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Correlation and path analysis studies in finger millet for yield and yield contributing traits [*Eluesine coracana* (L.) Gaertn.]

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Abstract
The present investigation consists of 34 finger millet genotypes used for studying genetic variability parameters, correlation and path analysis which was carried out at Field Experiment Centre, Department of Genetics and Plant Breeding during *Kharif* 2019 in Randomized Block Design with three replications. The data were recorded for 15 quantitative characters to study genetic variability, heritability, genetic advance, correlation and path analysis. The analysis of variance indicated significant difference among 34 genotypes for all the characters studied. Moderate GCV and PCV values were observed for harvest index and test weight. High heritability coupled with high genetic advance as percent mean observed for plant height the role of additive genes in the inheritance of these traits and hence these characters could be improved through simple phenotypic selection. Correlation studies revealed significant positive association of grain yield per plant with harvest index for both genotypic level and phenotypic level. The path coefficient analysis indicated that selection for ear head length, number of fingers per ear, biological yield, harvest index as both genotypic level and phenotypic level would directly increase seed yield. IE-3473, IE-4759 were observed as promising genotypes for important quantitative traits.

Keywords: Finger millet, GCV, PCV, variability, heritability, correlation and path analysis

Introduction
Finger millet (*Eleusine coracna* (L.) Gaertn.) is one of the most important crop belonging to family and sub family Chloridoide. Finger millet is self-pollinated tetraploid (2n =36, AABB). Based on morphological, cytological and molecular evidence, it is believed that modern finger millet (*Eleusine coracana* subsp. coracana) is domesticated from wild finger millet (*Eleusine coracana* subsp. africana) populations (chennaveeraiah and Hiremanth, 1974 and Hilu and De-wet, 1976) [6, 11]. It can stored for long period up years or more deteriorating or weevil damage so it is excellent for storage time of famine Among with quantitative achievement in food production, important since cereal grain occupy a dominant part in the poor people's diet, contribution 70 percent of calories in most case in most along with significant amountof protein in finger millet and other nutrients. Finger millet is almost 99% self-pollinating with negligible 1% cross pollination mediated by wind (Jansen and Ong, 1966, Purseglove, 1972) [13, 18]. The estimation account further indicates the requirement for the encouragement of HYV to meet the aggressive globlal marketing setting. In order to achieve the expected targets there is need to develop the varieties with higher yield potential by the existing yield plateau utilizing more distant lines in the breeding programmes (Singamsetti *et al.*, 2018) [2]

Materials and methods
The experiment was conducted to evaluate 34 genotypes of finger millet which were grown in Randomized Block Design (RBD) with three replications in *Kharif* -2019. The experimental field was divided into 3 blocks of equal size and each line possesses single genotype. The data were recorded on 15 quantitative characters *viz.*, Days to 50% flowering, Days to maturity, Plant height (cm), Number of leafs, Flag leaf length(cm), Flag leaf width(cm), Ear head length(cm), No of fingers per plant, Finger length(cm), Finger width(cm), No of productive tillers, Biological yield(g), Harvest index, Test weight(g), Grain weight(g) per plant. Mean values were computed and data were analysed for analysis of variance as suggested Fisher (1936) given in table 1. Phenotypic coefficient of variation (PCV) and genotypic coefficient of

variation (GCV) were given by Burton (1952) [3]. Heritability in broad sense was given by Lush (1949) [15] and Burton and Devane (1953) [4]. Genetic advance was given by Lush (1949) [15] and Johnson *et al.*, (1955) [12]. Correlation coefficients are estimated as suggested by Al-Jibouri *et al*., (1958) [1] and the path analysis was calculated as suggested by Dewey and Lu (1959) [8].

Results and discussion

The analysis of variance carried out 15 quantitative characters revealed significant differences (Table 1). Hence it was concluded that there is scope for ample genetic variation among genotype under study and further statistical analysis was carried out. On the basis of mean performance, the highest grain yield per plant was observed for the finger millet genotype IE-3473 followed by IE-4759.

The PCV was higher than GCV for all the characters under study which indicated that the environment factors influencing the characters studied. Moderate GCV was recorded for harvest index (18.56), test weight (16.94), biological yield per plant (15.58), number of productive tillers (15.58), ear head length (12.20), number of leafs (11.13), plant height (10.385). Low GCV was recorded for finger length (9.50), grain yield per plant (8.62), flag leaf width (8.48), number of fingers per ear (8.41), finger width (7.95), flag leaf length (7.59), days to maturity (7.74).

