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*Full Length Research Paper*

# Potential of Sunflower (*Helianthus annus* L.) Double Cross Hybrid as a commercial production-grain cultivar

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**An experiment to develop higher-yield sunflower hybrids, comprising seven single and seven double cross selected plants planted at the Agriculture Research Institute, Tarnab, Peshawar, Pakistan, was performed during August 2001. Hybrid selection data included 1000 grain weight, number of grains per head, number of filled grains per head, number of filled versus unfilled grains per head, harvest index and grain yield. Recorded data revealed positive correlations between all the analyzed grain yield characters. Two hybrid entries (*TF-7* x *TF-11)* and (*TF-7* x *TF-22*)x(*TF-17* x *TF-18*) showed superior grain yield and yield related characters recorded in single and double cross hybrids. This study demonstrated that diversity of grain yield characters in this study can be use as the effective selection of promising and superior double cross sunflower hybrids.**

**Keywords:** Double cross, sunflower, correlation and grain yield.

## INTRODUCTION

Sunflower (*Helianthus annus* L.) is an important member of Compositeae family. It is found in wild form world-wide, but the cultivated forms are very rich source of edible oil. According to Doeslhale, 1972 and Dinell, 1983, sunflower seeds contain about 40-50 % oil with high polyunsaturated fatty acids and 20 % protein. Sunflower is well adapted to water stress condition and can be raised twice a year. In recent years, sunflower was introduced into the cropping pattern of Pakistan. In addition, demand of edible oil has been increasing, which at present time, the market demand is higher compared with the Pakistan's production. This increasing demand for edible oil is related to the rise in this country population. Sunflower is playing an important role to bridge the gap between local production and demand of edible oil.

Sunflower single cross hybrid seed is important for domestic cultivation on farmer fields. This hybrid is far more expensive than the local wild varieties and is to be produced every year because in the next generation, the yield reaches 50 % reduction. For this, each year hybrid sunflower seed production is imported, which really increase the cost of production. Mre over, most of the farmer in Pakistan cannot afford to purchase hybrid seed each year because of their low income. Since the importance of hybrid sunflower seed production, the present study was carried out at Agriculture Research Institute (ARI) Tarnab to determine the possibility of double cross hybrid cultivars as a source of low cost seed production compared with single cross hybrid seed production, analyzing the potential of high grain yield in all the quantitative traits.

## MATERIALS AND METHODS

This study was conducted at the Agriculture Research Institute (ARI), Tarnab, Peshawar, Pakistan, during 2001-2002. Single- and double-cross hybrids were evaluated based on their grain yield potential. The experiment was shown on August 2001. The experimental material i.e

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single-crossed genotypes (TF-11xTF-4, TF-17x TF-4, TF-6x TF-8, TF-18xGP-9, TF-11x TF-14, TF-4x TF-1 and TF-7x TF-11) and double-crossed genotypes (TF-17xGP-122) x (TF-1097xGP-22), (TF-7x TF-22) x (TF-7x TF-22), (TF-22x 6201) x( GP-153x TF-1034), (TF-22xGP-9)x(DM-7x TF-7), (TF-3xGP-153) x (TF-17 x TF-37) and (TF-5003xGP-14)x( TF-8x BOL-1774) were provided by ARI, Tarnab. The experiment was designed at 5 feet single row, plant to plant and row to row distances were 0.75 and 0.25 m, respectively. Three seed per hill were sown and latter thinned to one plant per hill after 4-5 leaf stage. Fertilizer in the form of urea and Di Ammonium Phosphate (DAP) were applied at the rate of 120 and 60 kg $ha^{-1}$, the phosphate and half nitrogen dose were applied at first irrigation. All the standard cultural practices were carried out throughout the whole growing season. The following parameters were taken under consideration and data were recorded at their appropriate time during the study:

1. 1000-Grain weight (TGW)

1000-grain were counted through actual counting from each plot and weighted by a physical balance in grams.

