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Evaluation of sunflower hybrids under the climatic condition of Peshawar, Pakistan

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Abstract

A field experiment was conducted at Botanical Garden, Department of Botany, and Islamia College Peshawar in order to evaluate the performance of different sunflower hybrids under the climatic conditions of Peshawar and to bring about the correlative study between different morphological and physiological characteristics. A randomized complete block design with three replications was applied using four sunflower hybrids Ass-501, S-270, Samsung-30 and LG- 56.6. The statistical analysis of the data revealed that all sunflower hybrids were non-significantly different form one another with respect to days to flower initiation, days to 50% flowering, days to 100% flowering, days to head maturity, head diameter, plant height, 1000-seed weight, grain yield, oil content percentage. Performance of sunflower hybrids with respect to fatty acid profile was also non-significantly different from one another. In addition, positive and negative correlation was observed among different morphological and physiological parameters of these hybrids. It is concluded that all of the four sunflower hybrids perform, indicating that all of them suit equally to this climatic conditions. Simple correlation coefficient analysis proved that days to flower completion (100%), days to head maturity, plant height and 1000-seed weight had positive correlation with grain yield, while days to flower initiation, days to 50% flowering and head diameter had negative correlation with grain yield. The analysis of simple correlation coefficient also indicated that days to flower completion, days to head maturity and grain yield had positive correlation with percentage of palmitic, oleic and linoleic acid respectively. Therefore, these are worth characters to be taken by plant breeders for improving oil quality of sunflower hybrids. None of them supersede other, and all of them suit equally the climatic conditions of Peshawar.

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Introduction

The sunflower (*Helianthus annuus* L.) is one of the most important oil seed crops, which belongs to the family Asteraceae. Sunflower (*Helianthus annuus* L.) has its origin in North America. It was probably a camp follower of several western Native American tribes who domesticated the crop (possibly 1000 BC) and then carried it eastward and southward of North America. The first European observed sunflower cultivated in many places from Southern Canada to Mexico. Sunflower was probably first introduced to Europe through Spain, and spread throughout the Europe as a curiosity until it reached Russia where it was readily adapted. An array of sunflower hybrid is now under cultivation in the world (Putnam *et al.,* 1990). Sunflower leaves are phototropic and will follow the sun's rays with a lag of 120 behind the sun azimuth. This property has been shown to increase light interception and possibly photosynthesis (Putnam *et al.,* 1990).

Since many sunflower varieties have a degree of self-incompatibility, cross pollination by insects is important. In temperate regions, sunflower requires approximately 11 days from planting to emergence, 33 days from emergence to head appearance, 27 days from head appearance to first anther, 8 days from first tallest anther, and 30 days from last anther to maturity. Cultivar differences in maturity are usually associated with changes in vegetative period before the head is visible (Putnam *et al.,* 1990). Sunflower is a temperate zone crop but it can perform well under various climatic and soil conditions and this adaptability makes it possible to be grown under a wide range of growing conditions. Sunflower hybrids have evolutionary advantage of being able to maintain high level of viability in a variety of environments (NODP, 2005). Increasing of oil yield is one of the most important goals in sunflower (*Helianthus annuus* L.) breeding programs (Mijic *et al*., 2009). They assessed the interrelationships between oil yield and its components on 14 sunflower hybrids developed within a breeding program of the Agricultural Institute Osijek, Croatia. Plant height, 1,000 grain weight, test weight, grain yield, oil content and oil yield were analyzed. Phenotypic and genotypic coefficients of variation were highest for grain yield, followed by oil yield and 1,000 grain weight. High values of heritability were estimated for oil content and plant height, medium for 1,000 grain weight and test weight, and low values for grain and oil yield. Highly significant positive correlation was estimated between grain yield and oil yield, but the association between grain yield and oil content was negative and low. A positive correlation coefficient was estimated between 1000-grain weight and grain yield, and a negative one between 1000-grain weight and oil content.

Aims of the study

Keeping the importance of production of sunflower crop in view, the present study was aimed to evaluate and asses:

1. The performance of different sunflower hybrids under the climatic conditions of Peshawar.

2. The seed yield, oil content and quality of different sunflower hybrids under the climatic conditions of Peshawar.

3. The correlations among various morphological parameters with oil yield and its component characters in sunflower hybrids.

4. The correlation between morphological characters and quality of oil in sunflower hybrids.

The correlation between oil content and fatty acid profile of sunflower hybrids.

Material and method

The experiment was conducted at the Botanical Garden, Department of Botany, Islamia College Peshawar during spring, 2010.

