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EVALUATION OF SUNFLOWER LINES AND THEIR CROSSING COMBINATIONS FOR MORPHOLOGICAL CHARACTERS, YIELD AND OIL CONTENTS

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Abstract

The present study investigates sunflowers parental lines viz., TS-1, T-4, TS-7, TS-11, TR-1, TR-2, TR-120, SMTR-17, TR-6023 and their crossing combinations for their morphological characters and oil content. The experiment was laid out in RCB design with four replications at Agriculture Research Institute (ARI), Tarnab, Peshawar, KPK. Significant ($p<0.05$) variations were observed for all the parameters under investigation. Maximum seed yield (1.2 ton ha^{-1}) was produced by TR-6023 when compared with parental lines. Among the crossing combinations, maximum seed yield (2.8 ton ha^{-1}) was recorded by TS-7 x TR-6023 while minimum (1.08 ton ha^{-1}) in TS-11 x SMTR-17. Maximum oil content (42.00%) was noted in TR-120 while minimum (35.00%) in TR-6023. In case of crossing combinations, maximum oil content (49%) was recorded in hybrid TS-7 x TR-6023 while minimum (31.00%) in TS-11 x TR-120.

Introduction

Sunflower (*Halianthus annuus* L.) is one of the most important oil seed crop of the world (Bakht *et al.*, 2010 a, b). Sunflower seed contains high oil content ranging from 35-50% (Skoric & Marinkovic, 1986). Pakistan has been facing acute shortage of edible oil for the last so many years. Pakistan is producing about one third of its edible oil requirements and the rest is met through import at a cost of about Rs. 60 billion each year (MINFAL, 2008). This situation demands concerted efforts to mobilize all the available resources to arrest the import quantum of the present level with an ultimate goal of achieving self sufficiency in the shortest possible time.

Inspite of the large areas of deep soil, favorable topography, water wealth and suitable climatic conditions of Pakistan, the seed production of sunflower is still very low as compared to other countries of the world. There could be many reasons for this situation but one of the most important reasons is the cultivation of exotic hybrids, which are not well adapted to the agro-climatic conditions of Pakistan. To find out hybrids/cultivars for specific agro-climatic conditions is always a cherished goal of the plant breeders for evolving better-adapted hybrids/cultivars for a particular area. Selection of parents is the most important stage in any breeding programe to develop new genotypes having desirable traits. One of the methods to achieve this purpose is hybrid vigor (Ilker *et al.*, 2010; Khan *et al.*, 2010). Knowledge about the genetic potentials of different genotypes and inheritance of the morphological and yield traits is very much important for the breeder to cope with the problems of low yield (Ahmad *et al.*, 2008; Khan *et al.*, 2009a and b; Batool *et al.*, 2010). Ahire *et al.*, (1994) and Encheva *et al.*, (2002; 2003; 2004 and 2008) reported significant variation in yield and oil components in various sunflower lines and their crossing combinations. Luczkiewicz & Kaczmarek (2004) found significant variation for number leaves $plant^{-1}$ and other plant characters in sunflower lines. Kandhola *et al., (*1995), Limbore *et al*., (1998) and Radhika *et al.,* (2001) also revealed significant variation for days to 50% flowering, days to flower completion, days to maturity, seed yield, oil contents and 100-seed weight in sunflowers lines and their crossing combinations. The aim of the present study was to evaluate different sunflower cultivars which were developed locally from diverse origin for their yield potentials.