Phenotypic coefficient of variation (PCV) ranged from days to maturity (7.92) to harvest index (19.83). Moderate PCV was recorded for number of harvest index (19.83), test weight (19.63), number of productive tillers (18.82), biological yield (16.00), flag leaf width (15.76), ear head length (15.37), number of leafs (14.56), flag leaf length (13.35), plant height (13.29), days to 50% flowering (12.95), finger width (12.26), finger length (11.47) and low PCV for number of finger per ear (9.66), days to maturity (7.92).

The estimation of heritability (%) in the broad sense for 15 characters studied which range from flag leaf width (29.00) to days to 50 % flowering (97.00). High heritability was recorded for days to 50 % percent flowering(97.00), days to maturity (95.00), biological yield per plant (94.90), harvest index (87.70), number of fingers per ear (75.80), finger length (68.70), grain yield per plant (67.80), test weight (66.10), ear head length (63.00), plant height (61.00). Moderate heritability was recorded for number of leafs (58.580), number of productive tillers (51.90), finger width (42.00), flag leaf length (32.40). Low heritability was recorded for flag leaf width (29.00).

Genetic advance as % of mean varied from flag leaf width (9.40) to harvest index (35.81). High genetic advance was recorded for harvest index (35.81), biological yield per plant (31.28), test weight (28.38), days to 50% flowering (25.89), number of productive tillers (20.120). Moderate genetic advance was recorded for ear head length (19.94), number of leafs (17.536), plant height (16.71), finger length (16.22), days to maturity (15.59), grain yield per plant (14.63), finger width (10.61). Low genetic advance was recorded for flag leaf width (9.40), flag leaf length (8.90).

Genotypic correlation between grain yield per plant showed positive significant genotypic association with harvest index Similar results are observed by Chavan *et al.* (2020) [5] for harvest index. Phenotypic correlation between grain yield per plant showed positive significance phenotypic association with harvest index. Similar results are observed by Negi *et al.* (2017) [17], Chavan *et al.* (2020) [5] for harvest index.

In the present study the results of path coefficient analysis indicated that selection for ear head length, number of fingers per ear, biological yield, harvest index as both genotypic level and phenotypic level. Whereas days to 50% flowering, plant height, finger width, number of productive tillers, harvest index, test weight at genotypic level and days to maturity, number of leafs, flag leaf length, flag leaf width, finger length, harvest index at phenotypic level would directly increase seed yield. An increase in any one of these or all of this quantitative character would bring simultaneous increase in yield.

Conclusion

From the present investigation it is concluded that analysis of variance showed significant variation to all the characters. Among 34 genotypes of finger millet on the basis of mean performance IE-3473 (3.32g) shows maximum grain yield followed by IE-4759 (3.19g), IE-2568 (3.12g).

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. Moderate difference between GCV and PCV were depicted for test weight, harvest index.

Correlation studies revealed significant positive association of grain yield per plant with harvest index for both genotypic level and phenotypic level.

Path analysis revealed that the characters ear head length, number of fingers per ear, biological yield, harvest index as both genotypic level and phenotypic level. Hence utmost importance should be given to these characters during selection for seed yield per plant.

Application of research: Since the population is increasing there is urgent need to provide high yield varieties to meet the demand. Unavailability of cultivars with high potential. Therefore present study has been undertaken to identify the best hybrid which can give high yield.

Research Category: Genetics and Plant Breeding.

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Table 1: Analysis of variance for 15 characters of 34 finger millet genotypes during *kharif*-2019

Source of Variations	Replicate	Treatments	Error
DF	2	33	66
Days to 50% flowering	10.42 *	253.23 **	2.59
Days to maturity	10.16 *	184.91 **	2.83
Plant height (cm)	77.34	520.23 **	91.32
No. Of leaves	2.89	8.626**	1.65
Flag leaf length (cm)	72.12	44.61 *	18.32 **
Flag leaf width (cm)	0.016	0.17 **	0.008

Ear head length (cm)	0.010	2.47 **	0.406
Finger length (cm)	0.42	0.93 **	0.123
Finger width (cm)	0.002	0.008 **	0.002
No. of finger per ear	0.066	0.6 **	0.58
No. of productive tillers	0.007	0.15 **	0.035
Biological yield per plant(g)	0.152	34.85 **	0.614
Harvest index (%)	1.172	17.14 **	0.769
Test weight(g)	0.003	0.039 **	0.006
Grain yield per plant (g)	0.033	0.181 **	0.025

