PERFORMANCE OF SOME OILSEED SUNFLOWER (*HELIANTHUS ANNUUS* L.) VARIETIES IN AEGEAN REGION OF TURKEY

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ABSTRACT

Sunflower is one of the major and leading oilseed crops in Turkey. It is grown mainly Thrace Region of Turkey. Oilseed sunflower was grown 568995 ha area with 1500000 metric ton seed production, and average seed yield of 2640 kg ha^{-1} in Turkey in 2014. The main objectives of this study were to determine performance of oilseed hybrid varieties which in Aegean region. The experiments were conducted at first crop growing seasons in 2013 on the experiment field of Aegean Agricultural Research Institute in Menemen, Izmir in Aegean Region; Edirne and Luleburgaz in Thrace. The experiments were established in randomized complete block design with four replications. As a material, sunflower oilseed candidate varieties and commercial hybrids were used in this study. Adaptation study were undertaken for the characters seed yield, seed oil content (%), 1000 seed weight, plant height, head diameter, seed length, seed width, hull percentage (%), days to flowering and days to physiological maturity. The results indicated that statistically significant differences were found among the sunflower varieties for the characters in question. The highest seed yield 516 kg da^{-1} and the lowest 347 kg da^{-1} was obtained from the varieties 08 TR003 and TE-TM-2012-2 respectively in Menemen. However, in the rain fed condition, the highest seed yields were 209 and 204 kg da^{-1} were obtained from 08 TR003 in Edirne and LG 5550 in Luleburgaz locations respectively. The results indicated that TE-TM-2012-6 and TE-TM-2012-1 found to be promising candidate hybrids with the high yields over the locations. The results of this study indicated that the production for oilseed sunflower in this region ha the great potentiality. Because of gap for vegetable oil production in Turkey, Aegean Region is one of the possibilities to increase the vegetable oil production.

Keywords: Sunflower, *Helianthus annuus* L, hybrid variety, open pollinated variety, adaptation, yield, yield components.

INTRODUCTION

Because of an increasing world population it is difficult to deal with human feeding in the world. Vegetable oils are an important source of energy. To reduce oilseed production gap in Turkey, it is possible to grow sunflowers with high yield, oil percentage and oil quality; consequently, increasing oilseed production will result in increasing vegetable oil and decreasing import of vegetable oil (Gobbelen et al., 1989; Schneiter, 1997; Tan, 2007).

Turkey is one of the leading countries for sunflower production. According to production data oilseed sunflower was grown on 568995 ha area with 1500000 metric ton seed

production, and average seed yield of 2640 kg ha^{-1} in Turkey in 2014 (Anonim, 2015). However, amount of oilseed production including sunflower is not sufficient for the consumption; therefore, amount of the production should be increased. There are some other potential sunflower production areas such as Aegean Region and South East Anatolia besides main production area of Thrace of Turkey (Fırat and Tan, 1992; Tan, 2007; Tan, 2010a; b; Tan, 2014).

In Sunflower research project at AARI, oilseed and confectionary type of sunflower germplasms including hybrid and open pollinated variety have been developed, and candidate varieties are evaluated in yield trials under first and second crop production season. Variety performance tests and yield trials indicated that sunflower can grow with satisfactory yield performance (500-550 kg da^{-1}) at both first and second crop production seasons in Aegean Region of Turkey (Tan, 2007; Tan, 2010a: b; Tan, *et. al*., 2013a; Tan, 2014; Tan *et. al*., 2015). The Aegean Region that has suitable ecological conditions for first and second crop sunflower production should be considered for sunflower production to decrease vegetable oil gap in Turkey.

The main objectives of this study were: (1) to determine newly developed oilseed hybrids varieties which could be grown with satisfactory yield performance in Aegean region.

MATERIAL AND METHODS

This study was conducted to determine performance of oilseed hybrid for Menemen, Izmir conditions. The experiments including oilseed hybrid cultivars were conducted separately at first crop growing seasons in 2013 on the experiment field of Aegean Agricultural Research Institute (AARI) in Menemen, Izmir. They were also tested in Lüleburgaz and Edirne locations as well. Adaptation study were undertaken for the characters seed yield (kg da^{-1}), seed oil content (%), 1000 seed weight (g), plant height (cm), head diameter (cm), seed length (mm), seed width (mm), hull percentage (%), seed color (white, black, and intermediate), days to flowering and days to physiological maturity.

