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Character association and path analysis in Elite Italian millet [*setariaitalica* (L.) P. Beauv] Germplasm accessions

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ABSTARCT
The present investigation was carried out in Italian millet germplasm to measure correlation and path coefficients using 40 elite genotypes.The experiment was laid out in a randomized complete block design with three replications at National Bureau of Plant Genetic Resources, Regional Station, Rajendranagar, Hyderabad during Kharif, 2015.Among the yield attributing traits, while seed yield/plant recorded a significant positive correlation with no. of basal tillers, ear length, 1,000 seed weight and straw yield/plant, it recorded a significant negative correlation with no. of culm branches, flag leaf width, peduncle length and panicle exertion at both levelsand anon- significant negative one with protein content, carbohydrate content at phenotypic and genotypic levelsand days to 50% flowering at phenotypic level. The path analysis revealed that no. of basal tillers, no. of culm branches, ear length, ear width and straw yield/plant are the most important characters which could be used as selection criteria for effective improvement of grain yield. Through this study it can be deduced that, these characters can be considered as most important traits which should be used as selection criteria to develop high yielding cultivars in Italian millet.
***KEYWORDS**: Italian millet, Correlation, Path analysis.*

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INTRODUCTION

Italian millet [*Setaria italica* (L.) P. Beauv] also known as Foxtail millet, Chinese millet and Hungarian millet is an important staple food for millions of people in Africa, Asia and southern Europe. In India, it is known by varied vernacular names, Korra in Telugu, Navane in Kannada,Thinai in Tamil and Kangniin Hindi andranks second in the overall global production of millets. Italian millet is a good source of protein (12.3%), fat (4.7%)and carbohydrates (60.6%) (Murugan and Nirmalakumari, 2006) and usually cooked as whole or made into a meal.It is well known for its biotic and abiotic stress tolerance and its ability to thrive and yield even under moisture stress situations. Study of character association has considerable use in plant breeding because selection for one character may bring about simultaneous effect on the other, depending on the intensity of association between the two traits. However, the dependent traits might be a due to interaction of many mutually associated component characters. The path analysis proposed by Dewey and Lu (1959) takes into account the cause and effect relationship between the variables by partitioning the association into direct and indirect effects through other independent variables. It also helps to resolve these correlations, throwing more light on the contribution of component traits and thus grain yield being a complex character is under polygenic control more responsive under varying environmental conditions.

MATERIAL AND METHODS

The present investigation on 40 Italian millet accessions includingeightcheck varieties was carried out during *Kharif*, 2015at National Bureau of Plant Genetic Resources, Regional Station, Rajendranagar, Hyderabad.The experimental design adapted was a randomised block design (RBD) with three replications. Each entry in the replications was sown in two rows of three metres each spaced at 60cm

apart with a plant to plant distance of 15cm. Sowings were taken up during last week of July and irrigation was provided as and when required to obtain uniform plant stand by taking up cultural practices as per the requirement. Data was recorded on a set of descriptors which include among others plant height (cm), no. of basal tillers, no. of culm branches, flag leaf length (cm),flag leaf width (cm), peduncle length (cm), panicle exertion (cm), ear length (cm), ear width(cm), 1000 seed weight (gm), seed yield/plant (gm), straw yield/plant (gm), days to 50% flowering, protein content (%) and carbohydrate content (%).

