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Studies on Character Association in Winter Maize under Normal and Excess Soil Moisture (ESM) Conditions

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ABSTRACT

A set of forty-five genotypes including five parents, their $F_{1's}$, $F_{2's}$ and backcross generation of maize differing in their reaction to ESM conditions were used for estimating inter-character correlations between different morphological traits, planted during winter season. The knowledge of the relationships among various traits affecting grain yield is imperative to arrive at potentially affecting selection index because the efficacy of selection process is greatly enhanced by using appropriate selection indices Estimates of genotypic correlation coefficient were generally higher than phenotypic correlations coefficients in the both environments.

Key words: Correlation, maize

The ultimate aim of a breeding programme is to evolve superior genotypes by exploiting the available genetic variability from the broad array of breeding material. Crop yield is a complex character governed by several interacting intrinsic and extrinsic factors. Most of the yield components are less complex, simply inherited and less influenced by the environmental deviations. Therefore, Grafius (1956) suggested that selection based on component characters is more effective than on yield per se. The

appropriate knowledge of such interrelationships between grain yield and its contributing components can significantly improve the efficiency of breeding programmes through the use of appropriate selection indices (Mohammadia *et al.*, 2003). To end up with superior genotypes, the knowledge of interrelationship of yield and yield related traits in a particular situation is a prerequisite. The extent of relationship between the important traits in given conditions can be studied by correlation coefficients and will aid in developing suitable selection criterion in order to choose suitable breeding procedure for developing cultivars suitable for wide range of environments. The excess soil moisture (ESM) is becoming threat to maize crop as 15 per cent of the total maize growing area is affected by floods and waterlogging problem in south-East Asia alone. In India about 25-30 per cent loss of maize production occurs every year because of ESM stress (DMR, 2001).

MATERIALS AND METHODS

The experimental materials consisted of forty five genotypes of maize which included five parents (three tolerant and two susceptible), their $F_{1's}$, $F_{2's}$ and backcrosses, grown during *Rabi* 2005-06 at Crop Research Centre of G.B. Pant University of Agriculture and Technology, Pantnagar in randomized block design with three replications. The experiments were laid down in two sets (one under normal and the other under Excess Soil Moisture (ESM) conditions). Experimental material was sown in two row plots of 5 meter length with row to row spacing of 75 cm and plant to plant distance of 25 cm. In ESM trial, waterlogging treatment was given at knee high growth stage for 6 days, by keeping continuous submergence with an average depth of ponding of about 5 cm. After 6 days of ponding, water was drained out of the plots. Observations were

recorded on days to 50 per cent tasseling, days to 50 per cent silking, Anthesis Silking Interval (ASI), plant height, ear height, cob length, cob diameter, leaf temperature, SPAD value, Transpiration rate and Photosynthetically Active Radiation (PAR) for evaluation of genotypes for intercharacter relationship.

The correlations between all possible pairs of characters under study, at genotypic, phenotypic and environmental levels were worked out from the analysis of variance and covariance as suggested by Searle (1961).

RESULTS AND DISCUSSION

In the present investigation, character correlation coefficients estimated under normal and ESM trials of winter maize are presented in the Tables 1 and 2 respectively. The interpretation of results of character association among different morphological traits revealed interesting correlations among different traits particularly under Excess Soil Moisture (ESM) conditions. Under both sets of conditions, days to 50 per cent tasseling and days to 50 per cent silking were positively and significantly correlated with were each other both sets of conditions. An interesting correlation observed between Anthesis Silking Interval (ASI) and nodes bearing adventitious roots, as they were negatively and significantly correlated under ESM condition at both genotypic (r_g=-0.409) and phenotypic level (r_p=-0.250). This correlation under ESM conditions had practical implications as wider ASI is indication of susceptibility to ESM conditions and further lower number nodes bearing adventitious roots will add to the problem. It was noteworthy that under ESM conditions ASI and yield were negatively and significantly correlated with each other at both genotypic (r_g =-0.175) and phenotypic level (r_p=-0.116) which is in conformation to the findings of Zaidi *et al* (2003) and Ajaz and Warsi (2006).