In this study, as a material, 6 oilseed hybrids sunflower candidate varieties developed at AARI sunflower breeding program were used in the experiments. Restorer lines of these hybrids were developed by sunflower breeding program of AARI and CMS lines of these hybrids were developed by sunflower breeding program of Trakya Agricultural Research Institute (TARI). The newly developed oilseed hybrids used in this study were; TE-TM-2012-1; TE -TM-2012-2; TE -TM-2012-3; TE -TM-2012-4; TE -TM-2012-5; TE -TM-2012-6. Oilseed commercial hybris, LG-5550 (St-4); TURAY (ST-1); LG-5580 (St-5); P64G46 (St-2); 08 TR 003 (St-3) were used as control varieties.

The oilseed hybrid and OP confectionary variety variety experiments were conducted a randomized complete block design with four replications. The experiment plots were consisted of four row 7.70 m in length, spaced 0.7 m apart. There were 22 plants, spaced 0.35 (in Menemen) and 0.30 (in Luleburgaz and Edirne) cm on each row of experiments plots. Recommended agronomic crop production practices were followed. In Menemen and Edirne experiments 50 kg da^{-1} ($N_{10}P_{10}K_0$) and 25 kg da^{-1} ($N_{10}P_{10}K_0$) composed fertilizer applied respectively during the soil preparation. Three irrigation were applied in 2013 (27/06/2013, 12/07/2013, 31.07.2013) in Menemen experiment, however, irrigation were not applied in Edirne and Luleburgaz experiments. In all experiments weed control were routinely applied. The experiments were planted in 10, 20, and 21 May 2013 in Edirne, Luleburgaz and Menemöen locations respectively.

Data were obtained on;

Seed yield (kg da^{-1}): The yield was obtained from each of the two middle rows of the four row plots in the experiment. At the harvest, 1st and 4th rows and first and last plants of the middle row are removed as edge effect in the confectionary variety experiment. The first and last plants of the rows are removed as edge effect in the experiment for evaluation. Heads were hand harvested, threshed, and evaluated at 0% moisture.

Days to physiological maturity: days from planting to R9 stage (Schneiter, and Miller, 1981).

Days to flowering maturity: days from emergence to 75% of the flowering.

1000 seed weight (g): Weight of 1000 seed (g) determined from dried seed (0% moisture) sample.

Oil content (%): Sample from harvested seed was dried to 0% moisture and percent oil was determined by nuclear magnetic resonance (NMR).

Plant height (cm): Height of ten plants were measured at R9 (Schneiter, and Miller, 1981) from ground level to the base of the head (cm).

Head diameter (cm): Head diameter of ten plants were measured at R9 (Schneiter, and Miller, 1981).

Seed size (mm): The length and width of a sample of 10 seeds were measured in mm for only confectionary yield trial.

Hull percentage (%): Sample from harvested seed was dried to 0% moisture and the husk of seed was removed and weighted.

Uniformity: At the 75% of the flowering stage plants were observed whether they were uniform or not.

Statistical analyses were performed to determine the differences among the varieties (Steel, and Torrie, 1980).

RESULTS AND DISCUSSION

Results showed that statistically significant differences were found among the sunflower varieties for the characters in question. In the experiments; the highest seed yields (516, 483, and 443 kg da^{-1}) were obtained from the varieties 08 TR003, TE -TM-2012-6, and TE -TM-2012-1 respectively and the lowest seed yield of 347 kg da^{-1} was obtained from TE -TM-2012-2 in Menemen.

While, the highest seed yields (516, 483, and 443 kg da^{-1}) were obtained from the varieties 08 TR003 (239 kg da^{-1}), TE-TM-2012-6 (237 kg da^{-1}), and TE -TM-2012-1 (221 kg da^{-1}) in Edirne location. In Luleburgaz location, the highest yields; 204 kg da^{-1}, 199 kg da^{-1}, and 190 kg da^{-1} were obtained from the varieties 08 TR003, TE -TM-2012-6 and TE -TM-2012-1 respectively (Tan, *et. al*., 2013).

