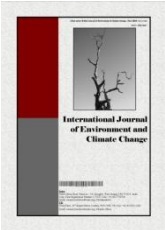

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Association and Path Studies in Maize Over Southern Aravalli Regions of Rajasthan

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The environment highly influences a complex trait such as grain yield and indirect selection through component traits would be an advisable strategy to increase the selection efficiency. The 45 F_1s and their 18 parents and 2 checks were evaluated in three environments *viz.,* E1, E2 and E3 in RBD design with three replications to assess the correlation among the yield components and direct and indirect effects of yield components on grain yield. The association analysis among the eleven traits revealed that the traits days to 50 per cent silking, plant height, ear height, ear length, ear girth, grain rows per ear, 100-grain weight and harvest index had showed positive and significant correlation with grain yield per plant. The perusal of the path coefficient analysis revealed that the maximum direct positive effect was depicted by the harvest index followed by the traits ear height, grain rows per ear, days to 50 per cent silking, 100-grain weight, days to 75 per cent brown husk, ear girth and plant height.

Keywords: Path analysis; correlation analysis; maize hybrids; Southern Aravalli regions of Rajasthan.

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1. INTRODUCTION

Maize is one of the three important cereal crops after wheat and rice and consumed as a staple food. It is a multipurpose cereal crop grown across the varied agro-ecological regions of the world due to its wider adaptability [1]. The crop is a key source of calories, protein, vitamins and minerals throughout the world especially in Africa, South America, and Asia [2]. It is used extensively as animal feed, particularly for poultry and pigs, in industry, it is currently used for ethanol production. In India, it is grown in 9.20 M ha with a total production of 28.00 MMT, and productivity of 3.04 metric t/ha [3,4]. It is estimated that half of the increased world food demand in terms of cereals as a whole will be produced from maize [5]. It is challenging to quantify grain yield because it is highly influenced by the environment and results of the interrelationship between various yield components [6]. Information on genotypic and phenotypic correlation coefficients between different plant traits helps determine their relationship to economic productivity. The phenotypic correlation may depict the direct relationship between two variables or traits, while genotypic correlation reveals the extent to which they are associated at the genetic level. Correlation at genotypic and phenotypic levels among the traits offers opportunities for indirect selection in crop improvement breeding programs. The genetic basis of the material and the role of environments are of great importance while studying genetic correlation among various quantitative characters in crops. These studies may guide plant breeders on selecting traits that contribute to the character(s) of concern, and improve through hybridization. Breeders need to understand the correlations among different traits, especially for grain yield, which is the ultimate goal of any breeding program. Thus, objective of the current research was to estimate direct and indirect effects of yield components on grain yield and derive information about their correlation with grain yield.

2. MATERIALS AND METHODS

The experimental material comprised 45 F_1s, along with their 18 parents and with two checks, were evaluated in three environments *viz.,* E1 (*Kharif*-2019, Instructional Farm, Rajasthan College of Agriculture, Udaipur), E2 (*Kharif*-2019, Agriculture Research Sub-Station, Vallabh Nagar) and E3 (*Rabi*-2019-2020, Instructional Farm, Rajasthan College of Agriculture, Udaipur) in RBD design with three replications. Each genotype was sown in single row plot of 4.0 m in length with geometry of 60 x 20 cm (R X P). The Udaipur district is located in the Aravalli Hilly Ranges of the Southern part of the Rajasthan with a latitude of 24°35'31.5" longitudes 73°44'18.2" with an altitude of 582.17 meters above mean sea level. The Vallabhnagar is located in Bhinder town of Udaipur district of Rajasthan State with latitude 24°40′23″ longitudes 74°00′09″ with an altitude of 495.00 m above mean sea level. The soil of both Udaipur and Vallabhnagar experimental fields was alluvial in origin, clay loam, well-drained. All the recommended package of practices of zone IV-A (Sub-Humid Southern Plains) was used to raise a healthy crop. The observations were recorded on five randomly selected plants from each plot to record the data on 11 traits in all the environments. However, the data on three phenological traits *viz.,* days to 50 per cent tasseling, days to 50 per cent silking and days to 75 per cent brown husk and 100-grain weight recorded on a whole plot basis. The standardized traits mean values were pooled and used to investigate character association between different pairs of characters at phenotypic and genotypic levels as per described by Singh et al. 1985 [7]. The path analysis was also carried out as per method described by Wright, 1921 [8] and illustrated by Dewey and Lu [9].

