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Research Notes

Analysis of correlations and path effects for popping expansion in popcorn (*Zea mays* var. *everta* Sturt.)

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Abstract
Correlation and path analysis involving 35 genotypes of popcorn (*Zea mays* var. *everta* Sturt.) indicated that degree of popping alone exhibited positive association with popping expansion. The path analysis revealed that cob weight showed very high positive direct effect on popping expansion followed by plant height, days to maturity and days to 50% silking. Characters namely degree of popping, lesser cob length, cob girth and 100-kernel weight could be given greater emphasis while making selections for the improvement of popping expansion.

Key words: Association analysis, popping expansion, popcorn

Influence of different components on dependant character as well as among themselves is necessary for selection in breeding programme. However, genotypic correlation which provides the association for the heritable part only, shows the real picture for effective selection. Study of path coefficients enable breeders to concentrate on the character which shows high direct effect on dependant character. These studies helps the breeder to reduce the time in looking for more number of components by restricting selection to one or few important characters. Therefore, path coefficient analysis was done in order to study the direct and indirect effects of individual component characters on the dependent character popping expansion in popcorn.

The experimental materials comprised of eight lines (*viz.,* UPC 1, UPC 4, UPC 5, UPC 7, UPC 8, UPC 9, UPC 10 and UPC 11), three testers (*viz.,* Amber popcorn, Bangalore popcorn and UPC 6) and their 24 hybrids. These crosses along with parents were evaluated in Randomized Block Design (RBD) with two replications at Agricultural College and Research Institute, Madurai, during *rabi/ summer* 2007-08. Each genotype was grown in two rows of 3 m length with 60 x 30 cm spacing. Data were recorded on 10 randomly selected competitive plants from each genotype in each replication for 14 characters *viz.,* plant height (cm), days to 50% tasseling, days to 50% silking, days to maturity, harvest index (%), number of kernel rows per cob, number of kernels per row, cob length (cm), cob girth (cm), cob weight (g), 100-kernel weight (g), degree of popping (%), popping expansion (cm3/ g) and single plant yield (g). Difference between number of popped and unpopped kernels out of a random sample of 100 kernels was recorded as degree of popping. Volume of hot-air popped popcorn using mini popcorn maker was measured using 2000 mL graduated cylinder and expressed as cm3/ g. The popping method of Srinivasa Reddy *et al.* (2003) was used with slight modifications. Genotypic correlations were computed according to Panse and Sukhatme (1964). Genotypic correlations were used to perform the path analysis on popping expansion as suggested by Dewey and Lu (1959).

Genotypic correlation coefficients of fourteen characters were presented in Table 1. Degree of popping alone exhibited positive association (0.340) with popping expansion. Earlier study also indicated that degree of popping as one of the important quality character (Srinivasa Reddy *et al.*, 2003). Cob

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girth (0.596) and cob length (0.317) exhibited significant negative correlation with popping expansion. However, non-significant association of popping expansion with cob length and cob girth was reported by Sharma and Kumar (1987). The association of 100-kernel weight with popping expansion was significantly negative (-0.549), which is in conformity with the findings of Valéria Carpentieri-Pípolo *et al.* (2003). Ceylan and Karababa (2002) stated that the smallest sized kernel gave the highest expansion volume. Song *et al.* (1991) and Allred-Coyle *et al.* (2002) reported that middle sized kernels had the highest expansion volume. But, large sized kernels generally give lower popping volume than small kernels, because they contain a high percentage of soft endosperm (Pajic and Babic, 1991). Dofing *et al.* (1990) and Gökmen (2004) reported that large kernel samples had large flake size than small kernel samples, and higher expansion. The inconsistency in the relationship of 100-kernel weight with popping expansion could possibly describe to variations in kernel size (Souza Júnior *et al.*, 1985) and the environmental effects (Li *et al.*, 2003) and popping methods (Dofing *et al.*, 1990). Correlation between popping expansion and single plant yield was non-significant. This is accordance with the findings of Dofing *et al.* (1991); Sawazaki, (1996); Valéria Carpentieri-Pípolo *et al.* (2003) and Freddy Mora and Carlos Alberto Scapim, (2007).

The estimate of correlation coefficient indicated relationship between the characters but did not furnish information on cause and effect. Path analysis helps the breeder in identifying the ideal selection index. The results of path coefficients were furnished in Table 2. Cob weight showed very high positive direct effect on popping expansion (4.650) even though the correlation study showed non-significant association characters *viz.,* plant height (0.391) and 50% silking (0.714) showed high positive direct effect on popping expansion. Number of kernels per row and cob length which indicated significant negative correlations showed directly and indirectly negative effect with popping expansion. Other characters like cob girth and single plant yield exhibited very high direct effect; days to 50% tasseling, number of kernel rows per cob and 100-kernel weight showed negative high direct effect on popping expansion. Similar results of direct negative influence on popping expansion exhibited by cob girth number of kernels per row and single plant yield were reported by Srinivasa Reddy *et al.* (2003). 100-kernel weight showed high negative direct effect on popping expansion.

