GENETIC VARIABILITY AND CHARACTER ASSOCIATION BETWEEN GRAIN YIELD AND OIL CONTENT TRAITS IN SUNFLOWER (*HELANTHUS ANNUUS* L.)

Tanweer Fatah Abro[1], Parvesh Kumar Oad[1], Jay Kumar Sootaher*[1], Kirshan Kumar Menghwar[1], Tanveer Ali Soomro[4], Aamir Ali Shaikh[5], Hafeez Ali Bhatti[4], Muhammad Saleem Chang[3], Waqar Hussain Shah[2] and Zafarullah Channa[1]

[1]*Department of Plant Breeding and Genetics, Sindh Agriculture University, Tandojam, Sindh, Pakistan*
[2]*Department of Soil Science, Sindh Agriculture University, Tandojam, Sindh, Pakistan*
[3]*Department of Agronomy, Sub-campus Umerkot, Sindh Agriculture University, Tandojam, Sindh, Pakistan*
[4]*Department of Biotechnology, Sindh Agriculture University, Tandojam, Sindh, Pakistan*
[5]*College of Life Science, Huazhong Agricultural University, Wuhan, China*

ABSTRACT

The present study was conducted to analyze character association between seed yield and oil content traits in sunflower for eight traits at Oilseeds Section, ARI, Tandojam in randomized complete block design having three replications during 2018-2019. The analysis of variance revealed that all genotypes were highly significant and significant at 0.01 and 0.05 level of probability for all the studied attributes indicating the presence of lots of genetic variation in the genotypes. In mean performance, the genotypes D-6, Melabour, Samsun, Vulgar and Turkish articulated the best values to be found as the most superior genotypes. Positive and highly significant correlations were observed for germination percentage (%), days to 95% flowering, days to 95% maturity, plant height and head diameter with grains per head (r = 0.5652**, 0.5383**, 0.6891**, 0.7457** and 0.8292**), whereas germination percentage, days to 95% flowering, days to 95% maturity, plant height and head diameter, grains per head and seed index also expressed similar associations with oil content (r = 0.7511**, 0.6844**, 0.8299**, 0.8842**, 0.9220**, 0.7591** and 0.7838**). It was suggested that positive correlation directed the selection of these attributes demonstrating significant results would be very fruitful and progressive for desirable genes in future for the sunflower development.

Keywords: Genetic variability, correlation, grain yield, oil content, sunflower

INTRODUCTION

Sunflower *(Helianthus annuus* L.*)* is a non-traditional oilseed crop used for edible purpose in the world (Andakhor, 2012). Sunflower is the fourth biggest edible source after soybean in the world and grown over 23 million hectares in the world (FAO, 2012). Sunflower is a bi-annual, potential oilseed crop that fits well in existing crop systems and can be grown without replacing any major crop (Ahmad *et al.,* 2009). It is the most important oilseed crop in Pakistan and ranked third for the production of oil after cotton, rapeseed, and mustard (Razzaq *et al.*, 2014). It is one of the important species among helianthus genus not only producing for oil purpose, but also used as bird feed, animal meal and kernel are used for confectionary (Amin *et al.,* 2014). Sunflower oil is useful and consists of linoleic acid and is a good source of calcium, nicotinic acid and vitamin E (Aslam *et al.,* 2010). Sunflower is short duration, high yielding; non-conventional oilseed crop which contains 48% oil and 27% protein, 60% polyunsaturated fatty acid which are best for the heart patient to reduce the blood cholesterol level (Ahuja *et al.,* 2003; Bakhsh *et al.*, 2014). Sunflower also contains A, D, E and K vitamins. Sunflower is also used as feed additives in poultry and livestock feeding, it is also used as vegetable oil for human consumption (Ghani *et al.,* 2015; Gholinezhad *et al.*, 2009).

In Pakistan, sunflower can grow 2 times (spring and autumn season) in a year and has great potential to fulfil the requirements of edible oil of the country. Pakistan is also fulfilling its 18% oil's demand after cotton. In Pakistan, the edible oils during 2015-16 contributed as 3.726 million tones and the import share of edible oil was 3.264 million tons (GOP, 2016). In Pakistan production of sunflower seed is less as compared to other countries. One reason for low sunflower seed is the utilization of exotic hybrids having different environmental conditions and their adaptation in Pakistan is not suitable. There is a need to develop such hybrids and varieties that give high yield, mature early and have improved oil content to fit in the intensive agriculture system of our country (Ahmad *et al*., 2017).