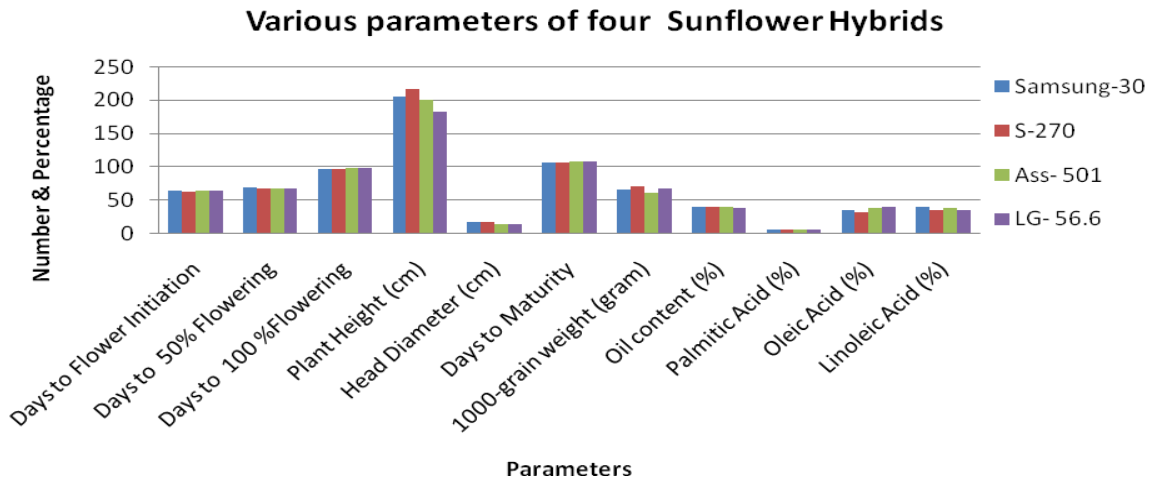
Climate

The meteorological data of Peshawar regarding humidity, rainfall and temperature from March 2010 to February 2011 is given in Table 1.The average maximum temperature (39.1° C) was recorded in the month of June, followed by July with average

maximum temperature of (38.7 ° C). The average minimum temperature (4.0 °C) was recorded for the month of January 2010 followed by December 2009 with average minimum temperature of (5.3). The annual average rainfall of (33.7 mm) was recorded from 1st March 2009 to 30 February 2010. The average highest relative humidity of 84 and 82 was recorded in the 1st and 2nd month of 2010 respectively, while in November 2009 the highest relative humidity was 82. The lowest average minimum relative humidity of 58 was recorded in May 2009.

Table 1. Different Parameters of Hybrid Sunflower under different conditions.

Hybrids	Days to Flower Initiation	Days to 50% Flowering	Days to 100 %Flowering	Plant Height (cm)	Head Diameter (cm)	Days to Maturity	1000-grain weight (gram)	Oil content (%)	Grain yield kg ha^{-1}	Palmitic Acid (%)	Oleic Acid (%)	Linoleic Acid (%)
Samsung-30	64.67	68.67	96.33	205.19	18.24	106.33	65.87	41	3022.54	5.95	35.72	40.53
S-270	63.33	67.33	96.67	216.38	17.14	106.67	71.67	40.79	3641.79	5.83	31.62	34.89
Ass- 501	65	68	98	199.64	15.24	108	60.9	40.72	3389.43	5.94	38.42	39.29
LG- 56.6	64.67	68	98.67	182.69	14.18	108.67	68.27	38.83	3311.26	6.53	40.05	35.44



Graph 1.

Experimental details

The experiment was laid out in a Randomized Complete Block Design with three replications. The plan of layout of the experiment is given in Fig. 1.There were four treatments comprising of different sunflower hybrids namely Ass-501, S-270, Samsung-30 and LG-56.6. Total no. of replica = 3, Total no. of treatments = 4 x 3 = 12, No. of treatment per replica = 4, No. of rows per treatment = 4, No. of rows per replica = 4 x 4 = 12, Row length = 300 cm, Row to row space = 61 cm, Plot size, Total plot area= 3m x 0.61m x 4 = 7.22 m^2, Harvested area = 3 x 0.61 x 2 = 3.66m^2.