The lowest flowering days (45 days) observed from ETAE TE-TM-2012-1 and the highest flowering day (50 days) observed LG-5580 (St-5). The lowest physiological maturity days (97 days) observed from 08 TR003 (St-3) and highest flowering day (104 days) observed from P64G46 (St-2). The highest plant height (201 cm) was obtained from ETAE-TM-4 and the lowest plant height (155,50 cm) was obtained from P64G46 (St-2). The highest head diameter (19,6 cm) were obtained from LG-5550 (St-4) and the lowest head diameter (15.5) was obtained from TE-TM-2012-5. The highest 1000-seed weight (82.97 g) was obtained from 08 TR003 (St-3) and the lowest 1000-seed weight (53.54 g) was obtained from TE -TM-2012-2. The highest oil content (45.88 %) was obtained from TANAY, and the lowest oil content (34.55 %) was obtained from TE-TM-2012-3. The highest hull percentage (27.27 %)

was obtained from TE-TM-2012-2, and the lowest hull percentage (20.29 %) was obtained from 08 TR 003 (St-3).

Hybrids varieties had suitable physiological maturity days for both first and second crop production seasons in Aegean and Thrace Regions. These hybrids and especially TE-TM-2012-6 and TE-TM-2012-1 showed satisfactory results of other plant characters in Izmir, Edirne, and Luleburgaz experiments (Tan*, et. al*., 2013a; b).

According to *Orobanche cumana* tests, P64G46 (K), TE-TM 2012-1, TE-TM 2012-2, TE-TM 2012-3, TE-TM 2012-5,TE-TM 2012-6 were found to be tolerant to *Orobanche cumana* (Tan, *et. al*., 2013). The oilseed hybrid variety TE-TM-2012-6 was one of the best candidate hybrid variety for registration because of high yield capacity and high tolerance to Orobanche (*Orobanche cumana* Wallr.) in the yield performance trials in Turkey (Sezgin and Yasar, 2015).

CONCLUSIONS

In the oilseed variety experiments; the highest seed yield (516 kg da^{-1}) and the lowest seed yield (347 kg da^{-1}) were obtained from the varieties. These oilseed hybrids varieties with short physiological maturity days that is suitable for both first and second crop production seasons in Aegean and Thrace Regions.

Research results indicated that Oilseed candidate hybrid TE-TM-2012-6 showed the highest yield and quality performance in Menemen, Edirne and Luleburgaz locations, and found to be highly tolerant to existing races of *Orabanche Cumana* Wallr. (Tan, et. al., 2013a; b; Sezgin and Yasar, 2015), and TE-TM-2012-6 was registered as SUN 2235 in April, 2016 (Sezgin and Yasar, 2016).

Increase in sunflower production could be possible by the expansion of acreage, giving importance to the high-yielding varieties need to be planted. Planting high yielding hybrids in Aegean Region that has suitable ecological conditions for first and second crop sunflower production may play an important role to decrease vegetable oil gap in Turkey.

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Table 1. Oilseed sunflowers yield trials yield, (kg/da), oil content and oil yield, 1000 seed weight (g), and husk percentage (%) values of the varieties. AARI, Menemen-Izmir (2013).

Variety Name	Seed yield (kg da^{-1})*	Yield groups (α=0.01)	Seed yield over St. mean (%)	Seed yield order	Oil content (%)	Oil yield (kg da^{-1}) *	Oil yield over St. mean (%)	Oil yield Order	1000 Seed weight (g)**	Husk Percentage (%)
LG-5550 (St-4)	400	CDEF	90	10	36.83	147	77	12	76.16	25.05
TE-TM-2012-1	**443**	**ABCDE**	**100**	**6**	**43.51**	**193**	**102**	**7**	**55.17**	**22.25**
TE -TM-2012-2	347	F	78	14	36.82	128	67	14	53.54	27.27
TE -TM-2012-3	382	DEF	86	11	34.55	132	70	13	56.42	25.07
TE -TM-2012-4	374	EF	84	12	41.46	155	82	11	58.74	24.10
TURAY (ST-1)	440	A BCDE	99	7	45.30	199	105	6	54.12	25.92
TE -TM-2012-5	372	EF	83	13	42.57	158	83	10	56.33	26.70
TE -TM-2012-6	**483**	**AB**	**108**	**2**	**43.58**	**210**	**111**	**3**	**57.10**	**24.35**
TANAY	478	ABC	107	3	45.88	219	115	2	56.57	20.85
ETAE-TM-4	456	ABCD	102	5	45.16	206	109	4	55.07	21.35
LG-5580 (St-5)	471	ABC	106	4	42.81	202	106	5	68.97	22.18