Yield in sunflower, as in all other crops, depends especially on yield components, which are quantitative traits, presumably controlled by several genes, their effect being modified by environment (Fick and Miller, 1997). Achene yield is a quantitative character which is influenced by different traits. Association is determined between the achene

yield and its related traits for the improvement of yield in sunflower. This may also be helpful in the identification of such traits which have direct or indirect effects on achene yield (Hladni *et al*., 2011). The correlation actually reduces the chance of uncertainly to happen, thus the predictions based on correlation analysis are likely to be very closer to reality. Several researchers observed different types of correlation among grain yield and oil content. Grain yield was significantly and positively correlated with head diameter and 100-seed weight as reported by Lakshminarayana *et al*. (2014) and Sujatha and Nadaf (2013).

The aim of this study was to evaluate the character association in genotypes of sunflower in order to estimate the grain yield and oil content traits in sunflower and identify the suitable genotypes of sunflower for optimum growth and yield traits.

MATERIALS AND METHODS

Field Experimental Details

The present experiment was carried out to study in sunflower genotypes for the grain yield and oil content at Oil Seed Research Institute, Tandojam during spring season. Eight genotypes were evaluated using Randomized Compete Block Design with three replications. The plot size was 5 x 3 m with the row length of 5 meters. Row to row distance was 75 cm, while 20 to 25 cm was the distance between plant to plant. The genotypes with which experimented were Turkish, Vulgar, Samsun-30, Peshawar-93, Samsun-20, Melabour, Aala and D-6, whereas the traits which were studied were Germination %, Days to 95% maturity, Days to 95% flowering, Plant height (cm), Head diameter (cm), Grains per head, 100-seed weight (g) and Oil content (%).

Data Collection

Germination (%): Germination was recorded by counting the days from sowing of seeds till the germination appeared for each genotype from each replication.

Days to 95 (%) flowering: Days to flowering was recorded by counting the days after complete germination of each genotype from each replication.

Days to 95 (%) maturity: Days to 95 % crop maturity was recorded by counting the days from sowing up to 95 percent crop maturity of tagged plants.

Plant height (cm): For plant height, each selected plant was measured from the surface of the soil up to the top of the plant in centimetres with measuring tape.

Head diameter (cm): Head diameter of each selected plant was measured at the time of maturity of the crop by using a scale in centimetres.

Grains per head: The selected head was threshed manually, and number of seeds were counted.

100 seed weight (g): After threshing, 100 achenes from each selected head were taken randomly and weighted on an electronic balance measured in grams in the laboratory.

Oil content (%): After weighting 100 seed the oil content in percent was recorded in the laboratory.

Statistical Data Analysis

Data collected from the experiment were subjected to the analysis of variance according to the method given by Gomez and Gomez (1984), the means of genotypes for all the traits were compared by using the least significant difference (LSD) at 5% probability level suggested by Steel and Torrie (1980) and correlation coefficient analysis between different traits was applied according to Raghavrao (1983). All these data were computed through the software Statistix 8.1.

RESULTS AND DISCUSSION

Analysis of Variance

The analysis of variance was computed for eight different attributes tested from genotypes of sunflower as presented in Table-1. The data were recorded for germination (%), days to 95% flowering, days to 95% maturity, plant height (cm), head diameter (cm), grains per head, 100-seed weight (g) and oil content (%). About the analysis of variance, the result exposed that all the genotypes were highly significant at 0.01 probability level for all those attributes which expressed a lot of genetic variation present in the genotypes of sunflower. These results were in favour of Mustafa *et al*. (2017) who supported that for betterment, variation is the fundamental necessity in any breeding system. Iqbal *et al*. (2012) exhibited significant varietal differences among genotypes for all the characters studied. Supriya *et al.* (2017) evaluated sunflower genotypes for various parameters in which he found significant

outcomes for all the attributes in his experiment. Rizk *et al*. (2019) also found statistically highly significant differences in genotypes for all the attributes.

