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Relationship of Some Morpho-physiological Traits with Grain Yield in Maize

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Abstract
Maize is sensitive to drought and suffers a serious setback in yield due to high temperature stress. There is need to evaluate maize inbred lines, which are resistant to drought conditions. Ten maize inbred lines namely MO-17, DK-656, IZI-7103, SYP-31, AYP-17, H-93, B-73, A-6660, IZI-4001 and KLI-2301 were exposed to water stress in drought chamber. Genotypic and phenotypic correlation coefficients of various plant morpho-physiological traits with grain yield were ascertained. Survival rate treat-II, root-shoot ratio, stomatal frequency and photosynthetically active rations showed significant correlation at genotypic level with grain yield. The study emphasized that these morpho-physiological traits have underlying genetic basis. Once these basis are understood precisely, breeders will be able to tailor maize varieties with better yield potential.

Introduction
Maize being C_4 plant has an efficient energy capturing system and is capable of rapid growth. Being a short duration crop, it has attained top priority in hilly areas where snowfall and chilling conditions limit the growing period of other cereals. With the possibility of raising two crops in a year, it could contribute significantly to overall food production programme of the country.

The adaptation of a particular genotype to a particular environment is determined by its response to effects of heat, cold, drought and soil nutrients. The plant breeder in collaboration with plant physiologist strives to make inherent modifications in plant physiological processes so as to enable them function more efficiently. In this connection various worker like Sen and Misra (1981), Dai *et al*. (1990), Metha and Sarkar (1991) and Ali (1994) have tried to establish relationship among different plant traits and grain yield. Koscielniak and Dubert (1985) discussed the significance of seedling traits in predicting grain yield in maize breeding programmes.

The main objective of the present study was to determine the extent and nature of correlation between various maize plant morpho-physiological traits under drought conditions. The information derived from this study will be helpful in tailoring maize genotypes with better photosynthetic ability and efficiency to survive under drought conditions.

Materials and Methods
The experimental material comprised of ten elite maize inbred lines viz., MO-17, DK-656, IZI-7103, SYP-31, AYP-17, H-93, B-73, A-6660, IZI-4001 and KLI-2301. The experiment was conducted both in the drought chamber and in the experimental area of the department of Plant Breeding and Genetics, University of Agriculture, Faisalabad, during 1994-95. The inbred lines were grown in drought chamber during Oct. 1994. Polythene bags (18 x 9 cm) were filled with fresh river sand washed distilled water to make it free form nutrients. One seed of each inbred line was sown in each bag at a uniform depth of 3 cm. A completely randomized design with three replications was followed. Each replication consisted of ten seedlings of each inbred line. At three-leaf stage, the seedlings were placed in drought chamber. The soil moisture was replenished to the desired level by weighing the individual bag and restoring the deficit if any by adding water. The combinations of drought components (temperature, relative humidity and soil moisture) were used as follows.

Treatments	Temp. (°C)	Moisture (% FC)	Humidity (%)
I	48	25	12
II	48	25	50-70
III	48	50	12
IV	48	50	60-70

FC = Field capacity

When there was 50 percent mortality, survived seedlings were taken out from drought chamber and Hogland's solution was applied to the seedlings and their survival rate counted after 15 days. The number of survived seedlings was counted in each replication. The survival rate was calculated as,

$$\frac{\text{Seedlings Survived after 15 days}}{\text{Total Number of Seedlings}}\times 100$$

Five seedlings of each inbred line from each treatment were chosen which survived drought shock. Polythene bags were carefully torn off, seedlings were shaken gently to shed off the sand, washed under tap water taking care that their shoots and roots were not damaged. Fresh roots and shoots were placed in kraft paper bags at 60°C in an electronic oven till they became dry. Thereafter, samples were weighed in milligrams using an electronic balance. Root-shoot ratio was determined as:

$$\frac{\text{Dry root weight (mg)}}{\text{Shoot shoot weight (mg)}}$$

The ten maize inbred lines were also grown in the field during Feb. -March, 1995 following a triplicated randomized complete block design. The stomata! frequency counts per unit area were made on the upper surface of the leaf under high power (40 x) microscopic field. The leaf venation samples were examined under low power (10 x) of microscope for counting the number of parallel veins of selected plant's leaf. Water potential of the selected plants was measured with the help of gas pressure chamber. The relative water contents was measured as:

$$\frac{\text{Fresh weight - dry weight}}{\text{Turgid weight - dry weight}} \times 100$$