** Significant at 1% Level of Significance, * Significant at 5% Level of Significance

Table 2: Estimation of genetic parameters for grain yield and other components

Genetic parameters Summary	GCV	PCV	h^2 (Broad Sense)	Genetic Advancement 5%	Gen.Adv as % of Mean 5%
Days to 50% flowering	12.76	12.95	97.00	18.54	25.89
Days to maturity	7.74	7.92	95.50	15.68	15.59
Plant height(cm)	10.38	13.29	61.00	21.24	16.71
No. Of leaves	11.13	14.56	58.50	2.40	17.53
Flag leaf length	7.59	13.35	32.40	3.46	8.90
Flag leaf width(cm)	8.48	15.76	29.00	0.062	9.40
Ear head length(cm)	12.20	15.37	63.00	1.358	19.94
Finger length(cm)	9.50	11.47	68.70	0.888	16.22
Finger width(cm)	7.95	12.26	42.00	0.056	10.61
No. of finger per ear	8.41	9.66	75.80	0.762	15.08
No. of productive tillers	13.56	18.82	51.90	0.290	20.12
Biological yield per plant(g)	15.58	16.00	94.90\	6.77	31.28
Harvest index (%)	18.56	19.83	87.70	4.506	35.81
Test weight(g)	16.94	19.63	66.10	0.17	28.38
Grain yield per plant(g)	8.62	10.47	67.80	0.387	14.63

GCV = Genotypic coefficient of variation, PCV = Phenotypic coefficient of variation,
GA = Genetic

Table 3: Genotypic correlation coefficient between yield and its related traits in 15 quantitative parameters in finger millet

characters	Days to 50% flowering	Days to maturity	Plant height (cm)	No of leafs	Flag leaf length (cm)	Flag leaf width (cm)	Ear head length (cm)	Finger length (cm)	Finger width (cm)	No of fingers per ear	No of productive tillers	Biological yield (g)	Harvest index (%)	Test weight (g)	Grain yield/ plant (cm)
Days to 50% flowering	1	0.988**	0.4129	0.4151	-0.0343	-0.4647	0.0986	0.1431	0.2543	0.0514	-0.286**	-0.1417	0.0805	-0.416**	0.0493
Days to maturity		1	0.4238	0.3987	-0.0613	-0.4721	0.0712	0.1147	0.1655	0.0592	-0.304**	-0.1556	0.1138	-0.385**	0.1051
Plant height(cm)			1	0.547	0.2209	-0.4763	-0.2092	0.0202	0.2565	0.1092	-0.0621	0.251*	-0.304**	0.133	-0.202*
No of leafs				1	-0.1491	-0.2248	-0.1404	-0.0426	0.482	0.1318	0.263**	0.314**	-0.367**	-0.0684	-0.1488
Flag leaf length(cm)					1	0.1793	0.2915	-0.0464	0.2226	0.326**	0.464**	0.1672	-0.1503	0.430**	0.0264
Flag leaf width(cm)						1	0.2828	-0.0602	0.5457	0.0972	0.256**	0.286**	-0.232*	0.156	-0.0501
Ear head length(cm)							1	0.717**	0.1887	0.1378	0.320**	0.1326	-0.292**	-0.1061	-0.210*
Finger length (cm)								1	0.0626	0.1028	0.0907	-0.1358	-0.1367	-0.1206	-0.358**
Finger width(cm)									1	-0.0504	0.425**	0.414**	-0.420**	-0.288**	-0.233**
No of fingers/ ear										1	-0.1401	0.1665	-0.1895	0.415**	0.0216
No of productive tillers											1	0.345**	-0.314**	0.0471	-0.0917
Biological yield(g)												1	-0.858**	0.183	-0.0871
Harvest index (%)													1	-0.242*	0.565**
Test weight(g)														1	-0.200*

Table 4: Phenotypic correlation coefficient between yield and its related traits in 15 quantitative parameters in finger millet

