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Research Note

Genetic variability, heritability and genetic advance for yield and yield components in sunflower (*Helianthus annuus L.*).

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Abstract:
Ten genotypes of sunflower were evaluated in the field following a randomized complete block design with three replications for plant height, stem diameter at base, inter nodal length, head diameter, number of whorls per head, achene weight per head, 100 achene weight, achene oil and protein contents. Highly significant differences were observed for all the characters in all genotypes. Characters like plant height, oil contents, protein contents and achene weight per head showed high heritability with moderate genetic advance.

Keywords: Sunflower, variability, coefficient of variations, heritability, Genetic advance.

Sunflower is one of the most important annual crop grown for vegetable and industrial oils in the world. It is successfully grown over a widely scattered geographical area and considered as a crop adapted to a wide range of environmental conditions (Ekin *et al.* 2005). Cultivated Sunflower is among one of the five largest oilseed crops in the world. Sunflower production was 7-9 per cent of world oilseed output between marketing years 1999-2000 and 2008-09. Sunflower seed oil, the main product of sunflower seed processing, accounted for 8-11% of world vegetable oil trade between 1999/2000 and 2008/09 (USDA, 2010). It is newly introduced in Pakistan, which gives very good performance regarding yield and quality of edible oil as compared to our conventional oil seed crops. The total availability of edible oil in 2008-09 was 2.821 million tons. Local production of edible oil stood at 684 thousand tons during 2008-09, which is 24% of the total availability in the country. While the remaining, 76% was made available through imports (GOP, 2011). Sunflower is a drought tolerant and short duration crop. Under agro-climatic conditions of Pakistan, it can be grown successfully twice a year as spring and autumn crop, both in irrigated and rainfed areas. Its seeds contain a high amount of oil i.e 40-50% which is an important source of polyunsaturated fatty acid (linoleic acid) of potential health benefits (Monotti, 2004). Sunflower seeds contain~ 20% of protein; whereas protein contents of the oil press cakes and extraction residues range from 30 to 50% (Dorrell and Vick, 1997). Sunflower oil is considered as premium oil due to its light color, mild flavor, low level of saturated fatty acids and ability to withstand high cooking temperatures. Despite these advantages, it can also be used as birdseed, livestock feed etc. (Robert *et al,* 1993). Mostly sunflower seed is imported from outside which is too much expensive, leading to increased cost of production and thus pushing the farmers away from sunflower cultivation. So there is dire need to develop locally adapted varieties.

The basic key to bring out the genetic gain to a crop is to utilize the available or created genetic variability. It is difficult to judge about what proportion of variability is heritable and what proportion is non-heritable i.e. environmental. So, it becomes necessary to partition the observed variability into its heritable and non-heritable components and to have an understanding of parameters such as genetic coefficient of variation, heritability and genetic advance (Nath and Alam, 2002). The present study was undertaken to achieve the following objectives: a) To estimate variability for yield and contributing traits in sunflower genotypes, b) To estimate heritability and genetic advance for yield and yield components and c) To find out and establish suitable selection criteria for high yield through study of variability.

Ten sunflower genotypes viz. G-46, A-185, G-51, G-59, G-100, G-34, A-133 and three checks viz. FH-243, Bemisal-205 and Bemisal-4710, were used in experiment layed out in field conditions under a

triplicated Randomized Complete Block Design(RCBD). Row to row distance of 75 cm and plant to plant distance of 30 cm were maintained.

At maturity, data were recorded on plant height, stem diameter at base, internodal length, head diameter, number of fertile whorls per head, achene weight per head, 100 achene weight, achene oil and protein contents. The mean data of 10 sample plants for different traits were analyzed for variance following DMR test suggested by Steel *et al,* 1997. Heritability in broad sense was estimated according to Burton and DeVane (1953). Genetic advance was computed at 10% selection intensity with formula given by Sleper and Poehlman (2006).

