GENETIC ANALYSIS OF YIELD AND YIELD RELATED TRAITS IN SUNFLOWER *(Helianthus annus L.)* HYBRIDS

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Abstract

Sunflower originated from Latin America, has become the major oil crop world wide. It is also an important edible oil crop in Pakistan. Major research has been conducted regarding genetic variance in sunflower. Sunflower hybrids are a focal point in contemporary research. The main aim of conducting this study was to evaluate the performance of selected hybrids for different parameters regarding yield and related traits Desired study was conducted at Agriculture Research Institute (ARI) Quetta during the period of April to August 2009.. Data was collected from ten hybrids of diverse origin; hybrids were US-666, FSS-64, Sierra, Barracuda, Roshan, FH-385, NK-S-278, VDH-487, Blazer-CL, Ausigold-61. Eight traits were observed for these hybrids, including days to flower initiation and completion, days to maturity, head diameter, plant height, 100 seed weight, number of leaves per plant and oil contents. Correlation along with heritability and genetic advance was determined for selected traits. On the basis of over all mean performance hybrid Blazer-CL was found best among all the selected hybrids. Using Anova significant difference was found for all the traits observed. High broad sense heritability and high genetic advance was recorded for most of the studied traits. Mostly positive and significant correlation was found among the observed traits.

Keywords: *sunflower, hybridization, genetic analysis.*

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INTRODUCTION

Pakistan is suffering from acute shortage of edible oil because the need of country is greater than the domestic oil production. Sunflower can be focused as the most suitable edible oil source in Pakistan. It is short duration, relatively drought tolerant and has shown potential to reduce the existing gap between production and consumption of edible oil. It can successfully be grown over a wide range of geographic area and is considered a crop adapted to a wide range of environment (Khalifa *et al* 2000).

Sunflower yield is a complex character and mostly undefined. The abilities to investigate and manipulate the phenotype in selection programs could be enhanced with improved resolution of genetic factors that influence yield and the rate at which genotypes proceed to its physiological maturity (Machikowa and Saetang, 2008; Weiss, 2000). The basic cause of differences between genotypes in their yield stability is the wide occurrence of genotype and environment interactions such as the ranking of the genotype depends on the particular environmental conditions where it is grown (Andrade 1995; Huehn, 1990).

Environmental conditions such as temperature, rainfall and distribution severely affect the growth and development of the crop. Temperature and moisture are major environmental constrains which determine the rate of plant development as well as oil accumulation in sunflower (Pinthus, 2005, Bange *et al*. 1997). It is concluded that an efficient breeding strategy for sunflower under moderate drought-stressed conditions is the simultaneous selection for seed yield in both rain-fed and irrigated

environments together with selection for canopy temperature and stem diameter (Hassan *et al*. 2005, Alza and Martinez, 2004; Kazi *et al.* 2002). The morphological characteristics of sunflower such as days to maturity, plant height, head diameter, number of achenes, achene weight, seed yield per plant strongly affect the seed yield and quality and quality of oil in sunflower. Seed yield generally exhibit positive and significant correlation with number of filled seeds, head diameter and 1000-seed weight (Arshad, *et al.*2007; Habib, 2006; Tahir *et al*. 2002) In a similar study, Machikowa and Saetang (2008) found that the seed yield was strongly correlated with head diameter and plant height. A highly negative correlation coefficient was found between days to flower and oil content.

MATERIALS AND METHODS

Ten sunflower hybrids of diverse origin were grown in a randomized complete block design (RCBD), during April,2009 in the research field at Agriculture Research Institute (ARI) Sariab Quetta, Baluchistan. The hybrids were grown in 3 rows of 5 cm length with row-to-row and plant-to-plant spacing of 75 and 25 cm apart, respectively. Randomly sampled plants were used for recording data. The trial was sown in the month of April 2009 using randomized complete block design having three replications. The plot size was 3X 5 meter accommodating 4 rows 75 cm apart. Two seed were dibbled at a uniform distance of 30 cm after first irrigation. The following hybrids possessing different morphogenetic plant characteristics and maturity period were selected for study.

Table 1: List of Hybrids used

Code No.	Name of Hybrids
1.	US-666
2.	FSS-64
3.	Sierra
4.	Barracuda
5.	Roshan
6.	FH-385
7.	NK-S-278
8.	VDH-487
9.	Blazer-CL
10.	Ausigold-61

For achieving the desired goal following characters were studied such as Days to flower initiation (DFI), Days to flower completion (DFC) , Days to maturity (DM), Head diameter (HD), Plant height (PH) cm, 100 seed weight (HSW) in grams, Number of leaves per plant and Oil content (Oil)%.

