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Correlation and Path Analysis for Seed Yield in Sunflower (*Helianthus annuus* L.) under Charcoal Rot (*Macrophomina phaseolina*) Stress Conditions

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ABSTARCT

One hundred and four (104) sunflower genotypes were analyzed for correlations between several yield components on one hand and seed yield on the other under charcoal rot (*Macrophmina phaseolina*) stress conditions. The genetic correlations of stem girth, head diameter, 100-achene weight, number of seeds per head and stem girth length ratio was positive and significant with sunflower seed yield. Path analysis showed that direct selection of traits like number of seeds per head and 100-achene weight can improve seed yield.

Key Words: Sunflower; Genotypic correlation; Path analysis; *Macrophmina phaseolina;* Stem girth; Head diameter and seed yield

INTRODUCTION

Sunflower is a rich source of edible oil. It has a nice fit in the cropping in Pakistan. It has the ability to meet domestic needs of the country. Sunflower diseases especially head rot followed by charcoal rot are the serious threat to sunflower growers in the country (Mehdi & Mehdi, 1988; Khan *et al*., 1999). The present studies were planned to work out the genotypic and phenotypic correlation coefficient for different agronomic plant traits of 104 sunflower genotypes under charcoal rot (*Macrophomina phaseolina*) stress conditions. Correlation coefficient analysis measures the mutual relationship between various plant characters and determines the component characters on which selection can be based for improvement of seed yield.

It was further planned to estimate the direct and indirect effects of each component character on seed yield through path analysis. Wright (1921) originally developed the concept of path analysis but Dewey and Lu (1959) first used the technique for plant selection in 1959. Path analysis is simply standardized partial regression coefficient, which splits the correlation coefficients into the measures of direct and indirect effects of set of independent variables on the dependent variable.

The basic goal in breeding of oil type sunflower is the increase in oil yield per unit area. Oil yield is the function of seed yield and oil content. Seed yield is combination of many traits, which are polygenic in nature and it is difficult to make direct selection for these traits. Therefore, indirect selection through associated component traits is possible to improve the yield. Sunflower breeders reported different types of character-associations (Punia & Gill, 1994; Patil *et al*., 1996; Lal *et al*., 1997; Teklewold *et al*., 2000; Ashok *et al*., 2000; Khan, 2001). The objective of the study was to expose the selection method for improving sunflower seed yield under charcoal rot stress conditions.

MATERIAL AND METHODS

The experiment consisted of 104 sunflower genotypes including 14 lines, 6 testers and their 84 cross combinations. The study was conducted at Oilseeds Research Institute, AARI, Faisalabad, Pakistan, during Spring 2001. The F_0 seed of 84 crosses along with their 20 parents were planted in a randomized complete block design with two replications. The experimental unit consisted of single row plot of 4.6 m length with plant to plant and row to row distances of 23 and 60 cm, respectively.

Macrophomina phaseolina inoculum was produced on sterile toothpicks in pathological laboratory of Oilseeds Research Institute, Faisalabad. Ten randomly selected plants from each plot of the experiment were inoculated during flowering by inserting toothpick inoculum into the third internode of each plant through a hole made with an iron needle (Anahosour, 1983). The bit of the needle was surface sterilized with alcohol each time before making the hole. All other precautions were taken at the time of inoculation.

All other standard agronomic practices were applied to the crop. The data were recorded on ten randomly selected plants of each entry from each replication for stem girth, head diameter, 100-achene weight, number of seeds per head, stem girth length ratio and seed yield. The data collected for above mentioned characters were statistically analyzed for variance and covariance using the method given by Steel and Torrie (1980). Phenotypic and genotypic correlation coefficients were calculated utilizing the procedure described by Kown and Torrie (1964). Path coefficient analysis was studied according to method explained by the Dewey and Lu (1959). This model was extensively used by sunflower researchers (Ivanov & Stoyanova, 1980; Lakshimanrao *et al*., 1985; Marinkovic, 1992; Punia & Gill, 1994). Seed yield was kept as resultant variable and other characters as casual variables.

RESULTS AND DISCUSSION

Analysis of variance indicated highly significant differences in sunflower genotypes for all the traits under study (Table I).

Estimates of genotypic and phenotypic correlation coefficients among the component traits and sunflower seed yield under *Macrophomina phaseolina* stress conditions are presented in Table II.

Stem girth was significantly and positively correlated head diameter, 100-achene weight, number of seeds per head and seed yield. Patil *et al*. (1996) and Lal *et al*. (1997) reported positive and significant correlation of stem girth and sunflower seed yield.

The positive and significant genetic correlation was observed between head diameter and seed yield. Head diameter also showed significant and positive genetic correlation with 100-achene weight and number of seeds per head. Hundred achene's weight displayed positive and significant genotypic and phenotypic correlation with number of seeds per head and seed yield. These results are in agreement with the findings of Vanisree *et al*. (1988), Lal *et al*. (1996) and Teklewold *et al*. (2000).

