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GENETIC ASSOCIATION AND PATH ANALYSIS FOR SEED YIELD IN SUNFLOWER (*HELIANTHUS ANNUUS* L.)

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An experiment comprising 104 sunflower genotypes was conducted at Oilseeds Research Institute, AARI, Faisalabad, Pakistan to study genetic correlation coefficients, direct and indirect effects of different plant traits on seed yield. The genetic correlation of stem girth, head diameter, 100-achene weight, number of seeds per head and stem girth length ratio was positive and significant with seed yield of sunflower. Path analysis indicated that seed yield can be improved by increasing the 100-achene weight, number of seeds per head and stem girth length ratio.
Key words: Sunflower, Genotypic correlation, Path analysis, Stem girth, Head diameter, Seed yield

INTRODUCITON

Sunflower is considered the most important crop to bridge the gap between total requirements and domestic production of edible oil in Pakistan. Total availability of edible oil in 2004-05 was 2.29 million tones. Local production accounted for 36.8 percent of the domestic requirements while the remaining 63.2 percent was met through imports (Anonymous, 2005). Analysis of genetic correlations measures the mutual relationship among various plant characters and helps in determining the yield components on which indirect selection can be based for achieving genetic improvement in yield. Phenotypic correlation refers to observed association between two traits. It includes both genotypic and environmental effects and therefore, differs under different environmental conditions. The inherent association between two characters is called genetic correlation. It may be due to pleiotropy or linkage or both. Genetic correlation is of direct practical value to a plant breeder (Singh, 1998).

Sunflower seed yield is affected by numerous other plant traits. Seed yield can be improved by increasing head diameter, 100-seed weight and stem circumference (Niranjana and Shambulingappa, 1989). Sunflower seed yield has high positive genetic association with plant height, stem girth and head diameter. Plant height and 100-seed weight had positive direct effects on seed yield, suggesting the possibility of direct selection through these traits (Lal *et al.*, 1997). The direct effect of number of seeds per head followed by 100-seed weight is maximum in respect of both seed yield and oil yield. The maximum indirect effect for any character was through number of seeds/head (Patil *et al.*, 1996).

The objective of the present study was to observe the genetic association of different plant traits with seed yield and to determine the direct and indirect effects of different plant traits on seed yield.

MATERIALS 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 alongwith 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 meter length with plant to plant and row to row distances of 23 and 60 cm, respectively.

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 analysed 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 Kwon and Torrie (1964). Path coefficient analysis was studied according to method explained by the Dewey and Lu (1957). This model was extensively used by sunflower researchers (Alba *et al.*, 1979; Ivanov *et al.*, 1980; Lakshmanrao *et al.*, 1985; Marinkovic, 1992; Punia and Gill, 1994 etc.). Seed yield was kept as resultant variable and other characters as causual variables.

RESULTS AND DISCUSSION

Mean squares from analysis of variance (Table I) indicated highly significant differences among sunflower genotypes for quantitative traits: stem girth, head diameter, 100-achene weight, number of seeds per head, stem girth length ratio and seed yield.

Genotypic and phenotypic correlation coefficients are presented in Table II. It is evident from the table that all studied traits have positive and significant phenotypic correlation with seed yield and among themselves.

Genetic correlation coefficient observed between stem girth and seed yield was positive and significant (Table II). This is in conformity with the findings of Vanisree *et al.* (1988), Patil *et al.* (1996) and Lal *et al.* (1997) who also reported positive and significant correlation of stem girth with seed yield. Stem girth also exhibited positive and significant genetic correlation with all other studied plant traits except stem girth length ratio.

Head diameter was noticed to be significantly and positively correlated with seed yield, which is in agreement with earlier findings of Vanisree *et al.* (1988), Niranjana and Shambulingappa (1989) and Lal *et al.* (1997). Head diameter was positively and significantly correlated genotypically with other studied plant traits except stem girth length ratio.

The positive and significant genetic correlation was observed between 100-achene weight and seed yield and this is in agreement with the results reported by Vanisree *et al.* (1988), Lal *et al.* (1997) and Teklewold *et al.* (2000). Genetic correlation of 100-achene weight with all other plant traits was also positive and significant except stem girth and length ratio.

The genotypic association of number of seeds per plant with seed and all other studied plant traits was positive and significant. Patil *et al.* (1996) also reported similar results in his respective study for association between number of seeds per head and seed yield.

Stem girth length ratio exhibited positive and significant genetic association with seed yield. It has also positive and significant genetic correlation with number of seeds per head. No data could be found in literature in favour or against these results.