RESULTS AND DISCUSSION

From the estimates of phenotypic and genotypic coefficients of variation in general(Table 1), it was observed that genotypic correlation coefficients were higher than the phenotypic correlation coefficients for most of the characters indicating a strong inherent influence of environment on their expression. (Aliya *et al.*, 2014).The most important trait seed yield/plant recorded a significant positive correlation with no. of basal tillers, ear length, 1000 seed weight and straw yield/plant and a significant negative correlation with no. of culm branches, flag leaf width, peduncle length, panicle exertion at both levels, negative non- significant with protein content, carbohydrate content at phenotypic and genotypic levels and days to 50% flowering at phenotypic level.Similar association was also reported by Brunda *et al.,*(2015) for 1000 seed weight and no. of basal tillers, Prasanna *et al.,*(2014) for ear length and ear widthand Sirisha*et al.,*(2009) for protein content.The results indicated that, there was increase in yield whenever there was increase in the values for traits no. of basal tillers, ear length, 1000 seed weight and straw yield/plant.Negative non- significant withdays to 50% flowering communicate that it is due to environment effect otherwise could breed for earlier types. These characters can be considered as criteria for selection for higher yield, as they were mutually and directly associated with grain yield. As plant height is positively associated with grain yield, it may be considered as a selection criterion for increase in grain yield and there is no scope for developing dwarf cultivars without any reduction in seed yield as reported by Das *et al.,*(2013). With respect to biochemical traits protein and carbohydrate content,they have shown negative association with seed yield which indicates that simultaneous selection for yield and quality traits is not possible.

The information deduced from correlation studies indicated only mutual association among the characters, whereas, path coefficient analysis helps in understanding the magnitude of direct and indirect contribution of each character on the dependant characters like seed yield.

Partitioning of correlation coefficients into direct and indirect effects provide information about the nature and magnitude of effects of other characters on seed yield.The direct and indirect effects of different yield components on grain yield worked out through path analysis at phenotypic and genotypic levels are presented in Table 2.The path coefficient analysis revealed that straw yield/plant exerted the highest positive direct effect on seed yield/plant, followed by no. of basal tillers, no. of culm branches and ear length along with positive correlation for all the above mentioned characters. These characters also exhibited indirect positive effect *viz*., no. of basal tillers exhibited indirect effect through plant height, panicle exertion and straw yield/plant on seed yield/plant. Among the traits, straw yield/plant shown indirect positive effect through no. of basal tillers, panicle exertion and ear length on seed yield/plant. Ear length contributed positive indirect effects through no. of basal tillers, flag leaf length, panicle exertion, straw yield/plant and carbohydrate content on seed yield/plant.Ear width recorded positive indirect effect through plant height, panicle exertion, 1000 seed weight, days to 50 % flowering, protein content and carbohydrate content. These results are in accordance with the findings of Brunda*et al.,*(2015) and in conformity with the results of Prasanna*et al.,*(2014) for positive direct effect of no. of basal tillers and Murugan and Nirmalakumari (2006) for ear length.While, plant height had negative direct effect on seed yield/ plant, it had positive significant correlation at phenotypic and positive non-significant correlation at genotypic level with it. It is due to the positive indirect contribution through flag leaf length and flag leaf width at genotypic level and peduncle length, panicle exertion and seed yield/ plant at both the levels. These results were in accordance with Murugan and Nirmalakumari (2006), Tyagi*et al*. (2011) and Prasanna*et al.* (2014).With reference to flowering, days to 50% flowering had negative direct effect on seed yield/ plant which is due to indirect negative contribution of plant height, no. of culm branches, peduncle length, ear width and protein content at both the levels andof flag leaf length, ear width and 1000 seed weight. These results are in conformity with the ones reported by Reddy and Jhansi Lakshmi (1991) and Nagarajan and Prasad (1980) for these path coefficient effects. Coming to panicle exertion, while it had negative direct effect on grain yield/ plant, it is negatively significantly correlated with it due to indirect contribution of no. of basal tillers, ear length, ear width and straw yield/ plant. In this case, the residual factor was 0.27P and 0.22G which were of moderate and negligible magnitude at phenotypic and genotypic levels, respectively revealing the sufficiency of the characters selected to define the total

grain yield.The path analysis revealed that no. of basal tillers, no. of culm branches, ear length, ear width and straw yield/ plant accounts maximum to make up the total grain yield compared to other strongly associated yield attributing traits.

