Plant Knowledge Journal
ISSN: 2200-5390
EISSN: 2200-5404
2(1): 20- 23 (2013)

Southern Cross Publishing Group
Australia

Genetic divergence and path coefficient analysis for yield related attributes in sunflower (*Helianthus annuus* L.) under less water conditions at productive phase

Mudassar Iqbal[1], Usman Ijaz[2], Smiullah[2], M. Iqbal[1], Khalid Mahmood[1], M. Najeebullah[1], Abdullah[1], Shahid Niaz[1]and Hafeez. A. Sadaqat[2]

[1]Ayub Agricultural Research Institute, Faisalabad, Pakistan
[2]Department of Plant Breeding and Genetics, University of Agriculture, Faisalabad, Pakistan

***Corresponding author: Musauaf@yahoo.com**

Abstract

Correlation and path coefficient analysis was studied in sunflower (*Helianthus annuus*) for achene yield and other quantitative traits like plant height, no of leaves, total leaf area, stem diameter, head diameter, whorls per head, fertile whorls per head, hundred achene weight and oil contents under standard and less water regimes at reproductive phase. Ten genotypes of sunflower were laid in a triplicate randomized complete block design (RCBD). The genotypes showed significant differences with each other for all studied traits. The traits total leaf area and achene yield showed highest genetic advance with moderate values of broad sense heritability. Based on correlation analysis, a classification was made to predict the relationship between different attributes. The traits plant height and total leaf area showed positive and significant ($P \leq 0.05$) correlation with achene yield at the genotypic level. The phenotypic correlation of different traits made it clear that only total leaf area had positively significant ($P \leq 0.01$) correlation with achene yield. Path analysis based on achene yield per plant as a dependent variable revealed that no of leaves, stem diameter, head diameter and oil contents exerted the positive direct effect on achene yield, head diameter being at the top of the list. It is concluded from current study that these traits may be used as selection criteria in sunflower improvement programs under water stress condition at reproductive stage of the crop.

Keywords: Achene yield, Correlation, Genetic parameters, *Helianthus annuus*, Water stress.
Abbreviation: section required here.

Introduction

The objectives of a plant breeder embrace selection from a natural population or from an indigenous population for one or several attributes. Yield is a complex character and is a function of several component traits and their interaction with environment. It is more appropriate if the structure of yield is probed through breeding techniques. It is important to measure the mutual relationship between various plant attributes and determine the component characters, on which selection procedure can be based for direct and indirect genetic improvement of crop yield. Sunflower (Helianthus annuus L.) has become an important oil crop in the world with annual production of 20 to 25 million hectares worldwide in present decade (Machikowa and Saetang, 2008). Sunflower as an oilseed crop was introduced in Pakistan in 1960. It ranks third after Soybean and palm oil in worldwide vegetable oil production. It is a short period crop (90-110 days) and is easily adjustable in our cropping pattern. It is being cultivated on 0.448 M hectares producing 0.643 M tons of seed annually (Economic Survey of Pakistan, 2012). As a plant of economic importance, sunflower seed contains high percentage of poly-unsaturated fatty acids (60%) including oleic acid and linoleic acid at 16.0% and 72.5% respectively, which help in controlling cholesterol level in blood (Satyabrata et al., 1988). Water shortage is becoming a major problem for sustainable agriculture in Pakistan. The reduced precipitation, together with high evapotranspiration is expected to subject natural and agricultural vegetation to a great risk of severe and prolonged water stress with each passing year (Ellsworth, 1999). In Pakistan, per capita water access has dropped from 5,600 cubic meters in 1947 to a mere 1,200 by 2005 (The Pakistan Times, 2007). Water stress, especially in sunflower at a vegetative and growth phase of the plant may result in 61% and 40% yield reduction, respectively (Iqbal.2004). Simple correlation analysis does not show the mutual relationships among the plant characters while path coefficient analysis splits the genotypic correlation into direct and indirect effects of independent variables on the dependent variable. So, the path analysis technique can be used for attaining the more explained results for the selection of desirable traits as used by the researchers (Punia and Gill, 1994; Joksimovic et al., 1999). Therefore, evaluation of high yielding sunflower genotypes possessing drought tolerance for local environment is need of the hour.