Materials and Methods

The present study was carried out at Agriculture Research Institute (ARI), Tarnab, Peshawar, KPK Pakistan. Seven parental lines of sunflowers (TS-1, T-4, TS-7, TS-11, TR-1, TR-2, TR-120, SMTR-17,TR-6023) and their crossing combination (TS1xtR1, TS4xtRI, TS7xTR1, TS11xTR1, TS1xtR2, TS4xtR2, TS7xTR2, TS11xTR2, TS1xtR109, TS4xtR109, TS7xTR109, TS11xTR109, TS4xtR120, TS7xTR120, TS11xTR120, TS4XsMTR17, TS7xSMTR17, TS1xTR6023, TS4xtR6023, TS7xtR6023, TS11xTR6023) were investigated for their yield and oil potentials using randomized complete block (RCB) design with four replications. Entries were grown as four rows $sub\text{-}plot^{-1}$ with row length of 3 m, row-to-row and plant-to-plant distance of 75 cm and 20-75 cm, respectively. During growing season, two manual hoeing were done to eradicate weeds. Fertilizers in the form of urea and DAP were applied at the rate of 120 and 60 kg ha^{-1} respectively. All phosphorous and half nitrogen was applied at the time of seedbed preparation, while the remaining half of nitrogen was applied at first irrigation. Recommended cultural practices were followed from sowing till harvesting.

Procedures for data recording: Numbers of leaves $plant^{-1}$ were determined by counting number of leaves in five randomly selected plants when flowers became visible. Plant height was measured in centimeters from ground level to the attachment of flower from five randomly selected plants $plot^{-1}$ at the time of physiological maturity. Data on 50% flowering was recorded from the date of sowing till when approximately 50% of the flower buds $sub\text{-}plot^{-1}$ opened its flowers in each treatment. Head diameter $plant^{-1}$ was noted in centimeter on five randomly selected plants from one edge of the head to the other of the same plant in each row and averaged. Days to maturity were counted from sowing to the full maturity of the plants for each plot. Thousand grains were counted and weighed in each sub-plot to record data for 1000 seed weight. For determination of the seed yield of the crop, heads of the plants of each treatment were cut at full maturity. The

heads were then dried in sun light for three days; seeds were then separated and weighed. Grain yield was then determined in ton ha^{-1}. Oil content was determined by Soxhlet method (Khalil & Manan, 1990).

Statistical analysis: All data are presented as mean values of three replicates. Data were analyzed statistically for analysis of variance (ANOVA) following the method described by Gomez & Gomez (1984). MSTATC computer software was used to carry out statistical analysis (Bricker, 1991). The significance of differences among means were compared by using Least Significant Difference (LSD) test (Steel & Torrie, 1997).

Results and Discussion

Plant growth: Significant ($p<0.05$) differences were observed for all parameters in the tested genotypes (Table 1). Parental line TR-120 showed maximum number of leaves $plant^{-1}$ (31) whereas TR-2 had minimum (21) number of leaves $plant^{-1}$. In case of hybrids, maximum number of leaves $plant^{-1}$ (33) was recorded for TS-7x TR-27, followed by TS-4 x TR-6023 (32). The number of leaves $plant^{-1}$ of the rest of the genotypes ranged from 17 to 31 (Table 3). Luczkiewicz & Kaczmarek (2004) also found significant variation for number leaves $plant^{-1}$ and other plant characters in sunflower lines. Analysis of variance (Table 1) indicated significant ($p<0.05$) differences among genotypes for plant height. Maximum parental plant height (132.55 cm) was attained by TR-2 whereas minimum (101.6 cm) in SMTR-17. Taller plants (174 cm) were recorded in hybrid TS-7 x TR-6023, followed by cross combination of TS-1 x SMTR-17 (172.85 cm), while smaller in TS-11 x TR-6023 (109.8 cm). Plant height of the rest of the cross combinations ranged between 121.0 cm and 166 (Table 2). These results are in agreement with those reported by Kumar *et al*., (1999) and Encheva *et al*., (2008) who observed significant differences in plant height of various sunflower lines and hybrids.

Table 1. Analysis of variance for various characters of different parental lines and hybrids of Sunflower.