2. Number of grain $head^{-1}$ (NG)

Data were recorded on three randomly selected plants. All the grains from each head were threshed separately and then counted for each head. The average data were subjected to analysis.

3. Number of filled (NFG) and unfilled grain (NUF) $head^{-1}$

Data were recorded in the already randomly selected plants by counting the number of filled and unfilled grains $head^{-1}$in the total number of grain $head^{-1}$.

4. Weight of grain (WG) $head^{-1}$ (g)

This was recorded by selecting heads randomly and weighing total grains $head^{-1}$.

5. Grain yield (GY)

For the determination of grain yield of the crop the heads of the plants of each plot were harvested at physical maturity. The heads were dried in sun light up to 8-9 % moisture and then the grains were separated from the heads. Grain yield was determined by adding the dried grains weight in the following formula.

$$GY\ (kg\ ha^{-1}) = \frac{kg \times 10000\ (m^2)}{Harvested\ \ area\ (m^2)}$$

6. Harvest index (HI)

The harvest index was calculated for each plot using the formula:

$$HI = \frac{Grain\ \ Yield\ (kg)\ \times 100}{Head\ \ Weight\ \ (kg)}$$

The data obtained were statistically analyzed using Standard Deviation Normal curve to find out the genotypic differences. Correlation analyses were performed using the computer MSTATC program (Nissen *et al*., 1987).

## RESULTS AND DISCUSSION

The analyzed data on 1000- grain weight, number of grains $head^{-1}$, number of filled and unfilled grains $head^{-1}$, weight of grains $head^{-1}$ (g), grain yield (kg $ha^{-1}$) and harvest index in single- and double- crossed hybrids are shown in table 1.

Significance differences were observed in 1000-grain weight in single- and double-cross hybrid of sunflower. Caylak and Emiroglu (1984) also reported 1000-grain weight for grain-yield among the cultivars for comparison proposes. In general, double-cross hybrid was comparatively superior compared with single-cross-hybrid, based on 1000-grain weight values. Gill and Punia (1996) also reported the superiority of double-cross hybrid over single-cross hybrid. The mean data of 1000-grain weight in single cross hybrid was between 28.87 g to 55.12 g, E-6 showed a minimum weight value of 28.87 g, whereas E-7 showed the maximum value of 55.12 g. In double-cross hybrid, the maximum weight value of 57.05 g was observed in E-2, followed by 55.62 and 53.50 g by E-5 and E-4, respectively. The lowest value of 1000-grain weight was recorded for E-1 (40.41 g) value which significantly positive correlated with 1000-grain weight in both single- and double-cross hybrid were (Table 3 and 4), were correlation values included weight of the grain $head^{-1}$, number of filled grain $head^{-1}$, harvest index and grain yield in kg $ha^{-1}$ (Chaudhary and Anand, 1993; Singh and Labana, 1990).

Significant differences in the number of seed $head^{-1}$ mean in single- and double- cross hybrid were also determined, supported by the findings of Pathak et al. (1983). In single-cross hybrids, the number of grain $head^{-1}$ mean in single-cross hybrids ranged from 508 to 1494. Maximum numbers of grain $head^{-1}$ were recorded for E-7 (1494) and minimum number of grain $head^{-1}$ (508) by E-3. In double- cross hybrids, the higher number was observed for E-2 (1113) while the lower number of grains was recorded for E- 6 (741). These observations are supporting the observation that descrives the compensation effect between grain weight and its number when referred to single- and double- cross hybrids (Gill and Punia 1996). Correlation of thenumber of grain $head^{-1}$ in single- and double-cross hybrids (Table 3 and 4) were a significantly positive correlation with the number of filled grain $head^{-1}$, the weight of grain $head^{-1}$, and the grain yields (Punia and Gill 1994, Sherff *et al*. 1986). The present data supports the previous study where the number of grain $head^{-1}$ is an important yield component as far as sunflower is concerned (reference?).