Results and discussion

Current studies revealed that there were highly significant differences ($p<0.01$)among sunflower accessions for head diameter, whorls per head, hundred achene weight, oil content/head and achene yield (Table 1). These results are in accordance with that of Steel et al., 1997. On the other hand, at ($p<0.05$), the traits like plant length, no of leaves, total leaf area and stem diameter showed significant differences (Table.1).The results showed that enough variation was present for selecting the suitable lines for achene yield in safflower, in accordance with Mozzafari and Asadi (2006). Arshad et al. (2007) and Sridhar et al. (2005) also reported

Table 1. Values of Mean squares, Gcv, Pcv, Heritability and Genetic advance from different genotypes of sunflower under less water conditions at productive phase.

	MS	GCV (%)	PCV (%)	h2 (BS)	GA
PH (cm)	328.880*	0.060	0.097	0.388±0.260	7.400
NL	2.346*	0.039	0.66	0.364±0.254	0.594
TLA (cm^2)	28356.45*	0.274	0.408	0.450±0.276	77.088
SD (cm)	0.510*	0.052	0.088	0.355±0.252	0.271
HD (cm)	4.860**	0.077	0.110	0.489±0.286	1.074
W/H	2.804*	0.53	0.085	0.392±0.261	0.688
FW/H	2.687**	0.060	0.087	0.488±0.286	0.796
HAW (g)	4.560**	0.103	0.149	0.478±0.283	1.021
OC (%)	62.040**	0.158	0.187	0.715±0.346	5.061
Achene yield (g)	294.382**	0.254	0.360	0.499±0.289	8.490

Where * significant at P>0.05 and ** significant at P>0.01, MS= Mean squares, GCV= Genotypic coefficient of variation, PCV= Phenotypic coefficient of variation, h2 (BS)= Heritability in broad sense, GA= Genetic advance, PH= Plant height, NL = Number of leaves, TLA = Total leaf area, SD = Stem diameter, HD = Head diameter, W/H = whorls per head, FW/H = fertile whorls per head, HAW = hundred achene weight, OC = Oil content /head, AY = Achene yield per plant

Table 2. Correlation coefficients among various characters under less water conditions at productive phase.

Character		NL	TLA	SD	HD	W/H	FW/H	HAW	OC	AY
PH	Genotypic	0.0002	0.799*	-0.188	0.281	-0.021	-0.003	-0.386	-0.037	0.588*
	Phenotypic	0.395	0.400	0.040	0.153	0.068	0.020	-0.131	-0.102	0.386
	Genotypic		0.714*	-0.023	0.096	-0.029	-0.208	-0.512	0.727*	0.226
NL	Phenotypic		0.151	-0.010	0.026	0.052	0.016	-0.239	0.372	0.062
	Genotypic			-0.212	-0.077	-0.314	-0.335	-0.012	-0.362	0.853*
TLA	Phenotypic			-0.019	-0.087	-0.151	-0.147	0.014	-0.011	0.698**
	Genotypic				0.969*	0.989*	0.954*	0.042	0.207	-0.244
SD	Phenotypic				0.717**	0.518*	0.464*	-0.064	0.198	0.078
	Genotypic					0.978*	0.957*	0.114	0.315	-0.296
HD	Phenotypic					0.812**	0.736**	-0.078	0.259	-0.043
	Genotypic						0.962*	-0.012	0.625*	-0.308
W/H	Phenotypic						0.941**	-0.004	0.280	-0.170
	Genotypic							0.005	0.477	-0.181
FW/H	Phenotypic							0.121	0.267	-0.199
	Genotypic								-0.768*	-0.042
HAW	Phenotypic								-0.476*	-0.073
	Genotypic									0.368
OC	Phenotypic									0.138