Results

Sunflower hybrid Ass-501 took maximum (65) days to initiate flowering, followed by Samsung-30 (64 days) and LG-56.6 (64 days). S-270 took minimum (63) days. The data regarding days to flower initiation showed that there was non-significant difference among the hybrids (Table1). Almost all of the hybrids took the same (68) days regarding 50% flowering. The data regarding days to 50 % flowering showed

that there was non-significant difference among the hybrid (Table1). Ass-501 and LG-56.6 took maximum time (98) days to complete flowering; however Samsung-30 and S- 270 reached to flower two days earlier than other hybrids. Non-significant differences were observed among the hybrid regarding 100% flowering days (Table 1). The mean value for plant height ranged between 182.69 cm to 216.38 cm. The maximum height (216.38 cm) was observed for hybrid S-270, followed by Samsung-30 with plant height of 205.19 cm. The smallest plant height of 182.59 cm was recorded in the hybrid LG-56.6. Non-significant difference was observed among the hybrids regarding plant height (Table 1). The mean value for head diameter ranged from 14.17 cm to 18.24 cm (Table 1); however the head diameter of Samsung-30 was recorded 18.24 cm, followed by hybrid S-270 with (17.14 cm) while minimum head diameter of 14.18 cm was observed in hybrid LG-56.6. The data about the head diameter showed that hybrids were non-significantly different (Table 1). Ass-501 and LG-56.6 took maximum time (108) to maturity, while Samsung-30 and S-270 matured two days earlier taking (106) days. However non-significant differences were seen among the hybrids regarding days to maturity (Table 1).

The highest value of 1000-grain weight (71.67 g) was shown by hybrid S-270, followed by hybrid LG 56.6 (68.27 g). Lowest 1000-grain weight was observed in hybrid Samsung-30 (65.87 g) and hybrid Ass-501 (60.90) respectively (Table 1). The data regarding 1000-grain weight showed non-significant differences among the hybrid of the sunflower. Oil content (%) mean values ranged from 38.83 % to 41.00 %. The highest mean value (41.00 %) was recorded for hybrid Samsung-30, while lowest means value (38.83 %) in LG-56.6. Hybrid, S-270 and Ass-501 almost tied each other with oil content of 40.79 % and 40.72 % respectively. The data regarding oil content (%) proved that all the sunflower hybrids were non-significantly different from each other (Table 1).

Palmatic acid mean value ranged from 5.83 % to 6.53 %. The highest mean value (6.53 %) was observed for LG-56.6, while Samsung-30, S-270 and Ass-501 showed almost the same mean value of 5.95 %, 5.83 % and 5.94 %, respectively (Table 1). The data about the palmaitic acid (C16:0) reveal that all the hybrids of sunflower are non-significantly different from each other. The highest mean oleic acid value (40.05 %) was observed for hybrid LG-56.6 followed by Ass-501 with mean value (38.42 %). The lowest mean oleic acid value (31.62 %) was shown by S-270, followed by Samsung-30 (35.72 %)(Table 1). Non-significant difference were observed for oleic acid (C18:1) among sunflower hybrids. The mean linoleic acid value ranged between 35.44 % to 40.53 %. However, the highest mean linoleic acid value (40.53 %) was observed for Samsung-30, followed by Ass-501 with mean value (39.29 %). The lowest mean linoleic acid value (34.89 %) was shown by hybrid S-270 (Table 1). Linoleic acid (C 18:2) percentages were non-significantly affected by hybrids of the sunflower.

Correlation study

The data indicates that flower initiation (days) had high positive correlation with 50 % flowering, 100 % flowering and head maturity (r= 0.736, r= 0.489 and r= 0.489), respectively, while flower initiation had high negative correlation with 1000-seed weight, yield (kg ha^{-1}), head diameter and plant height and oil content percentage (r= -.855, r= -0.680 r= - 0.388 and r= - 0.674 and r= -0.377), respectively. Results indicate that 50 % flowering (days) had weak positive correlation with 100 % flowering (days), head maturity and head diameter (r= 0.124 and r= 0.124 and r= 0.245 respectively), but 50 % flowering (days) had strong negative correlation with 1000-seed weight, grain yield kg ha^{-1} and Plant height and weak negative correlation with oil content. The 100 % flowering (days) had positive correlation with flower initiation (days), 50% flowering (days), head maturity (days) and grain yield kg ha^{-1} (r= 0.489, r= 0.124, r= 1.00 and r= 0.131), respectively, while it had negative correlation with 1000-seed weight, head diameter, and plant height. The head maturity (days) showed

negative correlation with 1000-seed weight (r= -0.284), head diameter(r= -0.992) and plant height (r= -0.857) and oil content percentage (r= -0.693), While positive correlation was observed for head maturity (days) with flower initiation (days), 50% flowering (days), 100% flowering (days), and yield kg ha^{-1} (r= 0.131).

