0.1957 NS	-0.2052 NS	0.2115 NS	0.1033 NS	-0.008 NS	1 **						
LFL (cm)	0.2943 *	0.0549 NS	-0.2338 NS	0.2744 *	0.2078 NS	0.0823 NS	0.0413 NS	1 **					
Protein	-0.0366 NS	0.1437 NS	0.0524 NS	0.0433 NS	0.0301 NS	-0.2373 NS	0.3789 **	-0.0849 NS	1 **				
Calcium	-0.1925 NS	-0.0781 NS	-0.2289 NS	-0.3638 **	0.1229 NS	0.1014 NS	-0.0725 NS	-0.0825 NS	-0.1209 NS	1 **			
Phosphorus	0.4866 **	-0.1303 NS	-0.3131 *	0.2362 NS	0.0084 NS	-0.0706 NS	0.2694 *	0.1371 NS	0.1914 NS	0.1535 NS	1 **		
Potassium	0.0506 NS	-0.3207 *	-0.1116 NS	-0.2084 NS	-0.0133 NS	-0.1973 NS	-0.2766 *	0.1797 NS	0.0656 NS	-0.0573 NS	-0.1303 NS	1 **	
Single plant yield	0.2087 NS	-0.3631 **	-0.139 NS	-0.1134 NS	0.0421 NS	-0.3148 *	0.4129 **	-0.1881 NS	-0.0356 NS	0.1822 NS	0.1371 NS	0.1702 NS	1 **

Note: DFH- Days to 50% heading, DEM- Days to 80% maturity, EE- Ear exertion, PH- Plant height, NF/H- Number of fingers per head, FL-Finger length, FW- Finger width, LFL- Length of flag leaf



DFH-0.2317	FW-0.4336
DEM--0.389	LFL- -0.2625
EE- -0.1411	Protein--0.0541
PH- -0.1097	Calcium-0.1888
NF/H- 0.0181	Phosphorus-0.1393
FL- -0.3197	Potassium- 0.1702

Results and Discussion

Information on the phenotypic and genotypic inter relationships of grain yield with its component characters and also among the component characters themselves would be useful to the breeder in developing an appropriate selection strategy. Since, grain yield is a complex character and influenced by number of traits and selection based on yield is usually not much effective, indirect selection on the basis of desirable component characters could be of great use (Devaliya *et al*., 2017) [2]. The efficiency of selection for yield mainly depends on the direction and magnitude of association between yield and its component characters and also among themselves. Character association provides information on the nature and extent of association between pairs of metric traits and helps in selection for the improvement of the character (Mahanthesha *et al*., 2018). Phenotypic and genotypic correlations were worked for yield and yield contributing characters in 22 genotypes. Phenotypic Coefficient of Variation (PCV) is higher than the Genotypic Coefficient of Variation (GCV) for all the characters studied indicating the greater influence of environmental factors (Table.3.). These findings were similar to the findings reported by Abhilash *et al*., 2020.

GCV ranged from 3.03 for number of fingers per head to 19.50 for single plant yield. Moderate GCV recorded for Potassium content (11.17), Ear exertion (11.69), Length of flag leaf (14.24) and Calcium content (16.38). Low percentage of GCV was recorded for plant height (9.03), days to 80% maturity (7.02), days to 50% heading (4.90) and protein content (4.84).

Highest PCV was observed in phosphorus content (20.16) and lowest for days to 50% heading (5.34). Moderate PCV percentage was recorded for single plant yield (19.92), finger width (19.62), finger length (19.57), length of flag leaf (18.62), number of fingers per head (18.09), Calcium content (16.58), ear exertion (11.74), Potassium content (11.62) and low PCV for plant height (9.46), days to 80 % maturity (7.28), protein content (5.38), days to 50% heading (5.34).

The estimation of heritability (%) in the broad sense for 13 characters studied which ranges from 99.00 for Ear exertion to 2% for number of fingers per plant. High heritability was observed for the traits calcium content (98.00), finger length (97.00), finger width (96.00), single plant yield (95.00), 92.00 for days to 80 % maturity, phosphorus, and potassium contents. Moderate heritability was recorded for days to 50% heading(86.00), protein content (81.00) followed by length of flag leaf (58.00).

Genetic advance as % of mean varied from number of fingers per head (1.04) to single plant yield (39.32). Genotypic correlation between grain yield per plant showed positive significant genotypic association with finger width. Non-significant correlation of plant height with grain yield shows that there is scope for developing dwarf types without any reduction in grain yield (Table 4.). Similar findings were reported by Mahanthesha *et al*., 2018.

Conclusion

From the present investigation, it is concluded that The estimates of GCV and PCV revealed that phenotypic coefficient of variation was higher than the genotypic coefficient of variation, which indicate presence of environment effect on expression on character studied. Correlation studies revealed significant positive association of grain yield per plant with finger width for both genotypic level and phenotypic level. To feed the ever-increasing population, development of high yielding varieties and hybrids in finger millet are on the urge. Hence the findings of this study can be utilized to select parental lines for genetic improvement of finger millet.

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