Yield and 100 kernel weight were positively correlated under both normal (r_g = 0.237) and ESM conditions (r_g=0.322). Under ESM conditions yield and nodes bearing adventitious roots were having positive correlation at both genotypic (r_g=0.190) and phenotypic level (r_p=0.130), the same findings were also observed by Rathore *et al* (1996) and Zaidi and Singh (2001). Increased number of nodes bearing adventitious roots assists in avoiding lodging of plants under ESM conditions which in turn results in increasing the overall yields (Zaidi *et al* 2002). Yield under both normal and ESM conditions was found to be positively correlated to SPAD values at both genotypic and phenotypic level. As higher SPAD values revealed more greenness of leaves which in turn contributes in net photosynthetic rates and subsequently higher yields. Also yield was found to be positively correlated to cob length and cob diameter under both sets of conditions. Under ESM conditions yield and transpirations rates were positively correlated (r_g=0.179). It was observed that under ESM conditions transpiration rates got reduced, so higher yields coupled with high transpiration rates was evident. Plant height was positively correlated to yield under both normal (r_g =0.606) and ESM condition (r_g = 0.267) whish are in confirmation to the findings of Lizaso and Riche (1997) and Ajaz and Warsi (2006).

Generally, correlation coefficients at genotypic levels were similar in direction but of higher magnitude than phenotypic correlation coefficient for most of the intercharacter associations. This suggested the preponderance of environmental factors which might have suppressed the expression of character association at phenotypic level.

In any breeding programme directed to improve the yield under ESM conditions it is necessary to conduct experiments under both the conditions as selection for yield under

stress is much less efficient than under non-stress conditions (Blum, 1988). Further due importance is to be given to the growth parameters like ASI, nodes bearing adventitious roots and there interrelationships to the yield.

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Table 1: Genotypic, phenotypic and environmental correlation coefficients among different characters under normal conditions in winter maize

Character		Days to 50% silking	ASI	Plant height	Ear height	Nodes bearing adventitious roots	*Yield*	100 kernel weight	Cob length	Cob diameter	Leaf temperature	SPAD value	Transpiration rate	PAR
Days to 50% tasseling	G	0.855**	-0.260	0.224	-0.217	0.140	0.080	0.142	2.611	0.539**	-0.192	-0.058	-0.251	-0.146
	P	0.742**	-0.193	-0.119	-0.131	0.009	0.055	0.066	0.080	-0.089	-0.049	-0.037	-0.170	-0.084
	E	0.675**	-0.169	-0.260	-0.101	-0.176	0.044	-0.074	-0.179	-0.237	-0.032	-0.019	-0.093	0.043
Days to 50% silking	G		0.245	0.392**	-0.112	-0084	0.174	0.147	2.414	0.384**	0.209	-0.220	-0.193	-0.068
	P		0.474**	-0.049	-0.142	-0.107	0.075	0.104	0.107	-0.141	-0.118	-0.118	-0.194	-0.045
	E		0.577**	-0.224	-0.157	-0.163	-0.194	0.803	-0.117	-0.263	-0.185	0.110	-0.238	-0.038
ASI	G			0.419**	0.218	-0.410**	0.324**	-0.070	0.182	-0.307*	0.962*	-0.259	0.048	0.110
	P			0.081	-0.013	-0.193	0.099*	0.015*	0.044**	-0.052	-0.076	-0.076	-0.067	0.046
	E			-0.012	-0.075	-0.053	-0.016	0.178	0.037	-0.002	-0.194	0.115	-0.204	-0.16
Plant height	G				0.558**	0.012	0.606**	0.462**	1.968	0.426**	1.263	0.103	-0.354*	-0.219
	P				0.499**	0.047	0.274	0.196	0.154	0.135*	0.198	0.066	-0.096	-0.098
	E				0.484**	0.098	0.007	-0024	0.035	0.072	0.093	0.130	0.107	0.015
Ear height	G					0.176	0.289	0.171	1.323	-0.370*	0.678**	-0.052	-0.209	0.120
	P					0.108	0.167	0.130	.180	0.217	0.142	-0.015	-0.096	0.028
	E					0.091	0.231	0.214	0.112	0.290	0.092	0.055	-0.033	0.187
Nodes bearing adventitious roots	G						-0.173	0.073	-0.717**	0.225	1.033	0.216	-0.382**	-0.209
	P						-0.146	0.046	-0.086*	0.066	0.069	0.191	-0.321**	-0.192
	E						0.032	-0.106	-0.001	-0.005	-0.246	0.051	-0.118	-0.169
Yield	G							0.237	0.680**	0.286	0.672**	0.246	0.006	-0.081
	P							0.222	0.114**	0.129	0.185	0.236	-0.006	-0.078
	E							0.003	0.123	0.160	0.277	-0.062	-0.121	0.013
100 kernel weight	G								0.489**	0.339*	0.234	0.186	0.081	-0.118
	P								0.125	0.134	0.049	0.182	0.077	-0.108
	E								0.209	0.069	0.014	0.128	0.061	0.105
Cob length	G									-1.339	-1.672	-0.583**	-0.590**	-0.417**
	P									0.287	-0.005	-0.097	-0.53	-0.075
	E									0.333*	0.042	-0.113	0.036	-0.143
Cob diameter	G										-0.224	-0.039	0.180	-0.109
	P										-0.046	0.006	-0.034	-0.021
	E										-0.029	0.109	-0.173	0.113
Leaf temperature	G											0.638**	-0.725**	0.080
	P											0.099	-0.109	0.055
	E											-0.177	0.041	0.293
SPAD value	G												-0.147	-0.022
	P												-0.128	-0.018
	E												-0.008	0.172
Transpiration rate	G													0.016
	P													0.013
	E													-0.007