Positive correlation was observed for 1000-seed weight with yield (kg ha^{-1}), head diameter, and plant height (r= 0.413, r= 0.217 and r= 0.217 respectively). 1000-seed had negative correlation with flower initiation (days), 50% flowering (days), 100% flowering (days), days to head maturity and oil content percentage (r= -0.855, r= -0.527, r= - 0.284, and r= -0.284 r= -0.006), respectively. Yield (kg ha^{-1}) showed positive correlation with days to 100% flowering (r=0.131), days to head maturity (r= 0.131), 1000-grain weight (r= 0.413), pant height(r = 0.351), and oil content percentage (r= 0.100).while seed (yield kg ha^{-1}) was negatively co-related with head diameter (r= -0.252). The head diameter was positively correlated with 50% flowering, 1000-grain weight, plant height and oil content (r= 0.245, r= 0.217 and r= 0.795, r= 0.321 respectively). The head diameter was negatively associated with flower initiation (days), (days), 100% flowering (days), head maturity (days), and grain yield (r= -0.0.388, r= -0.992 r= -0.992 and r= -0.252), respectively. The results revealed that plant height was positively correlated with 1000-grain weight (r= 0.273), grain yield kg ha^{-1} (r= 0.351), head diameter (r= 0.795) and oil content percentage (r= 0.566). The plant height was negatively correlated with flower initiation (days), 50% flowering (days) 100% flowering (days) and days to maturity (r= -0.674, r= -0.674, r= -0.326 and -0.857) respectively. The results showed that oil content percentage was positively correlated with grain yield (r= 0.100), head diameter (r= 0.321), and plant height (r= 0.566), while oil content was negatively associated with flower initiation (days) , 50% flowering (days) , 100% flowering (days) , head maturity (days), and 1000-grain weight (r= -0.377, r= -0.355, r= -0.693, r= -0..693 r=-0.006)respectively,

Correlation between bio-chemical and morphological characteristics

Palmitic acid C 16:0 % had positive correlation with flower initiation (r=0.246) 100% flowering (days) (r= 0.201), head maturity (r= 0.201), 1000-seed weight (r= 0.164), while negative correlation was observed with 50 % flowering, head diameter (r= -0.389), plant height (r= -0.693) and yield kg ha^{-1} (r= -0.183). The results indicate that positive correlation for oleic acid with flower initiation (r= 0.404), 50 % flowering (r= 0.73), 100% flowering(r= 0.190), head maturity(r= 0.190), however oleic acid was negatively correlated with 1000-seed weight (r= -0.207), plant height (r= -0.307), head diameter(r= -0.307) and yield kg ha^{-1} (r= -0.051). The results showed that linoleic acid was positively correlated with flower initiation (r=0.058), 50 % flowering (r= 1.718), 100% flowering (r= 0.751) and head diameter (r= 0.361), however oleic acid had negative correlation with 1000-seed weight (r= -0.138), plant height (r= -0.418) and yield kg ha^{-1} (r= -0.357). The correlation of oil content percentage with palmitic acid C16:0 percentage was negative (r= -0.592), while positive correlation was observed for oil content with percentage of oleic acid C18:1 and linoleic acid C18:2 (r= .089 and r= 0.433) respectively. Palmitic acid C16:0 was positively correlated with oleic acid C18:1 (r= 0.417) and had weak negative correlation with linoleic acid C18:1 (r= -0.163). Oleic acid C 18:1 percentage had positively correlation with linoleic acid C18:2 (r= 0.194).

Table 2. Simple correlation coefficients for morphological and chemical characters of various Sunflower hybrids at Peshawar.

	D50%F	DFC	DHM	1000-SW(GM)	GY KG/HAC	HD (CM)	PH(CM)	OC %	PA %	OA %	LA %
DFI	0.736	0.489	0.489	-0.855	-0.680	-0.388	-0.674	-0.377	0.246	0.404	0.058
D50%F		0.124	0.124	-0.527	-0.991	0.245	-0.674	-0.335	-0.00	0.73	1.718
DFC			1.00	-0.284	0.131	-0.992	-0.326	-0.693	0.201	0.190	0.751
DHM				-0.284	0.131	-0.992	-0.857	-0.693	0.201	0.190	0.751
1000 - SW(GM)					0.413	0.217	0.273	-0.006	0.164	-0.207	-0.138
GY KG/HAC							0.351	0.100	-0.183	-0.051	-0.357
HD (CM)							0.795	0.321	-0.389	-0.307	0.361
PH (CM)								0.566	-0.693	-0.307	-0.418
OC %									-0.512	-0.693	0.433
PA %										-0.512	-0.163
OA%											-0.194