Statistical Analysis

The analysis of variance (ANOVA) for all the traits was carried out separately as described by Gomez and Gomez (1984) to establish the level of significance among hybrids with the following model.

Source of variation	D.F	Mean squares	Mean squares expectations
Replicates (R)	(r-1)	MSR	
Genotypes (G)	(g-1)	MSG	$O^2e + rO^2g$
Error	(g-1)(r-1)	MSE	O^2e

In the present research, heritability percentage in broad sense and other genetic parameters of some quantitative traits in the hybrids were determined by adopting genetic analysis as suggested by Breese (1972) and utilized by different researchers. The genetic parameters studied were:

1. Genetic variance = (MSG-MSE)/r
2. Phenotypic variance = MSG/r
3. Heritability percentage in broad sense = h^2(b.s)
4. Genetic gain or genetic advance = (GA)

Where MSG and MSE are genotypic and error mean squares respectively from analysis of variance, r is the number of replications and i=1.75 at 10% selection intensity. Heritability in broad sense was estimated according to Burton (1953), which is as under:

$$h^2 (b.s) = Vg/Vpx100$$

Heritability range =0-1.High heritability > 0.5, medium heritability=0.2-0.5 and low heritability <0.2.Genetic advance was computed at 10% intensity =1.75 and was calculated by the following formula:

$$GA= i (Vp) h^2$$

RESULTS

Days to Maturity (DM)

There was significant difference (p-value 0.0312) among all the varieties. Mean values of days to Maturity for Hybrids varied from 93 days to 99 days and representing a net difference of 6 days. The lowest days to Maturity were observed for the hybrids FSS-64 and Roshan. Both hybrids took 93 days to mature. While maximum days were taken by hybrid Blazer-CL to mature. Fig 1 shows the highest peak for days to maturity which were observed in the hybrid Blazer-CL, while the two equally lowest peaks for the days to maturity were observed in the hybrid FSS-64 and Roshan. Table 3 showed moderate heritability percentage in broad sense (49.62 %), with enough genetic advance (3.81), for days to flower completion. Moderate heritability percentage with considerable genetic advance, suggest that trait is some how suitable for selection.

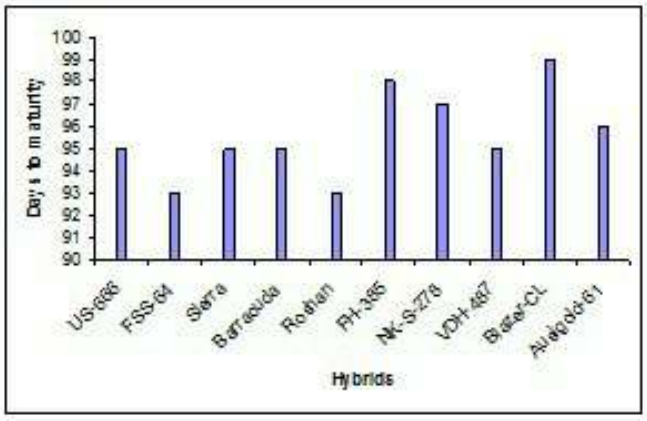

Figure 1: Graph Showing Days to maturity (DM)

Seed Weight (SW) g

A highly significant difference (p-value 0.00) for seed weight among ten selected varieties of hybrids were observed. Mean values of seed weight among the hybrids ranged from (4.80) grams to (7.16) grams representing a net difference of about (2.36) grams. The hybrid Sierra was found to contain the lowest seed weight while the hybrids VDH-487 and US-666 contain the highest seed weight. Hybrid Sierra have lowest seed weight and hybrid VDH-487, have highest seed weight . The hybrids showed high broad sense heritability percentage i.e. 98.70 % paired with low genetic advance, i.e. 0.92 (table 3). Low value of genetic advance suggest that trait is controlled by environmental effects and not desirable for selection. While seed weight showed positive and non significant correlation with days to maturity, plant height, head diameter and oil contents. Negatively significant correlation was observed among seed weight and number of leaves per plant.