S.V	D.F	Mean squares								
		NL/PT	PH	50%F	100%F	DM	HD	1000GW	GY	Oil (%)
Genotypes	29	99	1582.2	37.5	45.25	47.82	121.6	487	140.6	65.38
Error	87	0.93	10.36	1.43	2.1	2.76	0.69	2.83	0.87	0.53
F-ratio		106.38*	152.67*	26.17*	21.47*	17.89*	175.8*	172.16*	160.8*	124.1*

*= Significant at p< 0.05; NL/PT = Number of leaves per plant; PH = Plant height; 50% F= 50% flowering; 100% F= 100% flowering
DM = days to maturity; HD = Head diameter; 1000 GW = 1000 grain weight; GY; = Grain yield

Table 2. Mean values of number of leaves $plant^{-1}$, plant height, days to 50%, 100% flowering, days to maturity of different parental lines and hybrids of sunflower.

S.No.	Genotypes	Number of leaves $plant^{-1}$	Plant height (cm)	Days to 50% flowering	Days to 100% flowering	Days to maturity
1.	TR1	25 D-F	124.25 K-N	65 A-C	70 B-E	88.5 E-I
2.	TR2	21 I-J	121.7 L-N	62 E-G	66 I	85.5 I-M
3.	TR109	18 L-M	115.35 O-P	62 E-G	67 G–J	88.25 E-I
4.	TR120	31 B	132.55 I-J	63.25 C-E	65.25 J-K	87.75 F-J
5.	SMTR17	23 G-I	101.6 O	66 A-B	69 C-H	92.5 A-C
6.	TR6023	24 F-J	115.65 O-P	58.25 H	63.25 K-M	84.75 J-M
7.	TS1XtR1	25 D-E	140.75 F-H	66 A-B	71 B-D	92 A-D
8.	TS4XtRI	25 D-F	155 D	66 A-B	72 B	93 A-C
9.	TS7xTR1	17 M	121 M-O	66.25 A-B	69.25 C-G	91 A-E
10.	TS11xTR1	15 N	127.8 J-K	65.75 A-B	69.75 B-F	90 C-G
11.	TS1XtR2	23 H-I	135.8 H-I	61.75 E-G	68.75 D-I	87.5 F-J
12.	TS4XtR2	25 E-G	166.9 B-C	62.5 D-G	66.5 H-J	87 G-J
13.	TS7xTR2	28 C	146.15 E-F	60.75 F-G	66.25 I-J	87.75 F-J
14.	TS11xTR2	24 E-H	126.75 J-M	61.25 E-G	67.25 F-J	85.5 I-M
15.	TS1XtR109	15 N	158 D	64.25 B-D	69.25 C-G	90 C-G
16.	TS4XtR109	26D-E	148.9 E	65.25 A-C	67.5 E-J	90.25 B-F
17.	TS7xTR109	20 K-L	139.05 G-H	63.25 C-E	65 J-L	92.75 A-C
18.	TS11xTR109	21 J-K	127.3 J-L	65.25 A-C	70.25 B-D	93.5 A
19.	TS1XtR120	18 M	120.5 N-O	60.5 G	67 G-J	86.25 H-L
20.	TS4XtR120	31 B	160.6 D	61.25 E-G	66.25 I-J	89.25 D-H
21.	TS7xTR120	25 D-G	150.15 E	62.75 D-F	68.75 D-I	86.5 H-K
22.	TS11xTR120	25 D-F	142.9 F-G	62.25 D-G	69.25 C-G	90.5 A-F
23.	TS1XsMTR17	22 H-J	172.85 A-B	62.5 D-G	69.5 B-G	86.5 H-K
24.	TS4XsMTR17	26 C-D	141.15 F-H	65 A-C	69.5 B-G	90.25 B-F
25.	TS7xSMTR17	20 I-J	102.95 O	66 A-B	75 A	93.5 A
26.	TS11xSMTR17	24 E-H	136.55 H-I	66.5 A	71.5 B-C	93.25 A-B
27.	TS1xTR6023	31 B	163.1 C-D	57.5 H	62.5 L-M	83 M-N
28.	TS4XtR6023	32 A-B	138.05 G-I	56.75 H	60.75 M	83.25 L-N
29.	TS7XtR6023	33 A	174.8 A	56.5 H	61.5 M	81 N
30.	TS11xTR6023	19 K-L	109.8 P	57.25 H	61.25 M	83.75 K-N
LSD		**1.36**	**4.524**	**1.682**	**2.040**	**2.298**

The mean values with the same letter are non-significant at 5% level of probability

Table 3. Mean values of head diameter, 1000 grain weight, grain yield and oil content of different parental lines and hybrids of sunflower.