Analysis of variance showed highly significant (P=0.01) differences among the genotypes for the traits viz. plant height, stem diameter at base, internodal length, head diameter. 100-achene weight, oil contents and protein contents while variations were significant (P=0.05) for the traits viz, number of fertile whorls per head and achene weight per head (Table-1). This variation reflects the diverse geographic origin and distribution of genotypes. Table-2 revealed that maximum plant height (271.6 cm) was shown by genotype G-34 while FH-243 exhibited minimum plant height (108.8 cm). Differences between genotypes for plant height are highly significant. However, short stature varieties are desirable due to lodging threats. Tall varieties with robust stem can perform better. Genotype G-46 showed (Table-2) maximum stem diameter (11.03 cm) at base while Bemisal-205 exhibited minimum stem diameter (8.20 cm) at base. Highly significant differences for stem diameter at base were observed by Al-Chaarani *et al.* (2004). Highly significant differences for stem diameter at base will help to select the genotypes with thick and strong stem to avoid lodging. Table-2 depicts that internodal length was maximum (9.53 cm) in genotype A-133 while minimum (6.10 cm) in genotype G-100. Genotypes with smaller internodal length will bear small height which is desirable. Considering the character head diameter, emisal-205 bore maximum (17.63 cm) while genotype G-34 had minimum (14.23 cm) head diameter. Significant differences for head diameter were reported by Ozer *et al.* (2003) and Al-Chaarani *et al.* (2004). It is obvious that genotypes with larger head will give more yield than smaller ones and yield is the ultimate objective of breeding. Genotype A-185 produced maximum (22.33) number of fertile whorls per head while FH-243 bore minimum (19.33) number of fertile whorls per head (Table 2). More number of fertile whorls per head will lead towards larger head. 100-Achene weight was maximum (7.36 g) in FH-243 while minimum (4.60 g) in Bemisal-4710. Oil content were maximum (48.0 %) in genotype G-51 while minimum (34.6%) in genotype G-100. Highly significant differences for oil content observed in present studies coincided with the findings of Mokrani *et al.* (2002), Khan *et al.* (2003) and Luczkiewicz and Kaczmarck (2004). Protein content was maximum (26.3%) in FH-243 while minimum (18.3%) in genotype A-133. Oil content and protein contents are the important selection parameters so the genotypes with more oil and protein content can be used efficiently in breeding programme. Achene weight per head ranged from 70.8 g to 40.5 g and highest achene weight per head was exhibited by genotype A-133 while lowest by genotype G-100 (Table 2). These results are similar with the findings of Mokrani*et al.* (2002), Ozer *et al.* (2003) and Luczkiwicz and Kaczmarck (2004) who also reported significant differences for achene weight per head. Acheme weight per head or yield is the ultimate objective of sunflower breeding. All the efforts were made to increase yield. So, genotypes with more achene weight per head can be selected for further breeding and hybridization programme.

The phenotypic variance was slightly higher than the genotypic variance for all the traits except plant height (Table-3). There was a narrow range of differences between genotypic coefficient of variations and phenotypic coefficient of variations for most of the characters indicating less environmental influences on phenotypic expression of the characters and they were mostly governed by genetic factors. Achene weight per head showed considerable difference between phenotypic coefficient of variations (0.53%) and genotypic coefficient of variations (0.45%). High heritability (>60%) and high genetic advance (>10) were shown by plant height (Table 3). High heritability and moderate genetic advance were exhibited by oil content, protein content and achene weight per head. Mokrani *et al.* (2002) also found high heritability and moderate to high genetic advance for oil content Gill *et al.* (1997) found moderate heritability for achene weight per head. Stem diameter at base, internodal length, head diameter, number of fertile whorls per head and 100-achene weight showed high heritability but low genetic advance. The highly heritable character with high or moderate genetic advance could be further improved with individual plant selection. Characters with high heritability and low genetic advance indicated little scope for further improvement through individual plant selection.

References:

Al-Chaarani, R., Gentzbittel, L., Huang, X. andSarrafi, A. 2004. Genotypic Variations and identification of QTLs for agronomic traits, using AFLP and SSR markers in RILs of sunflower. *Theor. App. Genet.* **109**(7): 1353-1360.

Anonymous, 2010. United Sates Department of Agriculture. Economic Research Service The Economics of Food, Farming, Natural Resources and Rural America.

Anonymous, 2011. *Ministry of Food and Agriculture, Federal Bureau of Statistic.*Government of Pakistan, Islamabad.

Dorrell, G. and Vick, A. 1997. Properties and processing of oilseed sunflower.u: Schneiter Albert A. (ur.) Sunflower Technology and Production, Wisconsin: Agronomy Madison, str. 709-745.

Burton, G.W. and DeVane, E.H. 1953. Estimating heritability in tall fescue (Fascutata arundinaceae) from replicated clonal material. *Agron. J.,* **45** (10): 478-481.

Ekin, A., Tuncturk, M. and Yilmaz, I. 2005. Evaluation of seed, oil yield and yield properties of different sunflower hybrid varieties in Van, Turkey. *Pakistan J. Boil. Sci.,* **8** (5): 683-688.

Gill, H.S., Sheroan, R.K., Lokendra, K., Naveen, C., Kumar, L. and Chandra, N. 1997.Genetic variability, heritability and genetic advance for achene yield and component traits in sunflower (*Helianthus annuus*L.). *Ann. Biol.,* **13**(2):270-281.

Khan, A., Ullah, I., Murtaza S.B., and Khan, M.Y. 2003.Variability and correlation studies in different newly developed sunflower hybrids. *Asian J. Plant. Sci.*, **2**(12): 887-890.