P64G46 (St-2)	402	CDEF	90	9	41.66	167	88	9	60.54	23.34
08 TR003 (St-3)	516	A	116	1	45.33	234	123	1	82.97	20.29
EGE 2001	422	BCDEF	95	8	44.05	186	98	8	68.09	22.97
CV (%)	9.83								9.87	5.34
LSD (0.05)	60.13								8.67	1.08
LSD (0.01)	80.50								11.60	2.42

* 10% seed moisture; ** 0% seed moisture.

Table 2. Phenological Data of Firs Crop Oilseed Sunflowers Yield Trials. AARI, Menemen-Izmir (2013).

Variety Name	Days to flowering (day)	Pphysiological maturity (day)	Plant height (cm)	Head diameter (cm)	Uniformity (1-5)**
LG-5550 (St-4)	47	103	168.5	19.6	1.5
TE-TM-2012-1	**45**	**100**	**159.1**	**17.7**	**1.0**
TE -TM-2012-2	46	101	174.9	17.3	4.0
TE -TM-2012-3	46	98	165.3	18.4	1.8
TE -TM-2012-4	45	99	165.1	18.2	1.6
TURAY (ST-1)	47	100	187.4	17.9	1.1
TE -TM-2012-5	47	103	183.6	15.5	4.0
TE -TM-2012-6	**47**	**99**	**189.5**	**18.0**	**1.4**
TANAY	47	100	195.4	19.1	3.8
ETAE-TM-4	49	100	201.0	18.5	1.1
LG-5580 (St-5)	50	102	192.4	18.6	1.8
P64G46 (St-2)	48	104	155.5	19.1	1.4
08 TR003 (St-3)	46	97	165.4	18.6	1.4
EGE 2001	47	101	174.9	19.2	2.4
CV (%)	1.22	0.54	3.72	5.56	
LSD (0.05)	0.81	0.77	9.41	1.45	
LSD (0.01)	1.09	1.04	12.60	1.94	

*: 1 highly uniform, 2: uniform, 3: heterogen, 4: highly heterogen.

Table 3. Oilseed sunflowers yield trials yield, (kg/da), oil content and oil yield, and 1000 seed weight (g), values of the varieties. TARI, Edirne (2013).

Variety Name	Seed Yield (kg da^{-1})	Yield Groups (α=0.01)		Seed Yield over St. mean (%)	Seed Yield Order	Oil Content (%)	Oil Yield (kg da^{-1})	Oil Yield Groups (α=0.01)		OilYield Order	1000 Seed weight (g)*
08 TR 003 (K)	239	A		113.1	1	48.0	115	A		1	59.28
TE-TM 2012-6	237	A	B	112.4	2	46.3	110	A	B	2	40.24
TE-TM 2012-1	221	A	C	104.7	3	48.9	108	A	B	3	43.56
EGE 473 A x TT 119 R	217	A	C	102.8	4	46.3	100	B	C	5	50.40
P64G46 (K)	215	B	C	102.0	5	47.2	102	B	C	4	48.24
LG 5550 (K)	206	C	D	97.6	6	42.6	88	D	E	7	55.04
TE-TM 2012-4	204	C	D	96.6	7	46.1	94	C	D	6	40.32
TE-TM 2012-3	200	C	D	95.0	8	43.4	87	D	E	8	44.48
EGE 436 A x TT 119 R	185	D	E	87.6	9	43.4	80		E	10	39.12
TE-TM 2012-2	185	D	E	87.6	10	43.7	81		E	9	40.64
LG 5580 (K)	184	D	E	87.0	11	42.7	78		E	12	39.64
TE-TM 2012-5	169		E	80.0	12	47.6	80		E	11	41.28
CV (%)	7,65						7,60				
LSD (0.05)	22,57						10,24				

* 10% seed moisture.

Table 4. Phenological Data of Firs Crop Oilseed Sunflowers Yield Trials. TARI, Edirne (2013).

