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Correlation studies among morphological and yield-related traits in sunflower

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Abstract: Pakistan is in dire need of an oil and oil-based products For this, the prime objective is to pay serious attention to oilseed crops and mainly towards sunflower because the oil is of very good quality in terms of nutrition value; also the cake can be used as feed for animals. The crop can trim the import bill of edible oil. It takes only 130 days to reach maturity with comparatively less cost and highly divined in sense of plentiful yield. Thus breeders are trying to produce good quality accessions that may also fulfil the need of quantity where climate change is also the main issue. The present research was conducted at the Raja wala farm situated near the Department of Plant Breeding and Genetics, University of Agriculture, Faisalabad during the year 2020–21. Twenty accessions of sunflower were sown in Randomized Complete Block Design (RCBD) with three replications. From each line, five plants were tested to check the genetic variability, correlation coefficient analysis for different morphological characters and yield-related traits of sunflower. The data of quantitative traits were recorded i.e. plant height (cm), the number of leaves/plant, head diameter (cm), internodal length (cm), leaf area (cm), 100 seed weight (g), total yield per plant (%), oil content (%) and protein content (%). Analysis of variance and mean comparisons of sunflower accessions had highly significant differences for all traits. Most of the character's ranges are comparable with the ranges found in the literature. The accession G-32 showed good performance for oil content, protein content and head diameter. So, this breeding material can be used in the breeding program for the enhancement of sunflower yield. The accessions G-38, G-28 and G-32 showed good performance for total seed weight, 100 seed weight, oil content and protein content.

Keywords: correlation; morphological; sunflower; yield traits.

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Introduction

Sunflower (*Helianthus annuus* L.) is native to North America and is one of the most important oil crops ranked third in position among all oilseed crops (*H. annuus* L.) comprises 51 annual and perennial species (Kaya et al. 2012). Belonging to the family Asteraceae, the diploid genome of the sunflower comprises 34 chromosomes. The seeds of sunflower are termed **achene** a very good source of protein. The seed contains 40–48% oil and 20–27% protein content (Nazir et al. 1994). Sunflower oil is preferred as superior oil due to its bright colour, trivial taste and capability to endure at extraordinary food preparation temperatures. Its oil is recycled as steaming oil and in greasepaints. It comprises vitamin A, B, E and K (Gossal et al. 1988). The fatty acid summary reveals great poly-unsaturated fats like oleic acid 16% and linoleic acid (73%), which are preferable for regulating high cholesterol levels in the body (Satyabrata et al. 1988).

Self-pollination in sunflowers is of abundant significance as it offers the development of inbred lines. In general, the improvement of sunflower crosses involves the progress of homozygous inbred lines, exploration of these lines and assessment of these crosses. The breeders of sunflower do exertion on its accessions for achene and oil yield. The researcher's objective is mainly to focus on oil yield. For this, it is necessary to realize the hereditary constraints for the development of the sunflower (Rahman et al. 2013).

Pakistan cannot accomplish its oil necessities that's why we have to spend a huge aggregate of cash on its import. During FY 2021 (July–March), 2.917 million tons of edible oil of value Rs 574.199 billion (US$ 3.419 billion) were imported. Local production of edible oil during this period is provisionally estimated to be 0.374 million tons. During 2019–20 the total production (0.055 million tons) of sunflower oil was obtained from an area of 250 thousand acres while in 2020–21 the total production was 0.033 million tons from an area of 151 thousand acres (Pakistan Bureau of Statistics 2020–21). The great instabilities in the sunflower area and production were mainly due to the sharp ups and downs in the market worth of oilseed crops. But now, the Govt. of Pakistan (GOP) is taking new initiatives, for the promotion of oilseed crops. Pakistan Oilseed Development Board (PODB), Ministry of National Food Security & Research (MNFS&R) is executing a mega project "National Oilseed Enhancement Program" with a total cost of Rs 10.964 billion under the National Agriculture Emergency Program (Pakistan Bureau of Statistics 2021).

Two crops of sunflower are developed in Pakistan, i.e., spring and summer. However, the domestic yield is around **1193.23 kg/ha** (GOP, 2003). The chief explanations for this low yield are the absence of superior seed, relaxed approval of

better-quality agro-technologies and lack of thorough price reasons for the growers (Hussain and Khan 1998).

The objectives of this research are assessment of sunflower accessions for improved yield, yield contributing characters and expressing assortment principles established on character association, and direct and indirect effect on achene yield.