PH = Plant height, NL = Number of leaves, TLA = Total leaf area, SD = Stem diameter, HD = Head diameter, W/H = whorls per head, FW/H = fertile whorls per head, HAW = hundred achene weight, OC = Oil content /head, AY = Achene yield.

the presence of significant differences among sunflower genotypes under normal water regimes. The presence of significant variation in breeding material gives plant breeder an extra option to selector reject a genotype in a breeding program. The maximum genotypic coefficient of variation (GCV) was found for whorls per head, total leaf area and achene yield per plant respectively (Table. 1). These highest values of (GCV) indicated that the selection of these traits for drought tolerance is obligatory. Sujatha et al. (2002) also reported that oil yield and achene yield per plant showed highest genotypic coefficient of variation respectively. The characters, total leaf area and achene yield per plant exhibited highest genetic advance with moderate heritability thus these characters can be used as a selection criterion under less water conditions. Safavi et al. (2011) has reported the presence of maximum genetic advance for seed yield and head diameter in sunflower. The Genotypic correlation coefficients for most of the characters were higher than the phenotypic correlation coefficients, an indication of the reliability of the results. The results regarding correlation (Table 2) showed that only plant height and total leaf area exhibited significant ($p<0.05$) genotypic correlation with achene yield. Phenotypic coefficient of correlation showed that among all traits total leaf area kept highly significant positive ($p<0.01$) correlation with achene yield. Farhatullah et al. (2006) also reported highly significant correlation of plant height with yield per plant in sunflower. It is evident in the results that selection of these traits might be helpful for a breeder to develop high yielding variety under water deficit conditions. There are some other significant associations between the traits under less water regime (Table 2). Plant height and no of leaves showed genotypic significant association with total leaf area. Stem diameter exhibited the positive and significant correlation with head diameter, as well as with whorls per head and fertile whorls per head at both genotypic and phenotypic levels. Head diameter also displayed the significant ($p<0.05$) association at genotypic level and highly significant ($p<0.01$) association at the phenotypic level with whorls per head and fertile whorls per head. Khan et al (2003), Ozer et al. (2003) and Sridhar et al. (2005) have reported that head diameter had positive and significant correlations with achene yield. The path coefficient is a standardized regression coefficient technique which assesses the influence of different variables on resultant variable directly and indirectly, by partitioning the genotypic correlation coefficients. Such information may be useful in predicting correlation responses of different characters to directional selection. The path coefficient analysis (Table. 3) revealed that no of leaves, stem diameter, head diameter and oil contents exhibited the positive direct effect on sunflower yield under less water conditions, same kind of findings were found in correlation studies that no of

Table 3. Direct (bold diagonal values) and indirect (normal values) effects of different characters on achene yield under less water conditions at productive phase**.**

	PH	NL	TLA	SD	HD	W/H	FW/H	HAW	OC	Rg
PH	-0.127	7.781	-0.001	-0.052	0.309	0.006	0.002	0.402	0.048	0.588
NL	-2.651	0.373	-0.001	-0.006	0.106	0.008	0.161	0.533	-0.949	0.226
TLA	-0.101	0.267	-0.001	-0.059	-0.085	0.089	0.260	0.013	0.472	0.853
SD	0.024	-0.008	0.001	0.280	1.183	-0.379	-1.029	-0.044	-0.270	-0.244
HD	-0.035	0.036	9.441	0.300	1.102	-0.312	-0.856	-0.119	-0.411	-0.296
W/H	0.002	-0.011	0.001	0.374	1.121	-0.283	-0.801	0.013	-0.816	-0.308
FW/H	0.001	-0.077	0.001	0.372	1.219	-0.293	-0.774	-0.005	-0.622	-0.181
HAW	0.049	-0.191	1.541	0.001	0.126	0.003	-0.004	-1.039	1.002	-0.042
OC	0.004	-0.864	0.001	0.058	0.347	-0.177	-0.369	0.799	0.568	0.368

