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Correlation and path coefficient analysis in finger millet (*Eleusine coracana* (L.) Geartn)

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Abstract
A field experiment was conducted to carry out yield component analysis through correlation and path analysis. Forty eight genotypes of finger millet were sown in a randomized block design with three replications, during *kharif* 2014 at National Bureau of Plant Genetic Resources research field, Rajendranagar, Hyderabad. The objective of the experiment was to assess the nature of interrelationships and direct and indirect effect of different yield contributing traits towards grain yield. From correlation studies it was observed that grain yield per plant has exhibited significant positive association with total no. of basal tillers per plant, productive tillers per plant, total fingers on the main ear, finger length and finger width. Path analysis revealed that maximum positive direct effect on grain yield per plant was exhibited productive tillers per plant followed by Finger length, Finger width. Therefore, it is emphasized to lay attention on traits like productive tillers per plant followed by Finger length, Finger width while selecting for improvement in grain yield of finger millet.

Keywords: finger millet, correlation, path analysis, yield contributing traits

Introduction
Finger millet (*Eleusine coracana* (L.) Gaertn) is an annual plant widely grown as an important food crop in the arid areas of Africa and South Asia. It ranks third in importance among the millets after sorghum and pearl millet in India. In India it is very popularly known as ragi and is grown in an area of 2 million hectares with a production of 2.6 million tonnes. Important finger millet growing states are Karnataka, Tamil Nadu, Andhra Pradesh, Maharashtra, Orissa, Jharkhand, Chhattisgarh and Uttarakhand. Ragi is commonly called as "Nutritious millet" as the grains are nutritionally superior to many cereals providing fair amount of proteins, minerals, calcium and vitamins in abundance to the people. The protein of finger millet has been reported to possess a fairly high biological value, which is needed for the maintenance of nitrogen equilibrium of the body. The higher fibre content of finger millet helps in many ways as it prevents constipation, high cholesterol formation and intestinal cancer. Hence, people suffering from diabetics are advised to eat finger millet and other small millets instead of rice (Malleshi and Hadimani, 1993) [1]. Since yield is a complex trait, knowledge on the association of the different yield components with grain yield and interrelation among themselves is necessary. A study through correlation coefficients on the genotypic values provides dependable basis for selection. Correlation in conjunction with path analysis would give a better insight into cause and effect relationship between different pairs of characters by Venkatesan *et al*. (2004) [2]. Selection of superior genotypes based on yield as such is difficult due to the integrated structure of plant in which most of the characters are interrelated and being governed by more number of genes. This necessitates a thorough knowledge on the nature of relationship prevalent between contributory characters and grain yield and the extent of genetic variability. Therefore, the present investigation was undertaken to study the relative contribution of different yield attributes to grain yield and their interrelationship by estimating correlation, path analysis to assess the direct and indirect effect of component character on grain yield.

Materials and Methods
The experimental materials consisting of 48genetically diverse genotypes of finger millet was evaluated in a randomized block design with three replications during *kharif* 2014 and adopted a spacing of 22.5 cm between rows and 10 cm between plants respectively, at National Bureau of Plant Genetic Resources (NBPGR), regional station, Hyderabad. Recommended package of practices were followed to raise good and healthy crop stand. Five competitive plants were selected at random from each replication and observations were recorded on nine quantitative traits viz., Plant height (cm), total no. of basal tillers per plant, no. of leaves on the main tiller,

productive tillers per plant, main ear length (cm), finger length (cm), finger width (cm), total no. of finger on the main ear and grain yield per plant (g). Genotypic and phenotypic correlation coefficients for grain yield and its component traits were calculated as suggested by Johanson *et al*. (1955) [3]. The phenotypic correlation coefficient was tested by the method of Fisher and Yates (1943) [4], while genotypic correlation coefficients were tested by 'z' test as per the method used by Singh *et al*. (1974) [5]. The path coefficient analysis, as suggested by Dewey and Lu (1959) [6], which provides a means of understanding the complex correlations into direct and indirect contributions, was carried out at both genotypic and phenotypic levels.