* and ** denotes significance at 5 and 1 per cent level of significance

Table 2: Genotypic, phenotypic and environmental correlation coefficients among different characters in winter maize under ESM conditions

Character		Days to 50% silking	ASI	Plant height	Ear height	Nodes bearing adventitious roots	Yield	100 kernel weight	Cob length	Cob diameter	Leaf temperature	SPAD value	Transpiration rate	PAR
Days to 50% tasseling	G	0.427**	-0.318*	0.005	0.162	0.258	0.036	0.098	-0.119	-0.278	-0.626**	0.109	-0.070	0.090
	P	0.330*	-0.435**	-0.022	0.031	0.111	0.021	0.057	-0.126	-0.282	-0.333*	0.077	-0.049	0.057
	E	0.171	-0.619**	-0.098	-0.226	-0.176	0.128	-0.104	-0.196	-0.287	-0.377*	0.014	-0.016	-0.044
Days to 50% silking	G		0.725**	0.133	-0.095	-0.263	0.183	0.275	0.042	-0.089	0.235	0.099	0.250	0.112
	P		0.657**	0.117	-0.101	-0.196	0.134	0.229	-0.011	-0.048	-0.091	0.071	0.182	0.116
	E		0.507**	0.050	-0.118	0.015	-0.008	-0.028	-0.272	0.034	-0.256	-0.32	-0.006	0.173
ASI	G			0.150	-0.213	-0.409**	0.175**	0.225	0.143	0.190	0.601**	-0.055	0.356**	0.055
	P			0.152	-0.125	-0.250*	0.116**	0.183	0.107	0.195	0.142	-0.044	0.236	0.041
	E			0.180	0.089	0.151	-0.22	0.381	-0.013	0.205	0.096	-0.015	-0.030	-0.011
Plant height	G				0.589**	-0.035	0.269	0.569**	0.388**	0.504**	-0249	-0.043	-0.095	0.046
	P				0.542**	-0.010	0.272	0.509**	0.361*	0.340*	-0.165	-0.058	-0.069	0.033
	E				0.357*	0.105	0.302*	-0.074	0.174	-0067	-0.329*	-0.139	0.031	-0.082
Ear height	G					0.102	0.134	0.284	0.231	0430**	-0.616**	-0.181	-0.193	0.116
	P					0.107	0.096	0.232	0.214	0.296*	-0.116	-0.143	-0.098	0.072
	E					-0.081	-0.018	-0.115	0.140	0.026	-0.043	0.004	0.180	-0.211
Nodes bearing adventitious roots	G						0.190	-0.009	-0.303*	0.019	-0.966**	0.159	-0.338*	-0.079
	P						0.130	0.007	-0.226*	0.028	-0.209	-0.153	-0.286	-0.081
	E						0.060	0.164	0.179	0.053	-0.124	-0.129	-0.133	-0.112
Yield	G							0.322*	0.236	0.186	-0.146	0.203	0.179	-0.046
	P							0.279*	0.206	0.114	-0.149	0.117	0.158	-0.059
	E							0.081	0.083	-0.026	-0.254	-0.202	0.097	-0.165
100 kernel weight	G								0.186	0.367*	0.193	-0.049	-0.103	0.085
	P								0.156	0.248	0.053	-0.046	-0.087	0.077
	E								-0.249	-0.211	0.098	-0.034	-0.015	-0.069
Cob length	G									0.528**	0.257	-0.028	0.004	0.023
	P									0.419**	0.0009	-0.013	-0.008	0.020
	E									0.179	-0.105	0.084	-0.064	-0.008
Cob diameter	G										-0.618**	-0.324*	0.238	-0.025
	P										0.087	-0.229	0.145	-0.023
	E										0.270	-0.011	-0.031	-0.026
Leaf temperature	G											-0.312*	0.488**	-1.466
	P											-0.030	0.062	-0.250
	E											-0.049	-0.023	0.006
SPAD value	G												0.030	-0.102
	P												0.024	-0.095
	E												0.001	-0.049
Transpiration rate	G													-0.107
	P													-0.083
	E													0.043

* and ** denotes significance at 5 and 1 per cent level of significance