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Table: 1 Phenotypic (P) and Genotypic (G) correlation coefficients among yield attributes in 40 Italian millet germplasm accessions

character		PH	NBT	NCB	FLL	FLW	PL	PE	EL	EW	1000 SW	STY/P	DAF 50%	PC%	CC%	SEY/P
PH	P	**1.0000**	-0.0759	-0.2420**	0.0581	-0.1063	0.0854	-0.0594	0.4729**	-0.1830*	0.2863**	0.0929	0.1411	-0.0034	-0.1506	0.0394
	G	**1.0000**	-0.0541	-0.2491**	0.0946	-0.0986	0.0291	-0.1241	0.5719**	-0.3583**	0.2664**	0.0587	0.2062*	-0.0214	-0.1629	0.0076
NBT	P		**1.0000**	-0.0096	-0.2062*	-0.2818*	-0.3011**	-0.2393**	-0.0379	-0.2018*	0.3258**	0.4642**	0.1042	-0.2028**	-0.2743**	0.4004**
	G		**1.0000**	-0.0173	-0.3558**	-0.8375**	-0.4894**	0.3211**	0.0233	-0.3778**	0.4902**	0.6002**	0.1098	-0.2519**	-0.3504**	0.5126**
NCB	P			**1.0000**	-0.3739**	-0.1347	0.2528*	0.3029**	-0.3239**	-0.0776	-0.0557	-0.2122*	-0.1723	0.1070	-0.0746	-0.2176*
	G			**1.0000**	-0.5459**	-0.1790	0.4112**	0.3943**	-0.4149**	-0.1400	-0.0480	-0.2615**	-0.1941*	0.1126	-0.0888	-0.2710**
FLL	P				**1.0000**	0.3504**	-0.1213	-0.0876	0.2074*	0.0655	-0.0218	0.0268	0.0766	-0.1282	0.0925	0.0180
	G				**1.0000**	0.5312**	-0.0595	-0.0512	0.2195*	0.0332	-0.0539	0.0077	0.1229	-0.1499	0.1173	0.0039
FLW	P					**1.0000**	0.1466	0.2022*	-0.0834	0.1928*	-0.2383**	-0.3582**	-0.0423	0.1169	0.3359**	-0.2982**
	G					**1.0000**	0.3625**	0.4084**	-0.0028	0.4859**	-0.5143**	-0.5590**	-0.1740	0.2108*	0.5458**	-0.4661**
PL	P						**1.0000**	0.7584**	-0.1412	-0.0586	-0.4504**	-0.4345**	-0.1292	0.1753	0.1838*	-0.3793**
	G						**1.0000**	0.9125**	-0.2342*	-0.0034	-0.6953**	-0.6238**	-0.1734	0.2239*	0.2750**	-0.5271**
PE	P							**1.0000**	-0.3281**	-0.0993	-0.4186**	-0.4849**	-0.1220	0.1420	0.0873	-0.4948**
	G							**1.0000**	-0.4153**	-0.1301	-0.5518**	-0.6124**	-0.1391	0.1643	0.0963	-0.6070**
EL	P								**1.0000**	-0.0062	0.2194*	0.3460**	0.2929**	-0.0942	0.1068	0.4016**
	G								**1.0000**	-0.0207	0.2569**	0.3832**	0.3669**	-0.0960	0.1147	0.4416**
EW	P									**1.0000**	-0.0608	-0.0789	-0.3061**	0.0706	0.0573	0.0192
	G									**1.0000**	-0.1340	-0.1088	-0.4377**	0.0910	0.1024	0.0382
1000 SW	P										**1.0000**	0.4650**	0.0006	-0.0469	-0.3824**	0.3449**
	G										**1.0000**	0.5259**	-0.0040	-0.0696	-0.4494**	0.3749**
STY/P	P											**1.0000**	0.0419	-0.1361	-0.2099**	0.9407**
	G											**1.0000**	0.0475	-0.1479	-0.2256**	0.9407**
DAF 50%	P												**1.0000**	-0.1912*	0.0121	-0.0129
	G												**1.0000**	-0.1970*	0.0189	0.0104
PC%	P													**1.0000**	0.1852	-0.0887
	G													**1.0000**	0.1918**	-0.0956
CC%	P														**1.0000**	-0.0879
	G														**1.0000**	-0.0932
SEY/P	P															**1.0000**
	G															**1.0000**