Result and Discussion

a. Trait association

Crop yield is the end product of the interaction of a number of other, often interrelated attributes. A thorough understanding of the interaction of characters among themselves had been of great use in plant breeding. 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. Phenotypic and genotypic correlations were worked out on yield and yield contributing characters in 48 genotypes. In general, most of genotypic correlations were found to be higher than phenotypic correlations, which indicate that though there is strong inherent association between character studies, its expression is lessened due to influence of environment and considering the importance of phenotypic correlation it was discussed in the results which were presented in table 1. Information on the phenotypic and genotypic interrelationships 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, 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. In the present study, grain yield per plant recorded a non-significant positive correlation with no. of basal tillers per plant (0.1273P, 0.1235G), no. of leaves on the main tiller (0.1351P, 0.1817G) no. of productive tillers per plant (0.2064P, 0.2024G) main ear length (0.0072P, 0.0043G) finger width (0.2507P, 0.3415G) total fingers on the main ear (0.0678P, 0.1127G), grain yield per plot (0.9927P, 0.9990G) and plant height (0.3587P, 0.4525G) at both phenotypic and genotypic levels, negative and non-significant correlation with main ear width (-0.0419P, -0.0503G) and finger length (-0.0560P, -0.0758G) at both levels. The similar results were reported by Ravikumar and Seetharam (1993) [7] and Ravindran *et al*. (1996) [8] for total no. of finger and for total no. of basal tillers per plant, Priyadharshini *et al*. (2011) [9], Anantharaju and Meenakshiganesan (2005) [10] for no. of productive tillers, Sonnad *et al.* (2008) [11] and Chunilal (1996) [12] for finger length and Bendale *et al*. (2002) [13] for finger width. The results obtained indicate that, yield was increased whenever there was increase in effective total no. of basal tillers per plant, productive tillers per plant, total fingers on the main ear, finger length and finger width. These characters can be considered as criteria for selection for higher yield, as these are mutually and directly associated with grain yield. Plant height recorded positive non-significant correlation with grain yield per plant (0.3587P, 0.4525G) at both levels. The similar results were reported by John (2006) [14] for ear length, while it has been recorded by Haider and Mahto (1995) [15] that, total no. of leaves on the main tiller showed significant positive association with biological yield. Non-significant correlation of plant height with grain yield shows that there is scope for developing dwarf types without any reduction in grain yield. Regarding inter correlation between yield attributing traits plant height had significant positive correlation with no. of leaves on the main tiller (0.3357P. 0.4636G) main ear length (0.2228P, 0.1850G) and grain yield per plot (0.3617P, 0.4610G) at phenotypic level. The trait total no. of basal tillers per plant was significantly and positively associated with productive tillers per plant (0.9126P, 0.9592G) main ear length (0.1977P, 0.2343G) main ear width (0.3402P, 0.4085G) and finger length (0.2939P, 0.3858G). Total no. of leaves on the main tiller was non-significant and positively correlated with main ear length (0.0980P, 0.0353G) total fingers on the main ear (0.0275P, 0.1006G) and grain yield per plot (0.1353P, 0.2017G) at both levels. The trait productive tillers per plant had significant positive correlation with main ear length (0.2338P), main ear width (0.3990P) finger length (0.3226P) and grain yield per plot (0.1954P) at phenotypic level. Main ear length was significant positive correlation with main ear width (0.6550P) and finger length (0.8233P) at phenotypic level. Main ear width recorded significant positive correlation with finger length (0.7748P) at phenotypic level. Finger width recorded a significant positive correlation with grain yield per plot (0.2294P) at phenotypic level. Grain yield per plot recorded a significant positive correlation with the grain yield per plant (0.9927P, 0.9990G) at both phenotypic and genotypic levels. This indicated that there is a possibility of simultaneous improvement of these traits by a single selection programme.