3. RESULTS AND DISCUSSION

Analysis of variance revealed significant differences for all the eleven quantitative traits under the study The estimates of correlation coefficients at both genotypic and phenotypic levels between different traits on the pooled basis are presented in Table 1. The genotypic correlation was in general higher than the respective phenotypic correlation indicating strong inherent relationship among the characters under study. The grain yield per plant showed highly significant positive correlation with days to 50 per cent silking, plant height, ear height, ear length, ear girth, grain rows per ear, 100-grain weight and harvest index at both genotypic and phenotypic levels. The two phenological traits *viz.,* days to 50 per cent tasseling and days to 75 per cent brown husk had showed positive but non-significant association with grain yield under the study. The correlation between two variables may be due to third factor thus cause and effect relationship between dependent and independent variables is important to understand the real relationship

Table 1. The estimates of genotypic (r_g) and phenotypic (r_p) correlation coefficients for grain yield and its components on pooled basis in maize.

Characters	r	Days to 50 per cent silking	Days to 75 per cent brown husk	Plant height (cm)	Ear height (cm)	Ear length (cm)	Ear girth (cm)	Grain rows per ear	100-Grain weight (g)	Harvest index (%)	Grain yield per plant (g)
Days to 50 per cent tasseling	r_g	0.771**	0.600**	0.062^{NS}	0.045^{NS}	0.138^{NS}	0.117^{NS}	-0.082^{NS}	0.024^{NS}	0.157*	0.171*
	r_p	0.756**	0.507**	0.037^{NS}	0.008^{NS}	0.102^{NS}	0.065^{NS}	-0.039^{NS}	0.044^{NS}	0.109^{NS}	0.100^{NS}
Days to 50 per cent silking	r_g		0.704**	0.120^{NS}	0.084^{NS}	0.002^{NS}	0.032^{NS}	0.002^{NS}	0.091^{NS}	0.075^{NS}	0.236**
	r_p		0.611**	0.096^{NS}	0.059^{NS}	-0.038^{NS}	0.002^{NS}	0.030^{NS}	0.106^{NS}	0.077^{NS}	0.144*
Days to 75 per cent brown husk	r_g			0.201**	0.174*	0.151*	0.137^{NS}	0.074^{NS}	0.315**	0.021^{NS}	0.216**
	r_p			0.134^{NS}	0.108^{NS}	0.046^{NS}	0.093^{NS}	0.054^{NS}	0.231**	-0.008^{NS}	0.130^{NS}
Plant height (cm)	r_g				0.813**	0.464**	0.425**	0.376**	0.197**	0.454**	0.547**
	r_p				0.811**	0.375**	0.316**	0.288**	0.165*	0.351**	0.496**
Ear height (cm)	r_g					0.528**	0.484**	0.341**	0.181*	0.400**	0.561**
	r_p					0.388**	0.326**	0.225**	0.148*	0.285**	0.481**
Ear length (cm)	r_g						0.990**	0.326**	0.001^{NS}	0.371**	0.409**
	r_p						0.843**	0.248**	-0.049^{NS}	0.290**	0.329**
Ear girth (cm)	r_g							0.325**	-0.026^{NS}	0.446**	0.479**
	r_p							0.238**	-0.048^{NS}	0.291**	0.328**
Grain rows per ear	r_g								0.011^{NS}	0.225**	0.379**
	r_p								0.027^{NS}	0.154*	0.308**
100-Grain weight (g)	r_g									0.104^{NS}	0.196**
	r_p									0.097^{NS}	0.174*
Harvest index (%)	r_g										0.780**
	r_p										0.662**

** and ** represent level of significance at 5 and 1%, respectively r = correlation NS= Non-significant*

Table 2. The estimates of direct (diagonal values) and indirect effects for yield components towards grain yield per plant on pooled basis in maize