Cob weight showed positive high indirect effect through degree of popping. Degree of popping had significant positive association with popping expansion, whereas cob length, cob girth and 100-kernel weight showed significant negative association. Thus, selection for the improvement of popping expansion can be efficient, if it is based on degree of popping, lesser cob length, cob girth and 100-kernel weight. Ultimately it could be concluded that degree of popping, lesser cob length, cob girth and 100-kernel weight could be given importance during selection for the improvement of popping expansion.

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Table 1. Genotypic correlation coefficients of yield and quality characters with popping expansion

	DFT	DFS	DM	HI	NRC	NKR	CL	CG	CW	HKW	DP	SPY	PE
PH	-0.163	-0.118	-0.091	-0.113	0.524**	0.388**	0.415**	0.421**	0.546**	0.333**	0.141	0.548**	**-0.028**
DFT		0.973**	1.184**	-0.191	-0.026	0.228	0.122	-0.187	-0.140	-0.225	0.193	-0.158	**0.213**
DFS			1.226**	-0.158	-0.036	0.300*	0.215	-0.123	-0.098	-0.173	0.190	-0.124	**0.216**
DM				0.001	-0.116	0.403**	0.261	0.074	0.173	0.107	0.064	0.155	**0.154**
HI					0.317*	0.519**	0.296*	0.562**	0.607**	0.227	-0.040	0.605**	**-0.243**
NRC						0.431**	0.296*	0.607**	0.611**	0.045	0.129	0.572**	**-0.181**
NKR							0.683**	0.637**	0.718**	0.348**	0.147	0.682**	**-0.253**
CL								0.640**	0.655**	0.574**	0.008	0.605**	**-0.317***
CG									0.828**	0.723**	-0.021	0.794**	**-0.596****
CW										0.607**	0.153	0.989**	**-0.234**
HKW											0.052	0.606**	**-0.549****
DP												0.085	**0.340****
SPY													**-0.249**

*, ** Significant at 5% and 1% respectively

PH: Plant height (cm); DFT: Days to 50% tasseling; DFS: Days to 50% silking; DM: Days to maturity; HI: Harvest index; NRC: Number of kernel rows per cob; NKR: Number of Kernels per row; CL: Cob length (cm); CG: Cob girth (cm); CW: Cob weight (g); HKW: 100-kernel weight (g); DP: Degree of popping (%); PE: Popping expansion (cc/ g) and SPY: Single plant yield (g)

Table 2. Direct and indirect effects for yield and quality characters on popping expansion

	PH	DFT	DFS	DM	HI	NRC	NKR	CL	CG	CW	HKW	DP	SPY	PE
PH	**0.391**	0.114	-0.084	-0.021	-0.019	-0.160	-0.178	-0.125	-0.442	2.537	-0.128	-0.004	-1.909	**-0.028**
DFT	-0.064	**-0.701**	0.694	0.271	-0.031	0.008	-0.104	-0.037	0.196	-0.649	0.086	-0.006	0.550	**0.213**
DFS	-0.046	-0.682	**0.714**	0.280	-0.026	0.011	-0.137	-0.065	0.129	-0.454	0.066	-0.005	0.431	**0.216**
DM	-0.036	-0.830	0.875	**0.228**	0.000	0.036	-0.185	-0.079	-0.078	0.805	-0.041	-0.002	-0.539	**0.154**
HI	-0.044	0.134	-0.113	0.000	**0.164**	-0.097	-0.238	-0.089	-0.589	2.822	-0.087	0.001	-2.107	**-0.243**
NRC	0.205	0.018	-0.026	-0.027	0.052	**-0.306**	-0.197	-0.089	-0.636	2.839	-0.017	-0.004	-1.993	**-0.181**
NKR	0.152	-0.160	0.214	0.092	0.085	-0.132	**-0.458**	-0.206	-0.668	3.339	-0.133	-0.004	-2.374	**-0.253**
CL	0.162	-0.085	0.154	0.060	0.049	-0.091	-0.313	**-0.302**	-0.671	3.047	-0.220	0.000	-2.107	**-0.317***
CG	0.165	0.131	-0.088	0.017	0.092	-0.186	-0.292	-0.193	**-1.048**	3.848	-0.277	0.001	-2.766	**-0.596****
CW	0.213	0.098	-0.070	0.040	0.100	-0.187	-0.329	-0.198	-0.867	**4.650**	-0.233	-0.004	-3.447	**-0.234**
HKW	0.130	0.158	-0.124	0.025	0.037	-0.014	-0.159	-0.173	-0.758	2.824	**-0.383**	-0.001	-2.111	**-0.549****
DP	0.055	-0.135	0.135	0.015	-0.007	-0.039	-0.067	-0.003	0.022	0.711	-0.020	**-0.029**	-0.298	**0.340****
SPY	0.214	0.111	-0.088	0.035	0.099	-0.175	-0.312	-0.183	-0.832	4.600	-0.232	-0.002	**-3.484**	**-0.249**

*, ** Significant at 5% and 1% respectively

Residual effect: 0.372 Values on main diagonal denote direct effect