Mean Performance

Mean performance for eight genotypes was put in Table-2. The results indicated that the maximum germination (%) (73.667) was recorded for genotype of D-6, followed by Melabour (69.667), whereas the genotype Turkish (61.333) observed the least germination%. In days to 95% flowering, (77.000) was achieved by the genotype Melabour, followed by the genotype of D-6 (72.66), whereas the genotypePeshawer-93 (62.667) discovered the least days to 95% flowering. The maximum days to 95% maturity (75.333) was occupied by the genotype D-6, followed by the genotype Turkish (72.667), however the minimum days to 95% maturity (62.667) was recorded in the genotype Aala. In case of plant height, the longest plants (113.60 cm) were articulated by the genotype Samsun-30, followed by the genotype Melabour (107.53 cm), despite the fact the shortest plant height (103.40 cm) were detected by Aala. Furthermore, the maximum head diameter cm (13.200 cm) were counted in the genotype Vulgar, followed by the genotype D-6 (12.233 cm), nonetheless the minimum head diameter was expressed by the sunflower genotype Aala (11.133 cm). For grains per head, the maximum grains per head (1206.7) were calculated by the genotype Vulgar followed by Turkish (1160.0), but the minimum grains per head was found in the genotype D-6 (900.0). In the results of 100-seed weight the maximum values for 100-seed weight (5.093 g) was obtained by Turkish followed by Vulgar (4.8867 g), although the minimum values for 100-seed weight was shown by D-6 (4.3067g). Finally, the most oil content (36.28%) was disclosed by the genotype Vulgar followed by the genotype D-6 (34.61%), whilst the minimum oil content was displayed by the genotype Aala (27.53%.). Lira *et al*. (2017) showed high genetic variability among genotypes, which may contribute to the genetic improvement of sunflower. Manzoor *et al*. (2016) observed good mean performance for days to flowering and days to maturity. Such good results were also shown by Razzaq *et al*. (2014) for head diameter and 100 seed weight. These final results were in conformity with Follmann *et al*. (2019) who experimented with sunflower morphological traits. Supriya *et al.* (2017) found significant mean performance for all the attributes in his research. The existence of maximum genetic variability for seed yield and yield components had also been expressed by Nasreen *et al*. (2011).

Table 1. Mean Squares for Different Morphological Traits of Sunflower Genotypes.

S.O.V.	D. F.	Germination (75%)	Days to 95 % flowering	Days to 95 % maturity	Plant height (cm)
Replications	2	6.166	3.791	2.541	1.640
Genotypes	7	61.119**	90.660**	54.381**	24.178**
Error	14	3.976	4.982	4.827	1.956
Total	23	-	-	-	-

Table 2. Mean Squares for Different Morphological Traits of Sunflower Genotypes.

S.O.V.	D. F.	Head diameter (cm)	Grains per head	100-Seed weight (g)	Oil content (%)
Replications	2	2.221	8560.7	0.070	3.565
Genotypes	7	1.764*	33772.2**	0.222*	36.642**
Error	14	0.729	3216.7	0.044	1.157
Total	23	-	-	-	-

** = Highly significant at $P \leq 0.01$; * = Significant at $P \leq 0.05$

Correlation (r)

Germination (%): Germination % showed positive and highly significant connection with day to 95% flowering (0.9133**), days to 95% maturity (0.9680**), plant height (cm) (0.9182**), head diameter (cm) (0.8847**), grains head-1(0.5652**), 100-seed weight (g) (0.7634**) and oil content (%) (0.7511**). Anam *et al*. (2015) used sunflower accessions to estimate the genetic variability and found better results for seed germination.

Days to 95% flowering: Days to 95% flowering displayed highly positive and significant correlation with days to 95% maturity (0.8821**), plant height (0.8782**), grains per head (0.5383**), 100-seed weight (0.7501**) and oil content (0.6844**), whereas days to 95% flowering, it also articulated negative highly significantly relationship with

only head diameter (-0.8403**). It was advised by Manzoor *et al*. (2016) that these genotypes should be helpful for the future breeding programmes.