P represents Phenotype and **G** represents Genotype.*and** = significant at 5% and 1% level respectively

PH=plant height, **NBT**=no of basal tillers, **NCB**=no of culm branches, **FLL**=flag leaf length, **FLW**=flag leaf width, **PL**=peduncle length, **PE**=panicle exertion, **EL**=ear length, **EW**=ear width, **1000 SW**=1000 seed weight, **STY/P**=straw yield/plant, **DAF50%**=days to 50%flowering, **PC%=**protein content, **CC%**=carbohydrate content, **SEY/P**=seed .yield/plant

Table:2 Phenotypic (P) and Genotypic (G) Path coefficient analysis indicating direct (bold and diagonal) and indirect effects of component characters on seed yield

Character		PH	NBT	NCB	FLL	FLW	PL	PE	EL	EW	1000 SW	STY/P	DAF 50%	PC%	CC%	SEY/P
PH	P	-0.0623	-0.0017	-0.0004	-0.0020	-0.0023	0.0063	0.0064	0.0605	-0.0091	-0.0286	0.0878	-0.0090	-0.0001	-0.0062	0.0394**
	G	-0.0552	-0.0057	-0.0111	0.0072	0.0094	0.0043	0.0228	0.0947	-0.0439	-0.0439	0.0516	-0.0138	-0.0012	-0.0064	0.0076
NBT	P	0.0047	0.0233	0.0000	0.0071	-0.0061	-0.0223	0.0260	-0.0048	-0.0100	-0.0325	0.4387	-0.0067	-0.0048	-0.0112	0.4004**
	G	0.0030	0.1049	-0.0008	-0.0271	0.0796	-0.0728	0.0590	0.0039	-0.0462	-0.0829	0.5272	-0.0074	-0.0139	-0.0139	0.5126**
NCB	P	0.0151	-0.0002	0.0015	0.0129	-0.0029	0.0187	-0.0329	-0.0414	-0.0039	0.0056	-0.2006	0.0110	0.0025	-0.0031	-0.2176*
	G	0.0138	-0.0018	0.0446	-0.0416	0.0170	0.0611	-0.0724	-0.0687	-0.0171	0.0081	-0.2296	0.0130	0.0062	-0.0035	-0.2710*
FLL	P	-0.0036	-0.0046	-0.0006	-0.0345	0.0075	-0.0090	0.0095	0.0265	0.0033	0.0022	0.0253	-0.0049	-0.0030	0.0038	0.0180
	G	-0.0052	-0.0373	-0.0244	0.0762	-0.0505	-0.0089	0.0094	0.0364	0.0041	0.0091	0.0068	-0.0082	-0.0083	0.0046	0.0039
FLW	P	0.0066	-0.0063	-0.0002	-0.0121	0.0215	0.0108	-0.0219	-0.0107	0.0096	0.0238	-0.3385	0.0027	0.0028	0.0137	-0.2982**
	G	0.0054	-0.0879	-0.0080	0.0405	-0.0950	0.0539	-0.0750	-0.0005	0.0595	0.0870	-0.4909	0.0117	0.0116	0.0216	-0.4661**
PL	P	-0.0053	-0.0067	0.0004	0.0042	0.0031	0.0740	-0.0823	-0.0181	-0.0029	0.0450	-0.4106	0.0083	0.0041	0.0075	-0.3793**
	G	-0.0016	-0.0514	0.0184	-0.0045	-0.0344	0.1487	-0.1676	-0.0388	-0.0004	0.1176	-0.5478	0.0116	0.0123	0.0109	-0.5271**
PE	P	0.0037	-0.0053	0.0005	0.0030	0.0043	0.0561	-0.1085	-0.0420	-0.0049	0.0418	-0.4583	0.0078	0.0034	0.0036	-0.4948**