Materials and methods

The research was held at the research fields of the Plant Breeding and Genetics Department, University of Agriculture, Faisalabad, which is situated in the undulant flat plains of North East Punjab. It is among longitudes 73°–06° east, latitude 31°–26° north and at an altitude of 184.4 m. The testing material comprises 20 sunflower lines developed and maintained by the Oilseed Research Group, Department of Plant Breeding and Genetics, University of Agriculture, Faisalabad. The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications during the spring season of 2020. One row of 23 ft of each accession per replication was grown. Dibbler method was used for sowing of these accessions keeping the seed rate at 2–2.5 kg/acre. Row-Row and Plant-Plant distance of 75 and 23 cm was maintained respectively. Ten plants of each line and each replication were evaluated for these parameters like plant height (**PH** in cm), head diameter (**HD** in cm), number of leaves/plant (**NOL/P**), leaf area (**LA** in cm^2), internodal length (**INL**), 100 seed weight (**100 SW** in g), total yield per plant (**TY/P**), oil content (**OC** %) and protein content (**PC** %). Length based traits were measured with the help of measuring tape while100 achene weight and achene yield per plant was measured on the digital analytical balance. Biochemical parameters like oil content and protein content were analyzed by the soxhlet method at the National Institute of Food and Agriculture (NIFA) Peshawar.

Principle of soxhlet extraction method

Soxhlet extractor extracts the components using the condensed vapours of the solvent. The condensed vapours come in contact with the sample powder and the soluble part in the powder gets mixed with the solvent.

Biometrical approach

The data was analyzed for analysis of variance in a randomized complete block design (RCBD) given by Steel et al. (1997). The means of various progenies for each character were calculated and compared using Least Significant Design by Williams and Abdi (2010). Genotypic and phenotypic correlation coefficients are calculated according to Kwon and Torrie (1964). The statistical significance of the genotypic correlation was tested by the methodology outlined by Lathorp et al. (1985). Oil and protein content was analyzed by the Soxhlet extraction method given by Franz von Soxhlet in 1879.

Results and discussion

Mean values of 20 sunflower accessions for different traits (under study) are presented in Table 1. The mean values of the accessions vary significantly for all the traits such as plant height, internodal length, leaves per plant, leaf area, head diameter, 100 achene weight, oil content, protein content and achene yield per plant. The accession G-32 showed good performance for oil content, protein content and head diameter. While G-38, G-28 and G-32 exhibited better performance for 100 seed weight, total seed weight, oil content and protein content. Syed et al. (2004), Khan et al. (2007), Ilahi et al. (2009), Arshad et al. (2010), Jockovic et al. (2012), Sridhar et al. (2006), Sujatha et al. (2002), Razzaq et al. (2014), and Hassan et al. (2012) also reported similar results for the parameters discussed above. Mean comparison values of all the accessions are presented in Table 2.

Correlation analysis

Genotypic and phenotypic correlations within different quantitative and biochemical traits of sunflower are depicted in Tables 3 and 4 respectively.

The overall phenotypic correlation was less than the genotypic correlation. Plant height showed a negative and non-significant correlation with head diameter, oil content, protein content, 100 seed weight, total seed weight and leaf area. Chikkadevalah et al. (2002), Dagustu (2002), Farratullah et al. (2006), Arshad et al. (2007), Yasin and Singh (2010), Safavi et al. (2011), Safavi et al. (2014), Mahmoud (2012), and Tahir et al. (2019) also discussed in their results that genotypic correlation is higher than the phenotypic one. Ashok et al. (2000), Farratullah et al. (2006), Amorim et al. (2008), Kaya et al. (2008), Kaya et al. (2009), Sowmya et al. (2010), and Safavi et al. (2011). Head diameter, 100 seed weight, oil content and protein content showed negative and non-significant correlations with the number of leaves at the phenotypic level. Both genotypic and phenotypic correlations showed a positive and highly significant correlation with leaf area. Elena et al. (2009), Boain and Kongsamai (2009), and Kang and Ahmad (2014) also presented similar results for head diameter, 100 seed weight oil content and protein content. Oil content showed a positive but non-significant correlation at the phenotypic level. Ahmad et al. (1991), Marinkovic (1992), Habib et al. (2006), and Kalukhe et al. (2010) also reported that head diameter showed a significant correlation between protein content and seed weight. Both genotypic and phenotypic correlations had negative and significant correlations with head diameter. Negative and non-significant phenotypic correlations showed with total seed weight Hassan et al.

Table 1: Mean square values from ANOVA of various studied traits in 20 accessions of ***H. annuus***.

SOV	df	PH	INL	NOL/P	LA	HD	100 SW	OC	PC	TY/P
Replication	2	103.07	22.38	2.46	417.59	3.05	0.09	0.08	0.03	0.15
Accessions	19	2833.50	9.78	68.26	3652.10	19.89	1.15	1.50	1.28	1.70
Error	38	31.49	4.07	0.85	173.34	5.61	0.01	0.05	0.15	0.004

Table 2: Mean values of the studied traits of 20 accessions of sunflower.