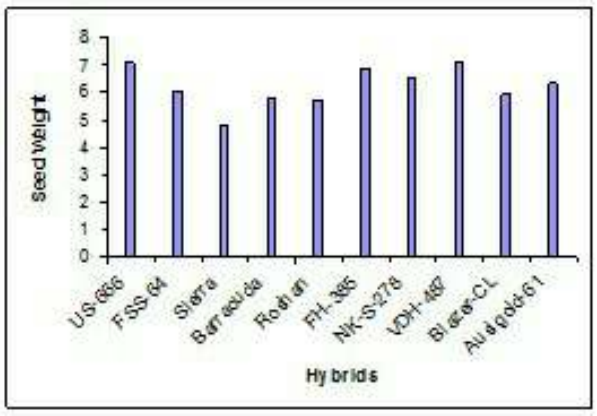

Figure 2: Graph showing Seed Weight (SW) gm

Oil Contents (Oil %)

Significant differences (p-value 0.00) for oil contents among ten selected varieties of hybrids were observed. Mean values of oil contents for Hybrids ranged from 35 percent to 43.8, percent representing a net difference of about 8.8, percent. The lowest oil contents were measured for the hybrid FSS-64. While the highest oil contents were observed in the hybrid Blazer-CL. The highest peak for oil contents and were observed in the hybrid Blazer-CL , while the lowest oil contents were recorded in the Hybrid FSS-64. Oil contents showed high heritability percentage 94.72 %, paired with high genetic advance 13.32, (table 2). High values of both broad sense heritability and genetic advance suggest that trait is under the control of additive type of gene action and suitable for selection. Oil contents showed a positive and non significant correlation at genotypic level with days to flowering, days to flower completion, head diameter and 100 seed weight (table 3). Oil contents showed positive and significant correlation with days to maturity and negative and non significant correlation with number of leaves per plant. While negatively significant correlation was observed among oil contents and plant height.

Table 2: Means Comparison of Hybrids for Oil Contents

HYBRIDS	Mean
US-666	35.7
FSS-64	35
Sierra	36.4
Barracuda	41.6
Roshan	38
FH-385	37.7
NK-S-278	39.1
VDH-487	41.3
Blazer-CL	43.8
Ausigold-61	39.9

Observations per Mean 3
Standard Error of a Mean 0.6508
Std Error (Diff of 2 Means) 0.9204

DISCUSSION

Data was carried for several quantitative characters of 10 genotypes. On the basis of heritability, genetic advance and correlation of studied traits these estimates showed valuable results, which are discussed below.

Analysis of Variance

According to results of analysis of variance among the genotypes, some variances were highly significant while others were less significant. According to result variances among the genotypes were highly significant for days to flower initiation, days to flower completion, head diameter, plant height, seed weight and oil contents. While days to maturity and number of leaves per plant showed less significant difference as compare to above traits.

Analysis of Mean

Mean values of days to flower initiation among the hybrids ranged from 61 to 70 days representing a net difference of about 9 days. According to mean values lowest days to first flowering were taken by the hybrid (Roshan), while maximum days for flower initiation were taken by the hybrid (Blazer-CL). So according to mean performance for flower initiation hybrid (Roshan) is best cultivar as it also contains the ability of early flower completion. Mean values of days to Maturity for Hybrids varied from 93 days to 99 days and representing a net difference of about 6 days. The lowest days to Maturity were observed for the hybrid FSS-64 and the hybrid Roshan. While the hybrid Blazer-CL took maximum days to mature. So on the basis of mean performance for early maturity hybrid Roshan and hybrid FSS-64 could be selected for future cultivation in uplands of Balochistan.

Mean values of head diameter showed that the hybrid Blazer-CL has largest head diameter. For head diameter our mean values (20.73 cm), closely related with the finding of Gurbuz and Arsalan (2006), he concluded mean value for head diameter i-e, (19.62 cm) On the basis of mean performance for plant height, maximum plant height was observed in the hybrid (VDH-487). Plant height also has positive impact on yield. So the hybrid (VDH-487) is best cultivar for uplands of Balochistan. Seed weight is also another important parameter regarding yield. On the basis of mean performance for seed weight hybrid (VDH-487) was found to contain the highest seed weight. For seed weight our result match with the finding of Habib (2006), he concluded that seed yield can be improved by increasing the seed weight. So increasing seed weight provides some better result regarding yield. According to mean values for oil contents the hybrid (Blazer-CL) contains the highest oil percentage. For oil contents our result do not match with the finding of Gurbuz and Arsalan (2006), his concluded mean value for oil contents was (43.73) %. But according to our result mean value among the hybrid for oil contents was (38.87) percent.

Analysis of Heritability

High broad sense heritability coupled with high genetic advance was recorded for the traits, days to flowering, days to flower completion, head diameter, plant height, number of leaves per plant and oil contents. Seed weight and days to maturity contain high broad sense heritability but low genetic advance.