	G	0.0069	-0.0337	0.0176	-0.0039	-0.0388	0.1357	-0.1837	-0.0688	-0.0159	0.0933	-0.5378	0.0093	0.0090	0.0038	-0.6070**
EL	P	-0.0295	-0.0008	-0.0005	-0.0071	-0.0018	-0.0105	0.0356	0.1280	-0.0003	-0.0219	0.3270	-0.0188	-0.0022	0.0044	0.4016**
	G	-0.0316	0.0024	-0.0185	0.0167	0.0003	-0.0348	0.0763	0.1656	-0.0025	-0.0434	0.3365	-0.0246	-0.0053	0.0045	0.4416**
EW	P	0.0114	-0.0045	-0.0001	-0.0023	0.0041	-0.0043	0.0108	-0.0008	0.0497	0.0061	-0.0745	0.0196	0.0017	0.0023	0.0192
	G	0.0198	-0.0396	-0.0062	0.0025	-0.0462	-0.0005	0.0239	-0.0034	0.1224	0.0227	-0.0956	0.0294	0.0050	0.0041	0.0382
1000 SW	P	-0.0179	0.0073	-0.0001	0.0008	-0.0051	-0.0333	0.0454	0.0281	-0.0030	-0.0999	0.4395	0.0000	-0.0011	-0.0156	0.3449**
	G	-0.0147	0.0514	-0.0021	-0.0041	0.0489	-0.1034	0.1014	0.0426	-0.0164	-0.1691	0.4619	0.0003	-0.0038	-0.0178	0.3749**
STY/P	P	-0.0058	0.0104	-0.0003	-0.0009	-0.0077	-0.0322	0.0526	0.0443	-0.0039	-0.0464	0.9452	-0.0027	-0.0032	-0.0086	0.9407**
	G	-0.0032	0.0630	-0.0117	0.0006	0.0531	-0.0928	0.1125	0.0635	-0.0133	-0.0889	0.8783	-0.0032	-0.0081	-0.0089	0.9407**
DAF50%	P	-0.0088	0.0023	-0.0003	-0.0026	-0.0009	-0.0096	0.0132	0.0375	-0.0152	-0.0001	0.0396	-0.0641	-0.0045	0.0005	-0.0129
	G	-0.0114	0.0115	-0.0087	0.0094	0.0165	-0.0258	0.0256	0.0608	-0.0536	0.0007	0.0418	-0.0671	-0.0109	0.0007	-0.0104
PC%	P	0.0002	-0.0045	0.0002	0.0044	0.0025	0.0130	0.0154	0.0121	-0.0035	-0.0047	0.1287	0.0123	-0.0236	0.0076	-0.0887
	G	0.0012	-0.0264	-0.0050	-0.0114	-0.0200	0.0333	-0.0302	-0.0159	0.0111	0.0118	-0.1299	0.0132	0.0551	0.0076	-0.0956
CC%	P	0.0094	-0.0061	-0.0001	-0.0032	0.0072	0.0136	-0.0095	0.0137	0.0028	0.0382	-0.1984	-0.0008	0.0044	0.0409	-0.0879
	G	0.0090	-0.0368	-0.0040	0.0089	-0.0519	0.0409	-0.0177	0.0190	0.0125	0.0760	-0.1982	-0.0013	0.0106	0.0396	-0.0932

P represents Phenotype and **G** represents Genotype.*and** = significant at 5% and 1% level respectively

PH=Plant height (cm), **NBT**= no. of basal tillers, **NCB**=no. of culm branches, **FLL**= flag leaf length (cm),**FLW**=flag leaf width (cm), **PL**=peduncle length (cm), **PE**=panicle exertion (cm), **EL**=ear length (cm), **EW**=ear width (cm), **1000 SW**= 1000 seed weight (gm),**STY/P**= straw yield/plant (gm), **DAF 50%=**days to 50%flowering, **PC%**=protein content, **CC%**=carbohydrate content, **SEY/P**=seed yield/plant(gm)

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