PH = Plant height, NL = Number of leaves, TLA = Total leaf area, SD = Stem diameter, HD = Head diameter, W/H = whorls per head, FW/H = fertile whorls per head, HAW = hundred achene weight, OC = Oil content /head, AY = Achene yield.

leaves and oil contents also showed positive correlation with achene yield. Iqbal et al. (2009) reported that stem diameter exerted positive direct effect on oil contents in sunflower under less water conditions, so selection of this trait might be helpful for breeders in achene yield and oil contents improvement programs. Maximum positive direct effect on sunflower yield was observed through head diameter in the current study (Table.3) and earlier projects (Puniaand Gill, 1994, Yasinand Singh, 2010). Total leaf area induced major positive indirect contribution on yield via head diameter (Table.3). It is evident from the correlation studies (Table. 2) that total leaf area also showed positively significant correlation with achene yield which can be used as selection tool in future projects. In previous studies, Mozaffari and Asadi (2006) reported the positive direct effect of head diameter on safflower yield under drought conditions. It is also suggested that considerations may be given to all casual factors during selection procedure which may affect the achene yield positively, as reported by Rao (1987).

Materials and methods

Plant materials

Ten sunflower accessions viz., G-5 G-3, G-9, G-33,G-57, G-93, G-128, A-133 and A-75 and a hybrid HBRS-2 were collected from the gene pool of Oilseed Research Group, Department of Plant Breeding and Genetics, University of Agriculture, Faisalabad. These accessions were sown in the experimental area of the Department of Plant Breeding and Genetics, University of Agriculture, Faisalabad (31o-26o N and 73o-06o E) during the spring season 2006-07.

Experimental design

Experiment was laid out following Randomized Complete Block Design in factorial arrangement with three replicates. The water stress was provided by skipping irrigation before the start of button stage up to the maturity of the plant to provide low moisture content during the whole reproductive phase. The plant to plant distance of 30 cm and row to row distance of 75 cm was maintained for each genotype. 10 plants were tagged at random in each replication, and data was recorded at seedling and maturity stage. Plant height (cm) was measured from ground level to the base of the head. Total number of leaves from each selected plant of each accession was counted before harvesting in all replications, and average was computed. Middle leaf was selected for taking leaf area of each plant in each genotype. Three readings of leaf width were recorded, one each from the base, the mid and near the tip of the leaf blade. Average width was calculated, and was multiplied by leaf length to calculate leaf area. To obtain total leaf area (cm2), a factor was calculated by randomly sampling leaves from the field. All of leaf samples were photocopied by using a Photostat machine. These photocopies were cut into square shapes to determine their average area. Thus correction factor and total leaf area were obtained as follows:

Correction factor = Average leaf area of random sample – average calculated leaf area of all accessions.

Total leaf area = Leaf area of a particular accession - correction factor.

Stem diameter (cm) of plants was measured from the base using measuring tape and average was calculated in all replications. Head diameter (cm), number of whorls on each head and number of fertile whorls on each head were counted at maturity on an individual plant basis. Heads of selected plants in each replication were harvested, dried and threshed individually. Achene yield per head (g) and 100 achene weight (g) were determined using an electronic balance; Achene yield per head is referred as achene yield.

Statistical methods

The recorded data were analyzed by the analysis of variance technique (Steel et al., 1997) to determine significant varietal differences between the 10 sunflower genotypes using M-STATC (MSTAT-C development Team 1989). Heritability in broad sense was estimated according to Falconer and Mackay (1996) while Genetic Advance was computed at 20% selection intensity using following formula given by Poehlman and Sleper (1995). Genotypic and phenotypic correlations were computed following Kwon andTorrie (1964). Path coefficients were estimated according to Dewey and Lu (1959), where Achene Yield was kept as resultant variable and other contributing characters as causal variables.