S.No.	Genotypes	Head diameter (cm)	1000 Grain weight (g)	Grain yield (tons ha^{-1})	Oil content (%)
1.	TR1	8.65 R	43.25 O-P	0.96 P-Q	40 I-J
2.	TR2	14.075 O-P	45.75 N-O	0.72 R-S	38.13 K-L
3.	TR109	12.55 P	43.25 O-P	0.64 S	40 I-J
4.	TR120	15.25 N-O	48.75 N	0.82 O-R	42 G-H
5.	SMTR17	10.8 O	44 O-P	0.57 S	40 I-J
6.	TR6023	7.375 R	42.5 P	1.2 L-N	35 M
7.	TS1xTR1	16.475 M-N	59.5 L	1.58 G-J	38 K-L
8.	TS4xTRI	26.7A-C	66.75 E-H	1.79 F-G	37.5 L
9.	TS7xTR1	18.3 K-L	54.75 M	1.54 I-K	40 I-J
10.	TS11xTR1	20.55 H-I	60 K-L	1.91 D-E	38 K-L
11.	TS1xTR2	21.5 G-H	66.5 E-H	2.05 D	43 F-G
12.	TS4xTR2	17.9 LM	64.75 H-J	2.33 C	44.36 C-F
13.	TS7xTR2	24.45 D-E	65.25 G-I	1.96 D-E	43.5 E-F
14.	TS11xTR2	18.35 J-L	68.5 E-F	2.07 D	44 D-F
15.	TS1xTR109	15.625 N	60 K-L	1.14 M-O	44 D-F
16.	TS4xTR109	13.95 O-P	61.25 J-L	1.35 K-L	38 K-L
17.	TS7xTR109	17.2 L-M	63 I-K	1.81 E-F	41 H-I
18.	TS11xTR109	17.75 L-M	64 H-J	1.70 F-H	35 M
19.	TS1xTR120	25.25 C-D	72.25 C-D	1.21 L-N	43 F-G
20.	TS4xTR120	26.95 A-B	73.5 B-C	1.03 O-P	45 B-D
21.	TS7xTR120	20.7 H-I	74.5 B-C	1.65 F-I	38 K-L
22.	TS11xTR120	22.35 F-G	75.25 B-C	1.53 F-J	31 N
23.	TS1xSMTR17	19.85I J	66 F-I	1.17 L-O	45 B-D
24.	TS4xSMTR17	18.3 K-L	68.25 E-G	1.26 L-M	35.37 M
25.	TS7xSMTR17	19.45 I-J	69.5 D-E	1.45 J-K	45.25 B-C
26.	TS11xSMTR17	23.3 E-F	68.5 E-F	1.08 N-P	39.5 J
27.	TS1xTR6023	27.95 A	76.5 A-B	2.48 B-C	43F G
28.	TS4xTR6023	26.25 B-C	74.25 B-C	2.31 C	39 J-K
29.	TS7xTR6023	26.3 B-C	79.25 A	2.81 A	49 A
30.	TS11xTR6023	23.95 D-E	75 B-C	2.57 B	46 B
LSD		**1.69**	**2.36**	**1.02**	**1.02**

The mean values with the same letter are non-significant at 5% level of probability