All above mentioned traits, containing high heritability along with high genetic advance may provide better opportunity for selection criteria. On the other hand, the traits that showed high broad sense

heritability but low genetic advance are not suitable for selection. Because we know that, if genetic advance is low and heritability is high, its mean trait is controlled by environment or it is due to dominant or epistatic type of gene action, hence not desirable for selection.

For Oil contents and plant height our result match with the finding of Lakshmaniah (1980), he found that broad sense heritability was high for oil content and plant height. According to our result days to maturity showed moderate heritability percentage i-e, 58.34 %. While high broad sense heritability was recorded for head diameter, i-e, about 85.73 %.

Analysis of correlation

At genotypic level positive and highly significant correlation was found among days to flowering with days to flower completion, days to maturity with days to flowering (Table 4). For correlation between days to flowering and days to maturity our result don not match with the finding of Kaya *et al*. (2007), he observed negative correlation between days to flowering and days to maturity. While negative and non significant correlation was found for plant height with days to flowering, 100 seed weight with days to flowering, days to maturity with plant height, 100 seed weight with days to flower completion.

Positive and significant correlation was observed for days to flowering with head diameter, days to flower completion with days to maturity, head diameter with days to flower completion, days to maturity with oil contents. While negative and significant correlation at genotypic level was observed for plant height with oil contents, head diameter with number of leaves per plant and 100 seed weight with number of leaves per plant. For correlation between plant height and oil contents our result do not match with the finding of Kaya *et al*. (2007), he observed positive correlation at genotypic level between plant height and oil contents.

Positive and non significant correlation at genotypic level was observed for days to flowering with number of leaves per plant, oil contents with days to flowering, days to flower completion with number of leaves per plant, oil contents with days to flower completion, days to maturity with 100 seed weight, days to maturity with number of leaves per plant, plant height with head diameter, plant height with 100 seed weight, head diameter with 100 seed weight, oil contents with head diameter and seed weight with oil contents. For correlation of oil contents with days to flower initiation and completion our result don not match with the finding of Arshad, M *et al.*(2007), who concluded that oil contents had negative association with days to flowering and completion. But for correlation between plant height and oil contents our result match with the finding of Arshad, M *et al.*(2007), he also observed negative association between plant height and oil contents.

Table 3: Estimates Of Coefficient Of Variance, Genotypic Variance Phenotypic Variance, Heritability And Genetic Advance For Traits Observed In Sunflower Hybrids

Character studied	Varietals variance (MSG)	varietals variance (MSE)	Genotypic Variance (MSG-MSE/r)	Phenotypic variance (MSG/r)	Heritability %(b.s) (G.V/P.Vx100)	Expected genetic advance %of means (HbsxP.VxK)
DFI	15.5000	3.4111	4.0296	5.1666	77.99 %	7.05
DFC	15.5741	3.2185	4.1185	5.1913	79.33 %	7.20
DM	13.1852	4.7519	2.8111	4.3950	49.62 %	3.81
HD	14.9481	1.3815	4.5222	4.9827	90.75 %	7.91
PH	355.689	29.944	108.586	118.563	91.58 %	190.01
SW	1.60000	0.0196	0.5267	0.5333	98.76 %	0.92
No.of leaves/plant	18.8000	7.2556	3.8481	6.2666	61.40 %	6.73
Oil Contents	24.1104	1.2706	7.6132	8.0368	94.72 %	13.32

Table 4: CORRELATION AMONG THE TRAITS OF SUNFLOWER HYBRIDS OBSERVED AT ARI, SARIAB ROAD QUETTA

Var.	DFI	DFC	DM	PH	HD	100 SW	No. of leaves
DFC	0.9639** 0.0000 P-VALUE						
DM	0.4736** 0.0082	0.4471* 0.0132					
PH	-0.0746 0.6953 N.S	-0.0519 0.7851 N.S	-0.1536 0.4176 N.S				
HD	0.3900* 0.0331	0.4432* 0.0142	-0.0053 0.9777 N.S	0.0093 0.9610 N.S			
100 SW	-0.0030 0.9873 N.S	-0.0281 0.8830 N.S	0.1121 0.5554 N.S	0.1550 0.4134 N.S	0.2107 0.2636 N.S		
No. of leaves per plant	0.2872 0.1239 N.S	0.3432 0.0633 N.S	0.2237 0.2348 N.S	-0.1868 0.3230 N.S	-0.1248 0.5113 N.S	-0.4142* 0.0229	
Oil Contents	0.2867 0.1246 N.S	0.1933 0.3062 N.S	0.3890* 0.0336	-0.4489* 0.0128	0.1522 0.4219 N.S	0.0374 0.8444 N.S	-0.0043 0.9819 N.S

** = Highly Significant
* = Significant
N.S = Non Significant

CONCLUSION

On the basis of over all mean performance it is concluded that the hybrid Blazer-CL was best among all the ten hybrids and it can be used for further selection. Hybrid Blazer-CL is an important hybrid for the improvement of oil contents for uplands of Balochistan.