Accessions	Plant height (cm)	No. of leaves	Head diameter (cm)	Internodal length (cm)	Leaf area (cm^2)	100 seed weight (g)	Total yield/ plant (g)	Protein content (%)	oil content (%)
G-21	251.47	21	17.78	10.16	109.22	6.70	18.30	20.20	20.20
G-22	246.38	33	16.93	10.16	127.00	6.50	19.20	19.67	19.70
G-23	198.12	23	15.24	11.85	139.70	5.50	18.70	20.43	20.40
G-24	185.42	25	16.93	9.31	160.02	5.70	19.30	20.20	20.70
G-25	157.63	25	15.24	8.62	165.10	6.40	19.90	19.87	20.50
G-26	220.98	33	22.86	11.85	142.24	5.10	19.60	20.80	20.80
G-27	226.91	23	15.24	12.70	251.46	5.20	20.20	19.97	19.30
G-28	234.35	36	15.24	8.47	109.22	6.80	19.80	19.97	19.60
G-29	198.12	26	17.78	10.16	142.24	5.70	19.70	20.50	20.50
G-30	165.10	28	15.24	10.16	162.56	5.90	20.20	19.40	19.40
G-31	208.20	23	18.63	9.313	109.22	6.00	20.50	20.80	20.80
G-32	167.64	25	16.09	8.47	91.44	6.30	18.30	21.77	21.80
G-33	228.60	24	13.55	11.85	143.09	5.10	19.30	21.50	21.50
G-34	236.53	21	13.55	7.62	162.56	5.90	20.50	19.20	19.20
G-35	197.94	15	15.24	7.62	127.00	6.80	19.30	20.43	20.40
G-36	205.90	24	18.63	13.55	121.92	5.30	18.20	21.07	21.10
G-37	249.07	21	14.39	10.16	109.22	5.20	19.70	20.43	20.40
G-38	167.79	22	12.37	9.313	182.88	4.90	20.60	20.57	19.50
G-39	238.76	24	16.93	12.70	134.31	5.10	20.50	20.30	20.30
G-40	243.99	23	11.01	12.70	139.70	5.70	19.30	19.63	20.50

Table 3: Genotypic correlation coefficient of various characters among the sunflower accessions.

	PH	NOL/P	HD	INL	LA	100 SW	Total Y/P	OC	PC
PH	1.000	0.080	−0.308[a]	0.464[b]	−0.181	−0.040	−0.047	−0.168	−0.217
NOL/P		1.000	−0.042	0.357[b]	0.362[b]	−0.132	0.233	−0.222	−0.162
HD			1.000	0.002	0.004	−0.115	−0.112	0.195	0.460[b]
INL				1.000	0.247	−0.839[b]	−0.270[a]	−0.211	0.203
LA					1.000	−0.432[b]	0.491[b]	−0.541[b]	−0.407[b]
100 SW						1.000	−0.187ty	−0.120	−0.242
Y/P							1.000	−0.580[b]	−0.461[b]
OC								1.00000	0.854[b]
PC									1.000

[a]Significant at 0.05 probability level. PH, plant height; NOL/P, number of leaves per plant; HD, head diameter; INL, inter nodal length; LA, leaf area; 100 SW, 100 seed weight; TSW, total seed weight; OC, oil content; PC, protein content. [b]Values are highly significance.

Table 4: Phenotypic correlation coefficient of various characters among the sunflower accessions.

	PH	NOL/P	HD	INL	LA	100 SW	Total Y/P	OC	PC
PH	1.000	0.081	−0.177	0.203	−0.177	−0.036	−0.049	−0.049	−0.185
NOL/P		1.000	−0.010	0.168	0.314[b]	−0.131	0.226	−0.207	−0.127
HD			1.000	−0.002	−0.059	−0.055	−0.055	0.114	0.271[b]
INL				1.000	0.188	−0.468	−0.137	0.154	0.132
LA					1.000	−0.397[b]	0.467[b]	−0.497[b]	−0.333[b]
100 SW						1.000	−0.185	−0.118	−0.207
T Y/P							1.000	−0.550[b]	−0.379[b]
OC								1.000	0.784[a]
PC									1.000

[a]Significant at 0.05 probability level. PH, plant height; NOL/P, number of leaves per plant; HD, head diameter; INL, inter nodal length; LA, leaf area; 100 SW, 100 seed weight; TSW, total seed weight; OC, oil content; PC, protein content. [b]Values are highly significance.

(2012). The leaf area had a positive and highly significant phenotypic correlation with the number of leaves and total seed weight. Leaf area had a negative and non-significant correlation with plant height and head diameter at the phenotypic level Kolghi et al. (2011). Both genotypic and phenotypic correlations had negative and highly significant correlations with internodal length and leaf area. One hundred seed weight had a negative and non-significant correlation with plant height, number of leaves, head diameter, total seed weight, oil content and protein content at the phenotypic level. Total seed weight had negative and non-significant with plant height, head diameter, internodal length and 100 seed weight. Habib et al. (2006), Ozturk and Ada (2009), and Yasin and Singh (2010). Oil content had a negative and non-significant phenotypic correlation with plant height, number of leaves and 100 seed weight.

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