Luczkiewicz, T. and Kaczmarck, Z., 2004. The influence of morphological differences between sunflower inbred lines on their SCA effects for yield components. *J. Appl. Genet.,* **45**(2): 175-182.

Monotti, M. 2004. Growing non-food sunflower in dry land conditions. *Ital. J. Agron.,* **8**: 3-8.

Mokrani, L., Gentzbittel, L.,Azanza. F.,Fitamant, L.,Al-Chaarani, G. andSarrafi, A. 2002. Mapping and analysis of quantitative trait loci for grain oil content and agronomic traits using AFLP and SSR in sunflower. *Theor. App. Genet.,* **106**(1): 149-156.

Nath, U. and Alam, M. 2002. Genetic variability, heritability and genetic advance of yield and related traits of groundnut. *Online J. Biol. Sci.,* **2**(11): 762-764.

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

Patil, B., Rudraaradhiya, M.Vijaykumar, C. Basappa,H. and Virupakshappa,K. 1996. Genetic variability in sunflower. *J. Oilseed Res.,* 13(2): 157-161.

Robert, L., Harry C.and Kaplan,B. 1993. Sunflower; an American native. Deptt.of Agronomy, University of Missouri, Colombia, USA.

Sleper, D.A. and Poehlman, J.M. 2006. Breeding Field Crops, 5th edition.Blackwell Publishing, Ames, IA, USA.

Steel, R., Torrie J. and Dicky, D.A. 1997. Principles and Procedures of Statistics; A Biomedical Approach. 3rd Ed. W.C.B/ McGraw -Hill, New York.

Table 1. Mean squares of analysis of variance of different characters in sunflower

Characters	Genotypes	Replication	Error
D. F	9	2	18
Plant height (cm)	8863.750**	237.036	154.695
Stem diameter at base (cm)	3.504**	0.482	0.226
Internodal length (cm)	2.564**	0.849	0.271
Head diameter (cm)	3.425**	1.662	0.687
No. of fertile whorls /head	2.874*	0.700	0.966
100-Achene weight (g)	2.341**	0.019	0.044
Oil contents (%)	52.448**	6.433	2.693
Protein contents (%)	16.549**	0.329	0.275
Achene weight/ head (g)	241.623*	20.594	68.174

***= Significant at 0.05 level of probability *= Significant at 0.01 level of probability*

Table 2: Mean values for different traits studied in sunflower

Genotype	PH	SD	IL	HD	NFWH	100 AW	O C	PC	AWH
G-34	271.6	10.0	8.63	14.23	19	5.73	37.33	21.73	52.75
G-59	256.5	10.93	7.43	15.50	21	5.43	40.33	18.37	50.80
G-46	254.1	11.03	8.53	16.53	20	6.96	44.33	20.0	65.31
A-185	250.7	10.53	8.43	17.13	22	5.80	43.67	20.03	65.21
G-51	242.9	9.13	8.36	16.43	21	5.23	48.0	20.30	54.94
A-133	240.1	10.17	9.53	16.63	20	6.06	39.0	18.30	70.83
G-100	224.3	9.56	6.10	15.10	19	5.33	34.67	20.97	40.57
Bem-205	173.4	8.20	8.03	17.63	19	4.76	38.0	22.90	49.56
Bem-4710	148.7	8.23	7.43	15.90	20	4.60	44.0	20.77	53.78
H1-243	108.8	8.46	8.40	17.37	19	7.36	45.0	26.37	59.39

PH=plant height (cm), SD= stem diameter at base (cm), IL= Internodal length (cm). HD= head diameter (cm), NFWH= number of fertile whorls/ head, 100-A W= 100-achene weight (g), OC= oil content (%), PC= protein content (%), A WH= achene weigh per head (g)

Table 3. Variance, Coefficient of variations, heritability and genetic advance for yield and its components in sunflower

Characters	Genotypic variance	Phenotypic variance	Genotypic coefficient of variation (%)	Phenotypic coefficient of variation (%)	Heritability (BS)	Genetic advance i=10%
Plant height (cm)	2903.02	1954.58	0.83	0.83	0.982	93.173
Stem diameter at base (cm)	1.092	1.167	0.36	0.37	0.935	1.721
Internodal length (cm)	0.764	0.854	0.36	0.38	0.894	1.376
Head diameter (cm)	0.912	1.141	0.20	0.22	0.799	1.344
No. of fertile whorls /head	0.625	0.958	0.13	0.16	0.653	0.909
100-Achene weight (g)	0.765	0.780	0.51	0.51	0.981	1.510
Oil contents (%)	16.585	17.482	0.33	0.34	0.948	6.799
Protein contents (%)	50424	5.516	0.37	0.37	0.983	4.031
Achene weight/ head (g)	57.816	80.540	0.45	0.53	0.717	9.606