DFI: days to flower initiation; **D50%F:** days to 50% flowering; **DFC:** days to flower completion; **DHM:** days to head maturity; SW **(G):** seeds weight in gram; **GY kg ha^{-1}:** grain yield; **HD (CM):** head diameter in centimeter; **PH (CM):** plant height in centimeter; **OC:** oil content; **PA:** Palmitic acid; **OA:** oleic acid; **LA:** linoleic acid.

Discussion

The experiment was aimed at determining variability in the performance of different sunflower hybrid and to determine the one that best suits the climatic conditions of Peshawar. Furthermore, the correlation study among different characters of sunflower hybrids was carried out to determine the combination of characters that contribute to high yielding capacity of sunflower hybrid. The results about days to flower initiation and days to 100% flowering (Table 1) showed non-significant differences among the hybrids. Similar results were reported by Bakht *et al*., (2006) who reported that days to flower initiation and days to flower completion was non-significantly affected by various hybrids of the sunflower. The results about days to 50% flowering showed that 50% flowering (days) were non-significantly affected by different sunflower hybrids (Table 1). These results do not correspond to Siddiqui *et al*., (2012) findings who observed significant difference for 50% flowering among all tested sunflower genotypes. The data (Table 1) demonstrated that head diameter was not affected by different sunflower hybrids. These results were in line with the findings of Bakht *et al.,* (2006) Arshad *et al.,* (2007) T. Machikowa and C. Saetang (2008) and Khan *et al*., (2003). They reported that head diameter was non-significantly affected by various sunflower hybrids, but deviate from the results of Ali *et al.,* (2011) who observed significant difference among hybrid for head diameter. The average values of the plant height showed that plant height was not significantly affected by various sunflower hybrids (Table 1). These results deviate from findings of Bakht *et al.,* (2006) Siddiqui *et al*., (2012) and Arshad *et al.,* (2003) who assessed significant difference for plant height among various sunflower hybrids. The data in (Table 1) revealed that days to head maturity showed non-significant difference among different sunflower hybrids. These results are not in concurrence with Bakht *et al*., (2006) and Khan *et al*., (2003), who found significant difference for head maturity among different sunflower hybrids.

The mean value about 1000-grain weight given in (Table 1) indicated non-significant difference among the sunflower hybrids, similar report was given by T. Machikowa and C. Saetang (2008), who observed non-significant difference among the different sunflower hybrids regarding 100 grain weight,

however the results are not in line with Ali *et al*., (2011) Bakht *et al*., (2006) Khan *et al*., (2003) and Saleem *et al.,* (1998) findings who reported significant difference among the hybrid for 1000-grain weight. The results about oil content showed non-significant difference among various sunflower hybrids (Table 1), similar reports were given by Khan *et al.,* (2003) and Siddiqui *et al*., (2012) who demonstrated significant difference for all characters of sunflower hybrids except oil content, but in contradiction with the results of Khan *et al*., (2007) T. Machikowa and C. Saetang (2008) who found significant difference among various sunflower hybrid regarding oil content.

Correlation study

The analysis of the data (Table 2) showed that days to flower initiation was positively correlated with days to 100% flowering and days to maturity, similar results were recorded by Khan *et al*., (2009) and Arshad *et al.,* (2007) who observed positive association for days to maturity with days to flower initiation and days to flower completion(100%).The results indicated that days to flower initiation was negatively associated with 1000-seed weight, seed yield and oil content, the results were confirmed by Arshad *et al.,* (2007) T. Machikowa and C. Saetang (2008), who reported that days to flower initiation had negative association with seed yield, 100 seed weight and percentage oil content, but these results deviate from the findings of khan *et al;* (2003), who observed positive correlation of days to flower initiation with seed yield and 1000-seed weight. The results revealed (Table 2) that days to 50% flowering was positively associated with head diameter and negatively associated with oil content, these results are in line with Manivannan *et al*., (2005) results, however the negative association of days to 50% flowering with grain yield kg ha^{-1}, deviate from Khan (2001) and Sowmaya *et al*., (2010) findings who reported positive correlation between days to 50% flowering and grain yield. The experimental results revealed (Table 2) that head diameter had positive correlation with 1000- grain weigh, plant height and oil content; similar results were reported by Khan *et al.,* (2003) they reported positive correlation for head diameter with plant height, 100 grain weight and oil content. The results of my experiment (Table 2) indicated that 1000-seed weight had positive correlation with grain yield (kg ha^{-1}), head diameter and plant height. These results of my experiment imply that pant height increases the size of the seeds in the head due to accumulation of greater amount of dry matter which contribute to increase in the total yield kg ha^{-1}. These results were supported by Khan *et al.,* (2003) who reported positive correlation of 100 grain weight with head diameter, grain yield and plant height. Farhatullah *et al*., (2006) and Manivannan *et al.,* (2008) also observed positive direct effect of 1000-grain weight on grain yield and considered it important character for yield improvement in sunflower hybrid. Mijic *et al*., (2009) found positive correlation between 1000-seed weight and gain yield but negative association of 1000- seed weight and oil content, which support the results of my experiment. Similar observations were reported by Nirmal *et al*., (2000) Tecklewold *et al*., (2000) and Khan (2000). They investigated that 100 seed weight positively correlated with seed yield.