Significant ($p<0.05$) differences were noted for days to 50% flowering among all the tested genotypes. Days to 50% flowering ranged from 58 to 66 days for parental lines and 56 days to 66 days for cross combinations. Maximum duration was taken by SMTR-17 (66.00 days) and minimum by TR-6023 (58.25 days) among the parental lines. Among hybrids, more days were taken by TS-7 x TR-1 (66.25 days) and less by TS-7 x TR-6023 (56.5 days) (Table 2). These results are in line with Kandhola *et al.,* (1995) who reported significant ($p<0.05$) variation for days to 50% flowering in various sunflower hybrids. Days to maturity were also significant ($P<0.05$) among the tested genotypes (Table 1). Parental line TR-6023 matured earlier (84.75 days) than the rest of the lines. Maximum duration to reach maturity (92.50 days) was recorded for SMTR-17. In case of hybrids, maximum days to maturity (93.50 days) were taken by recorded for the hybrid TS-7 x SMTR-17 (93.50 days), followed by TS-4 x SMTR-17 (93.25 days), while minimum (81.00 days) by hybrid TS-7 x TR-6023 (Table 2). Our results are in agreement with those reported by Kandhola *et al.,* (1995) who also found significant ($p<0.05$) variations for days to maturity.

Yield and yield components: Significant ($p<0.05$) differences were observed for head diameter among parental lines and their cross combinations (Table 1). The largest parental line head diameter (15.25 cm) was recorded for TR-120, while smallest (7.375 cm) for the line TR-6023 among the parents. Bigger heads (27.95 cm) were produced by hybrid TS-1 x TR-6023 closely followed by TS-4 x TR-102 (26.95 cm) while the smaller (13.95 cm) heads by TS-4 x TR-109 (Table 3). Radhika *et al.,* (2001) found significant ($p<0.05$) variation in head diameter and other yield contributing characters of sunflower varieties/hybrids. Significant ($p<0.05$) variations were observed for 1000-grain weight in both parents and hybrids (Table 1). Among the parents, T-3, TR-120 produced heavier grains (48.75 g 1000^{-1} grains), whereas lighter grains (42.50 g 1000^{-1} grains) were obtained in TRA-6023. Hybrids TS-7 x TR-6023 and TS1xTR6023 recorded the highest values of 79.25 g and 76.5 g 1000^{-1} grains respectively, followed by TS-11 x TR-6023 (75 g 1000^{-1} grains), while minimum 1000 grains weight (59.50 g) was observed for TS-1 x TR-1 (Table 3). These results are in line with Ahire *et al.,* (1994) and Encheva *et al.,* (2008) who reported significant ($p<0.05$) differences in yield component in various sunflower lines and crossing combinations.

Significant ($p<0.05$) differences were noted grain yield among the all tested genotypes. Maximum grain

yield (1.2 ton ha^{-1}) was produced by parental line TR-6023 while minimum (0.57 ton ha^{-1}) by SMTR-17. Among hybrids, grain yield was maximum (2.8 ton ha^{-1}) in TS-7 x TR-6023 closely followed by TS-11 x TR-6023 (2.10 ton ha^{-1}), while minimum grain yield (1.08 ton ha^{-1}) was obtained from TS-11 x SMTR-17. The grain yield of the rest of genotypes ranged between 1.1 ton ha^{-1} and 2.4 ton ha^{-1} (Table 3). Similar results were recorded by Ahire *et al.*, (1994), Kandhola *et al.*, (1995), Limbore *et al*., (1998) and Encheva *et al.*, (2008).

Oil content: Analysis of the data revealed that oil content was significantly ($p<0.05$) different among the genotypes under study. Maximum oil content (42%) was recorded for parental line TR-120 followed by SMTR-17 (40%) while minimum (35%) was noted in TR-6023. Among the hybrids, oil content was maximum (49%) in TS-7 x TR-6023 followed by TS-11 x TR-6023 (46%) while minimum oil content (31%) was recorded for TS-11 x TR-120. The oil content of the rest of genotypes ranged from 35 to 43% (Table 3). These results are in line with the findings of Kandhola *et al.*, (1995), Kumar *et al*., (1999) and Encheva *et al.*, (2008).

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