Analysis of variance revealed highly positive significant difference for days to flower initiation, days to flower completion, head diameter, plant height, seed weight and oil contents. These result indicate that there is considerable variation among the genotypes witch is helpful for future selection of these hybrids for yield and related traits.

Broad sense heritability with genetic advance was high for all the traits except days to maturity which showed low heritability. While low genetic advance was only recorded for seed weight. High heritability with high genetic advance is usually associated with additive type of gene action. So selection of these traits is reasonable for better yield production in uplands of Balochistan.

Positive and highly significant correlation at genotypic level was observed for days to flowering with days to flower completion and days to maturity with days to flowering. Mostly positive correlation was found among the traits observed, but some traits were negatively associated with others. Such as plant height and oil contents. Oil contents can be increased through selection of these traits for future utilization.

REFERENCES

- Alza JO and Martinez JMF. (2004). Genetic analysis of yield and related traits in Sunflower (Helianthus annuus L.) in dry land and irrigated environments. Euphytica . 95(2): 243-251.
- Andrade FH. (1995). “Analysis of growth and yield of maize, sunflower and soybean grown at Balcarce, Argentina”, Field Crops Res. 41:1-12.
- Arshad M, Ilyas MK and Khan MA. (2007). Genetic divergence and path coefficient analysis for seed yield traits in sunflower hybrids. *Pak. J. Bot.* 39(6): 2009-2015.
- Bange MP, Hammer GL and Rickert KG. (1997). “Environmental control of potential yield of sunflower in the subtropics”. Aust. J Agric. Res. 48, 231-240.
- Gomez KA and Gomez AA. (1984). Statistical procedure in Agriculture Research (2nd.Ed.) John Wiley & Sons, New York.
- Gurbuz B and Arslan N. (1993). Researchon some characters of synthetic cultivar obtained from inbres sunflower lines resistant to broom rape. *P.Br.Abst*.64(9):9679.
- Habib H. (2006). Genetic association analysis for seed yield in sunflower. *Pak.j.agri.sci*. 43:136-138.
- Hassan FU, Qadir G and Cheema MA. (2005). Growth and development of sunflower in response to seasonal variation. *Pak J. Bot.* 37(4): 859-864.
- Huehn M. (1990). Nonparametric measures of phenotypic stability. Part 1: theory. Euphytica 47: 189-194.in sunflower.*Pak.J.Agri.*13(3):232-238. in sunflower.*Pak.J.Agri*.13(3):232-238.
- Kaya Y, EVC G, Durak S, Pekcan V and Gucer T. (2007). Determining the Relationships between Yield and Yield Attributes in Sunflower. *Turk J.Agric.* 31:237-244.
- Kazi BR, Oad FC, Jamro GH, Jamali LA and Oad NL. (2002). Effect of water stress on growth, Yield and contents of sunflower. *Pakistan journal of applied Sciences*. 2:550-552.
- Khalifa FM, Schnetter AA and El-Tayeb. (2000). Temperature-germination response of sunflower (Helianthus annuus L.) genotypes. *Helia*. 23(33): 97-104.
- Lakshmaniah VH. (1980). Genetic Variability and association of morphological characters with seed yield and oil contents in sunflower (Helianthus annuus L). *Mysore J.Agric.* 14(2):259.
- Machikowa T and Saetang C. (2008). Correlation and path coefficient analysis on seed yield in sunflower. *Suranaree J. Sci. Technol.* 15 (3):243-248.
- Pinthus MJ. (2005). Some environmental effects on the oil yield components of sunflower seeds. *Plant Foods for Human Nutrition.* 9:328-336.

- Tahir MH, Sadaqat HA and Bashir S. (2002). Correlation and Path Coefficient Analysis of Morphological Traits in Sunflower (*Helianthus annuus L.)* Populations. *Int. J. Agri. Biol.* 4(3) 341–343.
- Weiss EA. (2000). “Oil Seed Crops”, 2nd Ed., World Agriculture Science, Blackwell Sci. Ltd. Paris, Berlin, Victoria. 365.