References

Arshad M, Ilyas MK, Khan MA (2007) Genetic divergence and path coefficient analysis for seed yield traits in sunflower (*Helianthus annuus L.*) hybrids. Pak J Bot. 39: 2009-2015

Dewey D, Lu K (1959) Correlation and path coefficient analysis of crested wheat grass seed production. Agron J. 51: 515-518

Ellsworth DS (1999) CO2 enrichment in maturing Pine forest; are CO2 exchange and water stress in the canopy affected. Plant Cell and Environ.22:461-472

Economic Survey of Pakistan 2011-12 (2012) Economic Advisor's Wing, Financial Division, Government of Pak, Islamabad, Pakistan

Falconer DS, Mackay TFC (1996) Introduction to Quantitative Genetics, 4th edn. Longman Harlow, Essex, UK.

Farhatullah, Farooq-e-azam, Khalil IH (2006) Path Analysis of the coefficients of sunflower (*Helianthus annuus* L.) hybrids. Inter J of Agr bio.5:621–625

Iqbal M, Ali AM, Abbas A, Zulkiffal M, Zeshan M, Saqaqat AH (2009) Genetic behavior and impact of various quantitative traits on oil contents in sunflower under waters stress conditions at productive phase. Plant Omics J. 2(2):70-77

Iqbal N (2004) Influence of exogenous glycine betaine on drought tolerance of sunflower (*Helianthus annuus* L.). Ph. D. thesis, Deptt. Of Bot, Univ. of Agri., Faisalabad. Pakistan

Joksimovic J, Atlagic J, Skoric D (1999) Path coefficient analysis of some oil yield components in sunflower (*Helianthus annuus* L.). Helia.22: 35–42

Khan MU, Chowdhry MA, Khliq I, Ahmad R (2003) Morphological responses of various genotypes to drought conditions. Asian J Plant Sci.2: 392-394

Kown S, Torrie J (1964) Heritability and interrelationship among traits of two soybean populations. Crop Sci. 4:196-198

Machikowa T, Saetang C (2008) Correlation and path coefficient analysis on seed yield in sunflower. Suranaree J Sci Technol. 15(3):243-248

Mozaffari K, Asadi AA (2006) Relationships among traits using correlations, principal components and path analysis in safflower mutants sown in irrigated and drought stress conditions. Asian J Plant Sci. 5: 972-983

M-STAT-C Development Team (1989) MSTAT User's Guide: A microcomputer Program for the design, Management and analysis of agronomic Research Experiments. Ist edition. Michigan State Univ East Lansing, ML

Ozer H, Erdogon O, Taskin P (2003) Determination of the agronomic performance of some oilseed sunflower hybrids grown under Erzurum ecological conditions. Turk J Agri For. 27:199-205

Poehlman JM, Sleper DA (1995) Breeding Field Crops, 4th edn. Panima, New Delhi. India

Punia MS and Gill HS (1994) Correlations and path coefficient analysis for seed yield traits in sunflower (*Helianthus annuus L.).* Helia17: 7-11

Rao NGL (1987) Studies on correlation and path coefficient analysis in sunflower (*Helianthus annuus* L.). Mysore J Agri Sci. 21: 94–5

Safavi AS, Safavi SM, Safavi SA (2011) Genetic variability of some morphological traits in sunflower *(Helianthus annus L.*). Am J Crop Res. 17:19-24

Satyabrata M, Hedge MR, SB Chattopodhay (1988) Hand Book of Annual Oilseed Crops. Oxford IBH. New Delhi. India

Sridhar V, Kuldeep SD, Vishnu VR, Sudheer K (2005) Character association and path analysis in sunflower (*Helianthus annuus* L.). Crop Res. 30: 63-67

Steel R, Torrie J, Dicky D (1997) Principles and Procedures of Statistics; a biometrical Approach, 3rd edn. W.C.B/ McGraw-Hill, New York. USA

Sujatha HL, Chikkadevaiah, Nandini (2002) Genetic variability study in sunflower inbreds. Helia, 37: 93-100

The Pakistan Times, Daily newspaper, 17 Feb, (2007) Times Group of Publications, Friendly printers.

Yasin BA, Singh S (2010) Correlation and path coefficient analyses in sunflower. J Plant Breed Crop Sci. 2(5): 129-133