Number of filled and unfilled grain $head^{-1}$ indicated significant differences among the genotypes of both types of hybrid crosses. The data of filled grains $head^{-1}$ ranges from 335 to 1397 (Table 1). Significant differences were observed in double-cross hybrid for the number of filled grain $head^{-1}$. The mean data in double cross hybrid

**Table 1.** Mean, standard deviation and increase percentages of the best cross-hybrid over population mean for different yield characters of seven single-cross sunflower hybrids

| E.# | Single cross | NG | NFG | NUFG | WG | 1000 GW | GY s(kg ha$^{-1}$) | HI(%) |
|---|---|---|---|---|---|---|---|---|
| 1 | TF-11xTF-4 | 1140 | 963 | 177 | 48.0 | 42.8 | 2560 | 53.6 |
| 2 | TF-17xTF-4 | 1355 | 1155 | 200 | 62.3 | 45.9 | 3323 | 55.5 |
| 3 | TF-6xTF-8 | 508 | 335 | 173 | 27.6 | 40.8 | 1472 | 40.9 |
| 4 | TF-18xGP-9 | 1348 | 1037 | 311 | 58.2 | 43.1 | 3105 | 58.9 |
| 5 | TF-11xTF-14 | 1052 | 968 | 84 | 59.4 | 48.4 | 3168 | 59.7 |
| 6 | TF-4xTF-1 | 1011 | 773 | 238 | 29.2 | 28.8 | 1557 | 41.9 |
| 7 | TF-7xTF-11 | 1494 | 1397 | 97 | 82.0 | 55.1 | 4373 | 61.9 |
| | Pop.mean | 1130 | 947 | 183 | 52.0 | 43.6 | 2794 | 53.2 |
| | S.D | 326.0 | 331.5 | 78.6 | 19.3 | 8.0 | 1028 | 8.5 |
| | Variance | 106312 | 109897 | 6172 | 371.6 | 64.8 | 1057048 | 72.5 |
| | % increase | 32.1 | 47.5 | 69.9 | 57.6 | 26.47 | 56.5 | 16.35 |

**Table 2.** Mean, standard deviation, and % increase of the best cross over population mean for different yield characters of seven double cross sunflower hybrids

| E.# | Double cross | NG | NFG | NUFG | WG | 1000 GW | GY (kg ha$^{-1}$) | HI (%) |
|---|---|---|---|---|---|---|---|---|
| 1 | (TF17xGP122)x(TF1097xGP22) | 1027 | 838 | 189 | 41.5 | 40.4 | 2214 | 57.6 |
| 2 | (TF7xTF22)x(TF17xTF18)) | 1113 | 877 | 236 | 63.5 | 57.05 | 3387 | 53.5 |
| 3 | (TF22xTF6201)x(GP153xTF1034) | 821 | 732 | 89 | 39.8 | 48.4 | 2123 | 56.2 |
| 4 | (TF22xTF17)x(TF15xTF11) | 807 | 678 | 129 | 42.9 | 53.2 | 2292 | 57.3 |
| 5 | (TF11xGP9)x(DM7xTF7) | 938 | 887 | 51 | 51.5 | 55.6 | 2747 | 54.9 |
| 6 | (TF3xGP153)x(TF17xTF37) | 711 | 570 | 141 | 22.5 | 30.4 | 1200 | 26.0 |
| 7 | (TF5003xGP14)x(TF8xBOL1774) | 1002 | 894 | 108 | 53.5 | 53.5 | 2853 | 56.0 |
| | Pop.mean | 917 | 782 | 135 | 45.0 | 48.4 | 2402 | 51.6 |
| | S.D | 142.5 | 125.1 | 62.0 | 12.9 | 9.7 | 690.7 | 11.4 |
| | Variance | 20322 | 15665 | 3848 | 167.7 | 93.9 | 477123 | 129.8 |
| | % increase | 21.37 | 14.32 | 74.81 | 40.8 | 17.8 | 40.9 | 10.96 |

ranged from 570 to 894 (Table 2). In double cross number of filled grain head$^{-1}$ increased at the rate of 14.32% over the mean of hybrid crosses, as far E-7 is concerned. Punia and Gill (1994) noted significant correlation of percentage of filled seed with seed yield per plant in both single- and double-cross hybrid.