The genotypic and phenotypic correlations of number of seeds per head and all other studied plant traits were positive and significant. Patil *et al*. (1996) also reported similar results. Stem girth length ratio showed positive and significant genetic association with seed yield.

To determine the relative importance of the characters the data were subjected to path analysis. It permits the separation of correlation coefficient with components of direct and indirect effects. The results pertaining to direct and indirect effects of components characters on sunflower seed yield under charcoal rot (*Macrophomina phaseolina*) stress conditions are presented in Table III. In 104 sunflower genotypes direct effects on seed yield were maximum for number of seeds per head followed by 100-achene weight.

It is evident from the Table III that the direct contribution of stem girth towards seed yield is negative (-0.008). The indirect effects of stem girth via head diameter and stem girth length ratio were also negative. However its indirect effects via 100-achene weight and number of seeds per head were negative. Niranjan and Shambulingappa (1989) reported that seed yield could be improved by increasing stem circumference.

The genotypic correlation coefficient between head diameter and seed yield was significantly positive. The direct effect of head diameter on seed yield was negative (-0.078). The indirect effects of head diameter via 100-achene weight and number of seeds per head were negative. The under direct effects of 100-achene weight was positive

Table I. Analysis of variance for agronomic traits and seed yield in sunflower (*Helianthus annuus* L.) under *Macrophomina phaseolina* conditions

Sources of variation	df				Mean squares		
		Stem girth	Head diameter	100-achene weight	Number of seeds per head	Stem girth length ratio	Seed yield
Replications	1	5.1164**	1.60^{ns}	0.32^{ns}	550044**	0.000038^{ns}	2441530**
Genotypes	103	0.5985**	7.19**	0.79**	66069**	0.000032**	662815**
Error	103	0.1706	1.25	0.09	10863	0.000013	120271

*, ** significant at 5% and 1% probability levels, respectively; ns = non-significant.

Table II. Estimates of genotypic (r_G) and phenotypic (r_P) correlation coefficients among agronomic traits and seed yield in sunflower (*Helianthus annuus* L.) under *Macrophomina phaseolina* conditions

Traits		Stem girth	Head diameter	100-achene weight	Number of seeds per head	Stem girth: length ratio	Seed yield
Stem girth	r_G	1	0.916*	0.471*	0.859*	0.476^{ns}	0.849*
	r_P	1	0.851**	0.454**	0.804**	0.527**	0.815**
Head diameter	r_G		1	0.540*	0.875*	0.416^{ns}	0.893*
	r_P		1	0.538**	0.824**	0.374**	0.464**
100-achene weight	r_G			1	0.292*	0.117^{ns}	0.698*
	r_P			1	0.278**	0.143*	0.680**
Number of seeds per head	r_G				1	0.270*	0.881*
	r_P				1	0.265**	0.882**
Stem girth length ratio	r_G					1	0.222*
	r_P					1	0.254**

*, ** significant at 5% and 1% probability levels, respectively; ns = non-significant.

Table III. Direct and indirect effects of agronomic traits on seed yield in sunflower (*Helianthus annuus* L.) under *Macrophomina phaseolina* conditions

Traits	Direct effects	Indirect effects via					Total direct and indirect effects (r_G with seed yield)
		Stem girth	Head diameter	100-achene weight	Number of seeds per head	Stem girth: length ratio	
Stem girth	-0.008	-	-0.072	0.240	0.699	-0.010	0.849
Head diameter	-0.078	-0.007	-	0.275	0.711	-0.009	0.893
100-achene weight	0.509	-0.008	-0.042	-	0.237	-0.002	0.698
Number of seeds per head	0.813	-0.007	-0.068	0.149	-	-0.006	0.881
Stem girth: length ratio	-0.021	-0.004	-0.032	0.060	0.219	-	0.222

(0.509) but its indirect effects via stem girth, head diameter and stem girth length ratio were negative under *Macrophomina phaseolina* stress conditions.

The direct effect of number of seeds per head on sunflower seed yield was highly positive (0.813). The indirect effects of number of seeds per head on seed yield via stem girth, head diameter and stem girth length ratio were negative, while its indirect effects via 100-achene weight were positive. Patil *et al*. (1996) and Lal *et al*. (1997) also reported positive direct effects of number of seeds per head on seed yield.

The direct effect of stem girth length ratio was found to be negative (-0.021) under charcoal rot stress conditions. The indirect effects of stem girth length ratio on seed yield were also negative via stem girth (-0.004) and head diameter (-0.032) but these indirect effects via 100-achene weight and number of seeds per head were positive.

The maximum positive and direct effects were of number of seeds per head followed by 100-achene weight on sunflower seed yield. The maximum indirect effect was shown by head diameter via number of seeds per head. So it is concluded that direct selection of number of seeds per head and 100-achene weight and indirect selection through head diameter, can improve sunflower seed yield.

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