characters	Days to 50% flowering	Days to maturity	Plant height (cm)	No of leafs	Flag leaf length (cm)	Flag leaf width (cm)	Earhead length (cm)	Finger length (cm)	Finger width (cm)	No of fingers per ear	No of productive tillers	Biological yield (g)	Harvest index (%)	Test weight (g)	Grain yield per plant(g)
Days to 50% flowering	1	0.9837 **	0.2949 **	0.2976 **	-0.0243	-0.2190 *	0.0709	0.0972	0.1836	0.0532	-0.1969 *	-0.1349	0.0739	-0.3340 **	0.0455
Days to maturity		1	0.2975 **	0.2878 **	-0.0363	-0.2192 *	0.0538	0.076	0.123	0.0497	-0.2059 *	-0.1483	0.1095	-0.3079 **	0.0972
Plant height(cm)			1	0.3330 **	0.1666	-0.2454 *	-0.0979	0.1113	0.083	0.0309	-0.0309	0.2133 *	-0.2057 *	0.1263	-0.0506
No of leafs				1	-0.0925	-0.1185	-0.0279	-0.0241	0.2109 *	0.1467	0.0913	0.2405 *	-0.2399 *	-0.0203	-0.0631
Flag leaf length(cm)					1	0.0854	0.2168 *	-0.0117	0.1256	0.2474 *	0.2983 **	0.0761	-0.0599	0.1534	0.0165
Flag leaf width(cm)						1	0.0974	-0.0051	0.2581 **	-0.0063	0.1341	0.1411	-0.1081	0.0468	0.0023
Ear head length(cm)							1	0.5723 **	0.1168	0.1355	0.2110 *	0.0781	-0.1619	-0.0702	-0.0991
Finger length(cm)								1	-0.0338	0.07	0.0088	-0.126	-0.0525	-0.0015	-0.1888
Finger width(cm)									1	-0.0087	0.1815	0.2656 **	-0.2696 **	-0.2194 *	-0.1287
No of fingers/ ear										1	-0.0024	0.1549	-0.1614	0.2950 **	0.0097
No of productive tillers											1	0.2443 *	-0.2679 **	-0.0102	-0.1642
Biological yield(g)												1	-0.8134 **	0.1384	-0.0416
Harvest index (%)													1	-0.1304	0.587**
Test weight(g)														1	-0.0649
Grain yield per plant (g)															1

* = Significane at 5% level of significance ** = Significance at 1% level of signifance

Table 5: Direct and indirect effect of genotypic path coefficient for 15 characters in finger millet

characters	Days to 50% flowering	Days to maturity	Plant height (cm)	No of leafs	Flag leaf length (cm)	Flag leaf width (cm)	Ear head length (cm)	Finger length (cm)	Finger width (cm)	No of fingers per ear	No of productive tillers	Biological yield(g)	Harvest index (%)	Test weight (g)	Grain yield per plant(g)
Days to 50% flowering	1.2474	-0.8445	0.2604	-0.4118	0.0456	0.1501	0.0805	-0.1168	0.1015	0.0312	-0.2587	-0.1798	0.1631	-0.2187	0.0493
Days to maturity	1.2325	-0.8547	0.2673	-0.3955	0.0814	0.1525	0.0581	-0.0936	0.0661	0.0359	-0.2754	-0.1973	0.2304	-0.2026	0.1051
Plant height(cm)	0.515	-0.3622	0.6307	-0.5427	-0.2935	0.1538	-0.1707	-0.0165	0.1024	0.0663	-0.0563	0.3178	-0.6157	0.07	-0.2015
No of leafs	0.5178	-0.3408	0.345	-0.9921	0.1981	0.0726	-0.1146	0.0348	0.1925	0.08	0.2378	0.3988	-0.7427	-0.036	-0.1488
Flag leaf length(cm)	-0.0428	0.0524	0.1393	0.1479	-0.9327	-0.0579	0.2378	0.0379	0.0889	0.1978	0.4203	0.2121	-0.3044	0.2261	0.0264
Flag leaf width(cm)	-0.5797	0.4035	-0.3004	0.223	-0.2383	-0.323	0.2307	0.0492	0.2179	0.059	0.2318	0.3629	-0.4689	0.0821	-0.0501
Ear head length(cm)	0.123	-0.0609	-0.1319	0.1393	-0.3874	-0.0913	0.8157	-0.5851	0.0754	0.0836	0.2898	0.1682	-0.592	-0.0558	-0.2095
Finger length(cm)	0.1785	-0.098	0.0127	0.0423	0.0617	0.0195	0.5846	-0.8164	0.025	0.0624	0.0821	-0.1722	-0.2768	-0.0635	-0.358
Finger width(cm)	0.3172	-0.1414	0.1618	-0.4782	-0.2959	-0.1762	0.1539	-0.0511	0.3993	-0.0306	0.385	0.5246	-0.8499	-0.1514	-0.2329
No of	0.0641	-0.0506	0.0689	-	-0.4331	-0.0314	0.1124	-0.084	-	0.6069	-0.1269	0.2113	-	0.2185	0.0216