Days to 95% maturity: Days to 90% maturity revealed positive and highly significant connections with plant height, head diameter, grains per head, 100-seed weight and oil content with the correlation coefficient values of r = 0.9701**, 0.9373**, 0.6891**, 0.8142** and 0.8299**. Arshad *et al*. (2015) Maurya *et al.* (2019) identified positive as well as negative associations of days to maturity with head diameter and seed yield in his experiment and suggested that these hybrids could be used for better outcomes.

Table 3. Mean Performance of Sunflower Genotypes for Yield and Yield Contributing Attributes.

Genotypes	Germination %	Days to 95% flowering	Days to 95% maturity	Plant height (cm)
Turkish	61.33	65.00	72.66	107.13
Vulgar	62.66	69.66	67.33	106.33
Samsun-30	68.00	68.33	75.00	113.60
Peshawer-93	71.33	62.66	72.66	107.40
Samsun-20	67.66	64.00	72.66	106.53
Melabour	69.66	77.00	72.33	107.53
Aala	73.00	76.33	62.66	103.40
D-6	73.66	72.66	75.33	107.43
LSD (5%)	0.42	0.50	0.46	0.51

Table 4. Mean Performance of Sunflower Genotypes for Yield and Yield Contributing Attributes.

Genotypes	Head diameter (cm)	Grains per head	100-seed weight (g)	Oil content (%)
Turkish	13.00	1160.0	5.09	33.52
Vulgar	13.20	1206.7	4.88	36.28
Samsun-30	12.00	1056.7	4.50	28.34
Peshawer-93	13.06	1005.3	4.34	30.52
Samsun-20	11.43	970.0	4.45	29.49
Melabour	12.13	946.7	4.50	31.35
Aala	11.13	986.0	4.56	27.53
D-6	12.23	900.0	4.30	34.61
LSD (5%)	0.58	0.46	0.48	0.44

Plant height (cm): For height of plant, highly significant positive associations were reported with grains per head and oil content with the correlation coefficient values of r = 0.7457**, 0.8842**. On the other hand, Plant height also articulated negative and highly significant relationship with head diameter and 100-seed weight with the correlation coefficient values of r = -0.9607**, -0.8294. Khan *et al*. (2012) showed highly significant and positive correlation of seed yield with plant height, oil content, seed weight, and oil yield. Such positive and significant results for plant height were also obtained by Supriya *et al.* (2017).

Table 5. Correlation Coefficients (r) Among Yield and Various Yield Traits in Sunflower Genotypes

Characters	Germination %	Days to 95% flowering	Days to 95% maturity	Plant height (cm)	Head diameter (cm)	Grains per head	100-seed weight (g)
Days to 95% flowering	0.9133**						
Days to 95% maturity	0.9680**	0.8821**					
Plant height (cm)	0.9182**	0.8782**	0.9701**				
Head diameter (cm)	0.8847**	-0.8403**	0.9373**	-0.9607**			
Grains per head	0.5652**	0.5383**	0.6891**	0.7457**	0.8292**		
100-seed weight (g)	0.7634**	0.7501**	0.8142**	-0.8294**	-0.8705**	0.8695**	
Oil content (%)	0.7511**	0.6844**	0.8299**	0.8842**	0.9220**	0.7591**	0.7838**

** = Highly significant at 0.01

Head diameter (cm): Head diameter only expressed highly significant and positive relationships with grains per head (0.8292**), and oil content (0.9220**), while it was negative and highly significant linked with only 100-seed weight (-0.8705**). Sincik and Goksoy (2014) revealed that there were significant positive correlations between seed yield and plant height as well as head diameter.

Grains per head: Grains per head disclosed only highly significant and positive connection with 100-seed weight (0.8695**) and oil content (0.7591**). Our results agree with Rizk *et al*. (2019).

100-seed weight (g): Seed index expressed positive and highly significant linkage with oil content (0.7838**). Razzaq *et al*. (2014) suggested that seed index and head diameter may be used in breeding program for selection of high yielding sunflower types. Qamar *et al***.** **(**2018) designed to find out differential response of sunflower genotypes and in this way, his results are in paradox with us.

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