b. Path coefficient

Correlation gives only the relation between two variables whereas path coefficient analysis allows separation of the direct effect and their indirect effects through other attributes by partitioning the correlations (Wright, 1921) [16]. Hence, this objective was undertaken in the present investigation. Data recorded based on forty eight genotypes in the present investigation, the genotypic and phenotypic correlations were estimated to determine direct and indirect effects of yield and yield contributing characters were presented in table 2. Path coefficient analysis revealed that grain yield per plant exerted the highest positive direct effect on grain yield per plot (0.9807P, 0.9606G), followed by finger width (0.0224P, 0.0520G) and plant height (0.0010P, 0.0421G) at both levels. The same result reported by Ravikumar and Seetharam (1993) [7], Bedis *et al.* (2006) [17], Priyadarshini *et al.* (2011) [9] and Anantharaju and Meenakshiganesan (2005) [10] for no. of productive tillers per plant. The same result reported by Sonnad *et al*. (2008), Anantharaju and Meenakshiganesan (2005) [10], Chunilal *et al*. (1996) [12] and Bendale *et al.* (2002) [13] for finger length and finger width. Grain yield per plot had positive direct effect (0.9807P, 0.9606G) on grain yield per plant while the correlation between grain yield per plot and grain yield per plant was positively non-significant. The correlation with grain yield per plant was positive and non-significant due to indirect positive effect through plant height (0.3547P, 0.4428G), no. of basal tillers per plant (0.1229P, 0.1112G), no. of leaves on the main tiller (0.1327P, 0.1938G), productive tillers per plant (0.1916P, 0.1833G), main ear length (0.0146P, 0.0109G), finger width (0.2249P, 0.2934G) and total fingers on the main ear (0.0651P, 0.1023G) at both phenotypic and genotypic levels. Plant height had positive direct effect (0.0010P, 0.0421G) on grain yield per plant at both phenotypic and genotypic levels. Finger width was recorded positive indirect effect through total fingers on the main ear (0.0011P, 0.0031G) and grain yield per plot (0.0051P, 0.0159G). Plant height had negative direct effect no. of basal tillers per plant (-0.0003P, -0.0206G) and productive tillers per plant (-0.0002P, -0.0139G) at both levels. The similar result reported by Priyadarshini *et al.* (2011) [9] and Bendale *et al.* (2002) [13], Ravindran *et al.* (1996) [8], Anantharaju and Meenakshiganesan (2005) [10] negative direct effect of plant height on grain yield. Finger width had positive direct effect (0.0224P, 0.0520G) on grain yield per plant while correlation between finger width and grain yield per plant was significantly positive. The correlation with grain yield per plant was positive and non-significant due to the indirect positive effect through total fingers on the main ear (0.0011P, 0.0031G) and grain yield per plot (0.0051P, 0.0159G). The same result reported by Bedis *et al.* (2006) [16] negative direct effect of main ear length on grain yield per plant.

Conclusion

Critical analysis of result obtained from character association and path analysis indicated that the character plant height, finger width and grain yield per plot had significant positive correlation and positive direct effects on grain yield. Moreover the indirect effect of most of the characters via these characters was positive. It is therefore suggested that performance should be given to plant height, finger width and grain yield per plot in the selection programme to isolate superior lines with genetic potentiality for high grain yield.

Table 1: Phenotypic (P) and genotypic (G) correlation coefficients among yield and yield attributes in forty eight genotypes

S. No	Character		Plant height (cm)	No of basal tillers/plant	No of leaves on the main tiller	Productive tillers/plant	Main ear length (cm)	Main ear width(cm)	Finger length (cm)	Finger width (cm)	Total fingers on the main ear	Grain yield /plot(g)	Grain yield/plant (g)
1		P	1.0000	-0.2976* *	0.3357**	-0.1939 *	0.2228 * *	0.0735	0.1192	0.1379	0.1434	0.3617**	0.3587
	PH	G	1.0000	-0.4887	0.4636	-0.3291	0.1850	0.0532	0.0847	0.1329	0.2170	0.4610	0.4525
2		P		1.0000	-0.0076	0.9126 **	0.1977 *	0.3402 **	0.2939 **	-0.0835	-0.0725	0.1254	0.1273
	NBT	G		1.0000	-0.1749	0.9592	0.2343	0.4085	0.3858	-0.1952	-0.0592	0.1157	0.1235
3		P			1.0000	0.0597	0.0980	-0.1058	-0.0030	-0.0480	0.0275	0.1353	0.1351
	NL	G			1.0000	-0.0662	0.0353	-0.1707	-0.0741	-0.0799	0.1006	0.2017	0.1817
4		P				1.0000	0.2338 **	0.3990 **	0.3226 **	-0.0382	-0.0206	0.1954 *	0.2064
	PT	G				1.0000	0.2781	0.4657	0.3899	-0.0721	0.0118	0.1908	0.2024
5		P					1.0000	0.6533 **	0.8233 **	-0.1180	0.0435	0.0149	0.0072
	EL	G					1.0000	0.7916	0.8996	-0.2082	-0.0541	0.0113	0.0043
6		P						1.0000	0.7748 **	-0.1047	-0.0233	-0.0398	-0.0419
	EW	G						1.0000	0.8821	-0.1658	-0.0747	-0.0484	-0.0503
7		P							1.0000	-0.1588	-0.0372	-0.0495	-0.0560
	FL	G							1.0000	-0.2441	-0.0856	-0.0664	-0.0758
8		P								1.0000	0.0511	0.2294 **	0.2507
	FW	G								1.0000	0.0591	0.3055	0.3415
9	TF	P									1.0000	0.0664	0.0678
		G									1.0000	0.1065	0.1127
10	GYP	P										1.0000	0.9927
		G										1.0000	0.9990
11	GYPP	P											1.0000
		G											1.0000

P represents phenotype and G represents genotype

PH- Plant height (cm), NBT- No. of basal tillers per plant, NL- No. of leaves on the main tiller, PT- Productive tillers per plant, EL-Main ear length, EW-Main ear width, FL- Finger length, FW- Finger width, TF-Total fingers on the main ear, GYP-Grain yield per plot, GYPP-Grain yield per plant.