fingers/ ear				0.1308					0.0201				0.3837		
No of productive tillers	-0.3563	0.2598	-0.0392	-0.2604	-0.6167	-0.0826	0.261	-0.074	0.1697	-0.085	0.9058	0.4381	-0.6367	0.0248	-0.0917
Biological yield(g)	-0.1768	0.133	0.158	-0.3119	-0.2222	-0.0924	0.1082	0.1108	0.1651	0.1011	0.3128	1.2687	-1.7378	0.0963	-0.0871
Harvest index (%)	0.1005	-0.0973	-0.1917	0.3638	0.1997	0.0748	-0.2385	0.1116	-0.1676	-0.115	-0.2848	-0.9998	2.0252	-0.1276	0.5645
Test weight(g)	-0.5184	0.329	0.0839	0.0679	-0.571	-0.0504	-0.0865	0.0984	-0.1148	0.252	0.0426	0.2322	-0.491	0.5264	-0.1998

Table 6: Direct and indirect effect of phenotypic path coefficient for 15 characters in finger millet

characters	Days to 50% flowering	Days to maturity	Plant height (cm)	No of leafs	Flag leaf length (cm)	Flag leaf width (cm)	Ear head length (cm)	Finger length (cm)	Finger width (cm)	No of fingers per ear	No of productive tillers	Biological yield (g)	Harvest index (%)	Test weight (g)	Grain yield per plant(g)
Days to 50% flowering	-0.2976	0.3906	-0.0067	0.0005	-0.0006	-0.005	0.002	0.0042	-0.0084	0.0034	0.0073	-0.1786	0.1206	0.0139	0.0455
Days to maturity	-0.2927	0.3971	-0.0068	0.0005	-0.0009	-0.005	0.0015	0.0 033	-0.0056	0.0032	0.0076	-0.1964	0.1787	0.0128	0.0972
Plant height(cm)	-0.0878	0.1181	-0.0229	0.0005	0.0041	-0.0056	-0.0028	0.0048	-0.0038	0.002	0.0011	0.2825	-0.3356	-0.0052	-0.0506
No of leafs	-0.0886	0.1143	-0.0076	0.0016	-0.0023	-0.0027	-0.0008	-0.001	-0.0097	0.0093	-0.0034	0.3184	-0.3915	0.0008	-0.0631
Flag leaf length(cm)	0.0072	-0.0144	-0.0038	-0.0001	0.0244	0.0019	0.0062	-0.0005	-0.0057	0.0157	-0.011	0.1008	-0.0977	-0.0064	0.0165
Flag leaf width(cm)	0.0652	-0.087	0.0056	-0.0002	0.0021	0.0228	0.0028	-0.0002	-0.0118	-0.0004	-0.0049	0.1868	-0.1764	-0.0019	0.0023
Ear head length(cm)	-0.0211	0.0214	0.0022	0.0011	0.0053	0.0022	0.0287	0.0247	-0.0053	0.0086	-0.0078	0.1034	-0.2641	0.0029	-0.0991
Finger length(cm)	-0.0289	0.0302	-0.0025	0.0011	-0.0003	-0.0001	0.0164	0.0431	0.0015	0.0044	-0.0003	-0.1668	-0.0856	0.0001	-0.1888
Finger width(cm)	-0.0546	0.0489	-0.0019	0.0003	0.0031	0.0059	0.0034	-0.0015	-0.0458	-0.0006	-0.0067	0.3517	-0.4399	0.0091	-0.1287
No of fingers/ ear	-0.0158	0.0197	-0.0007	0.0002	0.006	-0.0001	0.0039	0.003	0.0004	0.0635	0.0001	0.205	-0.2633	-0.0122	0.0097
No of productive tillers	0.0586	-0.0818	0.0007	0.0001	0.0073	0.0031	0.0061	0.0004	-0.0083	-0.0002	-0.0369	0.3234	-0.4372	0.0004	-0.1642
Biological yield(g)	0.0401	-0.0589	-0.0049	0.0004	0.0019	0.0032	0.0022	-0.0054	-0.0122	0.0098	-0.009	1.324	-1.3271	-0.0057	-0.0416
Harvest index (%)	-0.022	0.0435	0.0047	-0.0004	-0.0015	-0.0025	-0.0046	-0.0023	0.0123	-0.0102	0.0099	-0.9643	1.6316	0.0054	0.587
Test weight(g)	0.0994	-0.1223	-0.0029	0.0001	0.0037	0.0011	-0.002	-0.0001	0.01	0.0187	0.0004	0.1832	-0.2128	-0.0415	-0.0649

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