Hydrophilic colloids were estimated indirectly by the leaf powder method. Transpiration rate, photo-synthetically active radiation (PAR) and net photosynthesis were measured with the help of infra-red gas analyzer (Irga) Medell LCA-3 using Parkinson leaf chamber. Correlation coefficient among these traits were calculated according to Kwon and Torrie (1964).

Results and Discussion

The values of genotypic (rg) and phenotypic (rp) correlation coefficients among various morpho-physiological traits are given in Table 1. Survival rate treat-I showed significant and positive correlation both at genotypic and phenotypic level with survival rate treat-II, III and IV. Its association with root-shoot ratio, leaf venation and relative water content was also significant and positive but only at genotypic level. Positive association between survival rate and root-shoot ratio is in an agreement with Dai *et al*. (1990). Survival rate treat-I, III and IV were negatively associated with grain yield per plant. However, survival rate treat-II showed positive correlation with grain yield and also with survival rate III, IV and root-shoot ratio, relative water contents and PAR (Photosynthetically active ration). Survival rate treat-III exhibited significant correlation for survival rate treat-IV, leaf venation, water potential, relative water content (RWC) and PAR. The results get support from the findings of Oregan *et al*. (1993). There existed a strong positive correlation between survival rate treat-IV and root-shoot ratio, RWC and PAR. Root-shoot ratio shared negative association with most of the traits, however, a significantly positive genotypic correlation was borne between root-shoot ratio and PAR and grain yield per plant. A significantly positive association of stomatal frequency with hydrophilic colloids, net photosynthesis and grain yield per plant was also observed. Earlier Sen and Misra (1981) and Shah (1996) observed positive association between stomata! frequency and grain yield in wheat. Leaf venation showed significant association with water potential only, while, its relationship with grain yield was negative. Transpiration rate did not show any prominent association with the remaining traits except PAR. Water potential was positively associated with RWC and PAR, whereas it was negatively correlated with grain yield per plant. RWC was positive only with PAR. Similarly hydrophilic colloids were significantly correlated only with the photosynthesis. The negative and non-significant association between grain yield and hydrophilic colloids is in agreement with Ali (1994). PAR was significantly and positively correlated at genotypic level with net photosynthesis and grain yield per plant. A positive association between photosynthesis and yield per plant is evident from Metha and Sarkar (1991).

From the present study it is concluded that all the plant morpho-physiological traits have genetic basis which could be improved through breeding. Root-shoot ratio, stomatal frequency and PAR should be given due consideration for improving grain yield in maize.

References

Ali, A., 1994. Evaluation for stress related traits in *Aestivum* spp. M.Sc. Thesis, Department of Plant Breeding and Genetics, University of Agriculture, Faisalabad, Pakistan.

Dai, J.Y., W.L. Gu, X.Y. Shen, B. Zheng, H. Qi and S.F. Cai, 1990. Effect of drought on the development and yield of maize at different growth stages. J. Shenyang Agric. Univ., 21: 181-185.

Koscielniak, J. and F. Dubert, 1985. Physiological indices of productivity of various breeding lines of maize. III. Correlations between simple morphological features of seedlings and final yield of grain and dry matter under natural conditions of vegetative growth. Acta Agraria Silvestria Agraria, 24: 35-48.

Kwon, S.H. and J.H. Torrie, 1964. Heritability of and interrelationships among traits of two soybean populations. Crop Sci., 4: 196-198.