Path analysis was carried out to determine the relative importance of five selected plant traits on sunflower seed yield.

Table I. Analysis of variance for agronomic traits and seed yield of sunflower (Helianthus annuus L.)

Sources of variation	df	Mean squares					
		Stem girth	Head diameter	100-achene weight	No. of seeds per head	Stem girth length ratio	Seed yield
Replications	1	6.473**	1.525 ns	1.70**	112605**	0.000029 ns	3331229**
Genotypes	103	1.148**	12.50**	1.31**	104192**	0.000044**	1635728**
Error	103	0.264	1.77	0.167	15647	0.0000123	300607

*, ** 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 of sunflower (Helianthus annuus L.)

Traits		Head diameter	100-achene weight	No. of seeds per head	Stem girth: length ratio	Seed yield
Stem girth	r_G	0.9414*	0.4844*	0.8588*	0.6463	0.8127*
	r_P	0.9045**	0.5015**	0.7939**	0.6929**	0.7905**
Head diameter	r_G		0.5219*	0.9287*	0.5669	0.8955*
	r_P		0.5460**	0.8563**	0.5878**	0.8583**
100-achene weight	r_G			0.3238*	0.1904	0.7211*
	r_P			0.3149**	0.2571**	0.7094**
No. of seeds per head	r_G				0.3228*	0.8773*
	r_P				0.3364**	0.8768**
Stem girth length ratio	r_G					0.2661*
	r_P					0.3330**

This analysis permits the separation of genotypic correlation coefficient with components of direct and indirect effects. The results of path analysis are presented in Table III. The results pertaining to Table III revealed that the direct contribution of stem girth to seed yield was negative (–0.2770) and indirect effects via 100-seed weight, number of seeds per head and stem girth length ratio were positive. The indirect effect of stem girth via head diameter was negative –0.7648. The maximum positive indirect contribution of stem girth to seed yield was through number of seeds per head. Niranjana and Shambulingappa (1989) also indicated that seed yield can be improved by increasing stem circumference.

The direct effect of head diameter on seed yield was negative (–0.8124). The genotypic correlation coefficient was positive (0.8955). The indirect effects via 100-achene weight, number of seeds per head and stem girth length ratio were positive. The indirect effect through stem girth was negative and low. The deleterious effects of head diameter directly and via stem girth were nullified by its indirect effects via number of seeds per head, 100-achene weight and stem girth length ratio. The importance of head diameter for seed yield improvement has also been reported by Niranjana and Shambulingappa (1989) and Lal *et al.* (1997).

It is evident from the table III that 100-achene weight had direct positive effect (0.7272) on seed yield. The contribution of 100-achene weight via stem girth and head diameter was found to be negative but through number of seeds per head and stem girth length ration was positive. These results are in agreement with earlier researchers Nirangana and Shambulingappa (1989), Patil *et al.* (1996) and Lal *et al.* (1997) who also reported positive direct effect of 100-achene weight on seed yield.

The direct effect of number of seeds per head on seed yield was highly positive (1.5478). The indirect effects of number of seeds per head on seed yield via stem girth and head diameter were negative while these indirect effects via 100-achene weight and stem girth length ratio were positive. Patil *et al.* (1996) and Lal *et al.* (1997) also reported positive direct effects of seeds per head on seed yield. The maximum indirect effect for any character was through seeds per head (Patil *et al.*, 1996).

Table III. Direct and indirect effects of agronomic traits on seed yield of sunflower (Helianthus annuus L.)

Traits	Direct effects	Indirect effects via					Total direct and indirect effects (r_G with seed yield)
		Stem girth	Head diameter	100-achene weight	No. of seeds per head	Stem girth: length ratio	
Stem girth	-0.2770	-	-0.7648	0.3523	1.3293	0.1729	0.8127
Head diameter	-0.8124	-0.2608	-	0.3795	1.4375	0.1517	0.8955
100-achene weight	0.7272	-0.1342	-0.4240	-	0.5012	0.0509	0.7211
No. of seeds per head	1.5478	-0.2379	-0.7545	0.2355	-	0.0864	0.8773
Stem girth: length ratio	0.2675	-0.1791	-0.4606	0.1385	0.4997	-	0.2661

The direct effect of stem girth length ratio on seed was found positive (0.2675). No similar data could be found in literature but an explanation of Niranjana and Shambulingappa (1989) implies that such a relationship is possible. The indirect effects of stem girth length ratio on seed yield were negative via stem girth and head diameter 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 and stem girth length ratio on sunflower seed yield. The direct selection of these traits and indirect through head diameter can improve sunflower seed yield.

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