The data indicates that grain yield had positive correlation with plant height (Table 2). This is because when plant is high, greater will be the number of leaves on the plant and greater will be the rate of accumulation of photosynthate (dry matter), which will increase weight of the stem and weight of grain in the head, producing greater yield. Similar results were observed by Farhatullah *et al*., (2006) Tyafi (1985) Kaya *et al.,* (2007) Khan *et al*., (2007) and Sowmya *et al.,* (2010). They observed positive correlation of grain yield with plant height. The result showed that grain yield was positively correlated with 1000-grain weight; this implies that heavier the grain of the hybrid will produce more yield kg ha^{-1}. These results are supported by Manivannan *et al.,* (2008) Khan *et al*., (2007) Nirmal *et al*., (2000) Tecklewold *et al*., (2000) and khan (2000) findings who also observed positive association between grain yield and 100 grain weight. The grain yield was positively

correlate with oil content %, these results are in line with Khan *et al.*, (2007). The results revealed that oil content was positively correlated with grain yield kg ha^{-1} (Table 2).These reports are in correspondence with and Khan *et al.*, (2007, 2001) who demonstrated positive correlation between oil content and grain yield, but deviate from Mijic., (2009) findings who reported negative association between oil content % and grain yield. The results indicated that oil content was negatively correlated with days to flower initiation, and 1000-grain weight; these results are in concurrence with T. Machikowa and C. Saetang (2008). Mijic *et al.*, (2009) and Hlandi *et al.*, (2010) also reported negative association for oil content with 1000-grain weight.

The results of the experiment (Table 2) indicated that percentage of palmitic acid, olic acid, and linoleic acid were positively correlated with days to flower initiation, days to 100% flowering and days to head maturity but negatively associated with plant height and grain yield. The results showed that percentage of palmitic acid was positively associated with 1000-grain weight while percentage of oleic acid and linoleic acid were negatively associated with 1000-grain weight. The results proved that palmitic acid and oleic acid were negatively associated with head diameter and oil content percentage. But linoleic acid was positively associated with head diameter and oil content percentage. The results proved that oleic acid and linoleic acid were negatively correlated with palmitic acid. The results showed negative interrelationship between the linoleic acid and oleic acid. These results are in line with Kaleem *et al.,* (2011) and Badwal *et al.*, (1993) who reported inverse relationship between linoleic acid and oleic acid.

Conclussion

It is concluded from the results and discussion that all of the sunflower hybrids performed equally under the climatic conditions of Peshawar which may be due to their closely related genetic makeup that express themselves equally towards the prevailing environment of Peshawar. Since the prevailing climatic conditions of Peshawar remain the same, so it does not significantly modify gene expression of different sunflower hybrids that is why all of the hybrids equally performed well under the climatic conditions of Peshawar. Therefore none of the sunflower hybrids is preferred over the other, all of them are equally recommended for Peshawar climatic conditions. Simple correlation coefficient analysis revealed that Days to flower completion (100%), days to head maturity, plant height and 1000-seed weight had positive correlation with grain yield, while days to flower initiation, days to 50% flowering and head diameter had negative correlation with grain yield. These are important characters to be taken to develop high yielding hybrids by the plant breeders.

The analysis of simple correlation coefficient also indicated that days to flower completion, days to head maturity and grain yield had positive correlation with palmitic, oleic and linoleic acid, respectively, and so these are worth characters to be taken by plant breeders for improving oil quality of sunflower hybrids.

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