Metha, H. and K.R. Sarkar, 1991. Heterosis for leaf photosynthesis, grain yield and its components in maize. Euphytica, 61: 161-168.

Oregan, B.P., W.A. Cress and J. Staden, 1993. Root growth, water relation of drought resistant and drought sensitive maize cultivars in response to water stress. South Afr. J. Bot., 59: 98-104.

Sen, A. and N.M. Misra, 1981. Correlation-coefficient between yield and some drought tolerance capacity measuring parameters in Kalyan Sona wheat. Food Farm. Agric., 14: 1-2.

Shah, S.A.H., 1996. Association analysis in hexaploid spring wheat under stress condition. M.Sc. Thesis, University of Agriculture, Faisalabad.

Table 1: Values of genotypic (r_g) and phenotypic (r_p) correlation coefficients among different characters of maize

Traits		Survival rate treat. II	Survival rate treat.III	Survival rate treat.IV	Root-shoot ratio	Stomatal frequency	Leaf venation	Transpiration rate	Water potential	Relative water	Hydrophilic colloids	Photosynth active	Net Photosynth	Yield per plant
Survival rate	r_g	0.282*	0.63*	0.899*	0.278*	-0.203*	0.346*	-0.777*	0.190	0.276*	-0.143	-0.122*	-0.602*	-0.119*
Treat. I	r_p	0.828**	0.63"	0.899"	0.275	-0.181	0.286	-0.684**	0.179	0.272	-0.143	-0.113	-0.434**	-0.166
Survival rate	r_g		0.634*	0.083*	0.360*	-0.597*	-0.153*	-0.654*	0.177	0.542*	-0.326*	0.256*	-0.571*	0.190*
Treat. II	r_p		0.634*	0.083	0.357	-0.533**	-0.127	-0.576**	0.161	0.535**	-0.326	0.236	-0.411	0.185
Survival rate	r_g			0.788*	-0.005	-0.463*	0.409	-0.232	0.557*	0.589*	-0.329*	0.021*	-0.926*	-0.289*
Treat. III	r_p			0.788**	-0.004	-0.412**	0.337	-0.204	0.506**	0.581**	0.329	0.018	-0.666**	-0.281
Survival rate	r_g				0.341*	-0.478*	-0.537*	-0.417*	0.392	0.317*	-0.366*	0.195*	-0.865*	-0.220*
Treat. IV	r_p				0.377	-0.428**	-0.442**	0.366**	0.356	0.313	-0.366**	0.18	-0.621	-0.214
Root-shoot	r_g					-0.340	0.223	-0.214	-0.597	-0.473*	-0.570	0.280*	-0.429	0.200*
Ratio	r_p					-0.311	0.333	-0.164	-0.536**	-0.468**	-0.564**	0.237	-0.3	0.19
Stomatal	r_g							0.331	-0.330	-0.402	0.422	-0.704	0.718	0.107*
frequency	r_p							0.279	-0.399	-0.332	0.380**	-0.604**	0.441**	0.112
Leaf	r_g							0.066	0.980*	-0.021	0.404	-0.252*	-0.188	-0.692*
Venation	r_p							0.053	0.598**	0.014	0.336	-0.164	-0.078	0.623**
Transp.	r_g								0.130	-0.282	-0.204	0.331*	0.25	0.094
Ratio	r_p								0.207	-0.254	-0.18	0.356	0.042	0.098
Water	r_g									0.671*	0.393	0.416*	-0.106	-0.657*
Potential	r_p									0.595**	0.356	0.378	-0.138	0.610**
Rel. Water	r_g										-0.067	0.263*	-0.184	-0.020
Contents	r_p										-0.065	0.235	-0.16	-0.026
Hydrophilic	r_g											-0.205*	0.882	-0.314
Colloids	r_p											-0.195	0.632**	-0.305
Photosynth	r_g												0.175*	0.173*
Active Rad.	r_p												0.012	0.116
Net	r_g													0.115
Photosynth.	r_p													0.068

*Significant; **Highly significant