Table 2: Phenotypic (P) and genotypic (G) path coefficient analysis indicating direct (bold and diagonal) and indirect effects of components characters on grain yield

S. No	Character		Plant height (cm)	No of basal tillers/plant	No of leaves on the main tiller	Productive tillers/plant	Main ear length (cm)	Main ear width(cm)	Finger length (cm)	Finger width (cm)	Total fingers on the main ear	Grain yield /plot(g)	Correlation
1		P	0.0010	-0.0003	0.0003	-0.0002	0.0002	0.0001	0.0001	0.0001	0.0001	0.0004	0.3587
	PH	G	0.0421	-0.0206	0.0195	-0.0139	0.0078	0.0022	0.0036	0.0056	0.0091	0.0194	0.4525
2		P	0.0147	-0.0493	0.0004	-0.0450	-0.0097	-0.0168	-0.0145	0.0041	0.0036	-0.0062	0.1273
	NBT	G	-0.0575	0.1177	-0.0206	0.1129	0.0276	0.0481	0.0454	-0.0230	-0.0070	0.0136	0.1235
3		P	-0.0004	0.0000	-0.0011	-0.0001	-0.0001	0.0001	0.0000	0.0001	0.0000	-0.0001	0.1351
	NL	G	-0.0077	0.0029	-0.0166	0.0011	-0.0006	0.0028	0.0012	0.0013	-0.0017	-0.0034	0.1817
4		P	-0.0125	0.0590	0.0039	0.0647	0.0151	0.0258	0.0209	-0.0025	-0.0013	0.0126	0.2064
	PT	G	0.0220	-0.0642	0.0044	-0.0669	-0.0186	-0.0312	-0.0261	0.0048	-0.0008	-0.0128	0.2024
5		P	-0.0011	-0.0010	-0.0005	-0.0011	-0.0049	-0.0032	-0.0040	0.0006	-0.0002	-0.0001	0.0072
	EL	G	0.0088	0.0112	0.0017	0.0133	0.0477	0.0378	0.0429	-0.0099	-0.0026	0.0005	0.0043
6		P	-0.0003	-0.0014	0.0004	-0.0017	-0.0027	-0.0041	-0.0032	0.0004	0.0001	0.0002	-0.0419
	EW	G	0.0009	0.0067	-0.0028	0.0077	0.0130	0.0165	0.0145	-0.0027	-0.0012	-0.0008	-0.0503
7		P	-0.0004	-0.0009	0.0000	-0.0010	-0.0026	-0.0025	-0.0032	0.0005	0.0001	0.0002	-0.0560
	FL	G	-0.0068	-0.0311	0.0060	-0.0314	-0.0724	-0.0710	-0.0805	0.0197	0.0069	0.0053	-0.0758
8		P	0.0031	-0.0019	-0.0011	-0.0009	-0.0026	-0.0023	-0.0036	0.0224	0.0011	0.0051	0.2507

	FW	G	0.0069	-0.0102	-0.0042	-0.0038	-0.0108	-0.0086	-0.0127	0.0520	0.0031	0.0159	0.3415
9	TF	P	-0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-0.0008	-0.0001	0.0678
		G	0.0010	-0.0003	0.0005	0.0001	-0.0002	-0.0003	-0.0004	0.0003	0.0045	0.0005	0.1127
10	GYP	P	0.3547	0.1229	0.1327	0.1916	0.0146	-0.0390	-0.0485	0.2249	0.0651	0.9807	0.9927
		G	0.4428	0.1112	0.1938	0.1833	0.0109	-0.0465	-0.0638	0.2934	0.1023	0.9606	0.9990

P represents phenotype and G represents genotype

PH- Plant height (cm), NBT- No. of basal tillers per plant, NL- No. of leaves on the main tiller, PT- Productive tillers per plant, EL-Main ear length, EW-Main ear width, FL- Finger length, FW- Finger width, TF-Total fingers on the main ear, GYP-Grain yield per plot

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