Characters		Days to 50 per cent tasseling	Days to 50 per cent silking	Days to 75 per cent brown husk	Plant height (cm)	Ear height (cm)	Ear length (cm)	Ear girth (cm)	Grain rows per ear	100-Grain weight (g)	Harvest index (%)	Correlation with grain yield per plant (g)
Days to 50 per cent tasseling	G	**-1.10622**	0.92871	0.01883	-0.02919	-0.00224	0.82867	-0.68774	-0.00735	-0.00268	0.22990	**0.171***
	P	**-0.05073**	0.05886	0.02876	0.00165	0.00180	-0.00003	0.00330	-0.00543	0.00270	0.05915	**0.100**^{NS}
Days to 50 per cent silking	G	-0.85320	**1.20412**	0.02208	-0.05653	-0.00417	0.01237	-0.18926	0.00017	-0.01035	0.11077	**0.236****
	P	-0.03836	**0.07785**	0.03463	0.00431	0.01311	0.00001	0.00010	0.00424	0.00646	0.04173	**0.144***
Days to 75 per cent brown husk	G	-0.66377	0.84726	**0.03137**	-0.09486	-0.00861	0.90696	-0.80367	0.00656	-0.03574	0.03035	**0.216****
	P	-0.02572	0.04754	**0.05671**	0.00602	0.02408	-0.00001	0.00471	0.00761	0.01412	-0.00458	**0.130**^{NS}
Plant height (cm)	G	-0.06836	0.14408	0.00630	**-0.47244**	-0.04034	2.79341	-2.49309	0.03354	-0.02235	0.66652	**0.547****
	P	-0.00186	0.00746	0.00758	**0.04502**	0.18104	-0.00009	0.01610	0.04051	0.01007	0.19000	**0.496****
Ear height (cm)	G	-0.05003	0.10133	0.00545	-0.38426	**-0.04959**	3.17865	-2.83776	0.03045	-0.02050	0.58750	**0.561****
	P	-0.00041	0.00457	0.00612	0.03652	**0.22316**	-0.00010	0.01659	0.03167	0.00901	0.15391	**0.481****
Ear length (cm)	G	-0.15216	0.00247	0.00472	-0.21905	-0.02617	**6.02457**	-5.79871	0.02908	-0.00017	0.54464	**0.409****
	P	-0.00517	-0.00296	0.00260	0.01688	0.08648	**-0.00025**	0.04292	0.03498	-0.00300	0.15666	**0.329****
Ear girth (cm)	G	-0.12985	0.03890	0.00430	-0.20102	-0.02402	5.96234	**-5.85923**	0.02900	0.00299	0.65542	**0.479****
	P	-0.00329	0.00015	0.00525	0.01424	0.07277	-0.00021	**0.05089**	0.03347	-0.00292	0.15745	**0.328****
Grain rows per ear	G	0.09125	0.00236	0.00231	-0.17770	-0.01694	1.96530	-1.90580	**0.08916**	-0.00121	0.33027	**0.379****
	P	0.00196	0.00234	0.00306	0.01295	0.05018	-0.00006	0.01209	**0.14082**	0.00164	0.08324	**0.308****
100-Grain weight (g)	G	-0.02615	0.11003	0.00990	-0.09323	-0.00898	0.00896	0.15489	0.00095	**-0.11328**	0.15287	**0.196****
	P	-0.00224	0.00825	0.01313	0.00744	0.03298	0.00001	-0.00243	0.00378	**0.06099**	0.05231	**0.174***
Harvest index (%)	G	-0.17323	0.09085	0.00065	-0.21449	-0.01985	2.23501	-2.61579	0.02006	-0.01180	**1.46810**	**0.780****
	P	-0.00555	0.00601	-0.00048	0.01582	0.06352	-0.00007	0.01482	0.02168	0.00590	**0.54076**	**0.662****

*Genotypic Residual=0.36841, Phenotypic Residual= 0.42797 * and ** represent level of significance at 5 and 1%, respectively G= Genotypic Path P= Phenotypic Path NS= Non-significant*

between them. Path analysis splits the correlation coefficient into the direct and indirect effects measures and provides the actual contribution of a trait on the yield. The estimates of direct and indirect effects of yield component traits on grain yield per plant at both genotypic (G) and phenotypic path (P) levels are presented in Table 2. The estimates of path analysis revealed that the harvest index had shown maximum direct effect followed by ear height, grain rows per ear, days to 50 per cent silking, 100-grain weight, days to 75 per cent brown husk, ear girth and plant height. The one phenological trait as days to 50 per cent tasseling showed negative direct effect on grain yield per plant under the study. Those traits that are not only correlated positively and significantly with grain yield but also have positive direct effects towards grain yield are likely to be useful as selection criteria in selection programmes. Considering the above criteria, the traits days to 50 per cent silking, plant height, ear height, ear girth, grain rows per ear, 100-grain weight and harvest index were found suitable as they had showed high positive and significant correlation as well as high positive direct effect towards grain yield per plant in maize. These results are found in accordance with the earlier findings of Manivannan, 1998 [10], Krishan and Natarajan, 1995 [11], Umakantha and Khan, 2001 [12], Sofi and Rather, 2007 [13], Ali et al. 2010 [14] in maize. The estimates of residual effects explain interaction pattern between other possible components of yield. The estimates of genotypic and phenotypic residual effects were found to be 0.36841 and 0.42797, respectively. It indicates the characters used in the experiment explain approximate 60 per cent of variations which may be contributed to higher yields in maize. The genetic linkage or pleiotropy effect may also be responsible for genetic correlation between different plant characters [15]. It is also observed there was a general agreement in the sign and magnitude between estimates of genotypic and phenotypic correlations. Since selection is based on phenotype, the correlation at the genetic level (genotypic correlation) alone may not be of practical value in selection.

4. CONCLUSION

In the present investigation it may be concluded that the traits ear girth, grain rows per ear, and 100-grain weight were the important yield components as they had high correlation as well as direct effects and thus selection for these traits could be considered as important selection criteria in improving yield of hybrid maize.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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