The mean value of weight of grain head$^{-1}$ showed significant variations. Maximum weight of 62.30 and 62 g was observed in E-2 and E-7, respectively. The lowest weight of head grains (21.20 g) was observed for E-6 in single- crosses while in double-cross hybrids recorded the maximum weight by E-2 (63.50g) and the minimum (22.50g) by E-6 (Table 1). Single-cross hybrids were superior in weight of grain head-1 than double-cross hybrids. Correlation of weight of grain per head in single- and double-crosses were positive with all the parameters studied. Abdel et al. (1983) and Pathak et al. (1983) also reported a significant association of weight of grains with seed yield.

The mean of harvest index value showed a significant variation among the genotypes of both hybrid crosses. Single-cross showed a higher harvest index compared with double-cross. In single-cross hybrid, the maximum harvest index (61.9 % ha-1) was observed for E-7 and the lowest (40.9 %) by E-3, whereas in double-cross hybrids the highest value (57.6%) was observed by E-1 and the lowest by E-6 (26.0%). In double-cross hybrids, the correlation of harvest index was significantly positive only when compared with 1000-grain weight data. Rao and Lakshamn (1987) reported a significantly positive correlation of harvest index with seed yield as well.

Grain yields showed significant differences in single- as well as double-cross hybrids. Similar results have also been reported by Tariq et al. (1989). Minimum grain yield was observed by E- 3 entry, while the maximum grain yield was recorded byentry E-7, showing an increase of 56.51 % over the mean of single-cross hybrids. The grain yield data in double-crosses ranged from 1200 to 3387 kg

**Table 3.** Correlations of different yield characters of seven single cross sunflower hybrids

| | NG | NFG | NUFG | WG(g) | 1000 GW | GY(kg ha$^{-1}$) | HI (%) |
|---|---|---|---|---|---|---|---|
| NG | | 0.97** | 0.05 | 0.845** | 0.49 | 0.84* | 0.81* |
| NFG | | | -0.18 | 0.92** | 0.63 | 0.92** | 0.86* |
| NUFG | | | | -0.366 | -0.59 | -0.36 | -0.28 |
| WG(g) | | | | | 0.87** | 1.00** | 0.99** |
| 1000 GW | | | | | | 0.87** | -0.82 |
| GY(kg ha-1) | | | | | | | 0.94** |
| HI (%) | | | | | | | |

**Table 4.** Correlations of different yield characters of seven double cross sunflower hybrids

| | NG | NFG | NUFG | WG(g) | 1000 GW | GY(kg ha$^{-1}$) | HI (%) |
|---|---|---|---|---|---|---|---|
| NG | | 0.90** | 0.48 | 0.85* | 0.89** | 0.85* | 0.58 |
| NFG | | | 0.05 | 0.86** | 0.68 | 0.86** | 0.69 |
| NUFG | | | | 0.21 | -0.12 | 0.21 | -0.06 |
| WG(g) | | | | | 0.89** | 1.00** | 0.69 |
| 1000 GW | | | | | | 0.89** | 0.75* |
| GY(kg ha-1) | | | | | | | 0.19 |
| HI (%) | | | | | | | |

*=significant at 0.05probability **=significant at 0.01 probability

per ha. E-2 entry showed the maximum grain yield, with an increase of 40.99% over the mean of the population. Single-cross hybrids were superior to double-cross hybrid for grain yield, supporting the report by Giridharin et al. (1996). Correlation of grain yield in single-cross hybrid were significantly positive with the1000-grain weight, the number and weight of grains per head, the number of filled / unfilled grain per head and the harvest index values (Punia and Gill 1994). The relation of grain yield between single-and double-cross hybrids showed the importance of using single cross-hybrid as indices for selection of superior double-cross hybrids.

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