Variety Name	Days to flowering (day)	Pphysiological maturity (day)	Plant height cm)	Head diameter (cm)
P64G46 (K)	58	102	133	15
LG 5580 (K)	60	102	147	18
LG 5550 (K)	58	101	137	16
08 TR 003 (K)	57	99	145	16
EGE 436 A x TT 119 R	59	103	158	14
EGE 473 A x TT 119 R	60	107	133	19
TE-TM 2012-1	56	105	124	20
TE-TM 2012-2	58	106	145	16
TE-TM 2012-3	57	105	142	14
TE-TM 2012-4	57	105	147	16
TE-TM 2012-5	58	106	158	15
TE-TM 2012-6	58	105	169	20

Table 5. Oilseed sunflowers yield trials yield, (kg/da), oil content and oil yield, and 1000 seed weight (g), values of the varieties. TARI, Luleburgaz, Edirne (2013).

Variety Name	Seed yield (kg da^{-1})	Yield groups (α=0.01)		Seed yield over St. mean (%)	Seed yield Order	Oil content (%)	Oil yield (kg da^{-1})	(α=0.01) Oil yield groups		Oil yield Order	1000 Seed weight (g)
LG 5550 (K)	204	A		109.5	1	44.7	91	A	C	3	54.66
TE-TM 2012-6	199	A	B	106.7	2	46.9	93	A	B	2	48.12
TE-TM 2012-1	190	A	C	102.1	3	51.1	97	A		1	42.64
EGE 473 A x TT 119 R	187	A	C	100.3	4	48.2	90	A	C	5	43.80
08 TR 003 (K)	185	B	D	99.6	5	49.0	91	A	C	4	50.32
P64G46 (K)	180	C	D	96.4	6	47.3	85	B	D	6	49.48
EGE 436 A x TT 119 R	179	C	D	96.2	7	46.1	83	C	E	8	39.96
LG 5580 (K)	176	C	D	94.3	8	43.0	76		E	11	43.32
TE-TM 2012-5	174	C	D	93.7	9	48.0	84	C	E	7	41.16
TE-TM 2012-3	172	C	D	92.5	10	44.3	76		E	12	41.52
TE-TM 2012-2	168		D	90.3	11	45.7	77	D	E	10	39.56
TE-TM 2012-4	168		D	90.2	12	46.4	78	D	E	9	45.48
CV (%)	7,00						7,01				
LSD (0.05)	18,32						8,58				

* 10% seed moisture.

Table 6. Phenological Data of Firs Crop Oilseed Sunflowers Yield Trials. TARI, Luleburgaz, Edirne (2013).

Variety Name	Days to flowering (day)	Pphysiological maturity (day)	Plant height (cm)	Head diameter (cm)
P64G46 (K)	59	103	137	11
LG 5580 (K)	61	102	146	9
LG 5550 (K)	59	101	144	10
08 TR 003 (K)	57	100	139	11
EGE 436 A x TT 119 R	59	104	164	10
EGE 473 A x TT 119 R	61	106	171	12
TE-TM 2012-1	57	106	144	11
TE-TM 2012-2	59	107	148	9
TE-TM 2012-3	59	105	154	10
TE-TM 2012-4	58	106	159	9
TE-TM 2012-5	59	106	168	9
TE-TM 2012-6	59	104	160	12

Table 7. Oilseed sunflowers yield trials combined data of Edirne and Luleburgaz on yield, (kg/da), oil content and oil yield, and 1000 seed weight (g), values of the varieties.

TARI, Luleburgaz and Edirne (2013).

Variety Name	Seed yield (kg da^{-1})*	Yield groups (α=0.01)		Seed yield over St. mean (%)	Seed yield Order	Oil content (%)	Oil yield (kg da^{-1})	(α=0.01) Oil yield groups		Oil yield order
08 TR 003 (K)	212	A	B	106.8	2	48.5	102,7	A		1
TE-TM 2012-1	206	A	C	103.6	3	50.0	102,6	A		2
TE-TM 2012-6	218	A		109.8	1	46.6	101,5	A	B	3
EGE 473 A x TT 119 R	202	B	C	101.7	5	47.3	95,2	B	C	4
P64G46 (K)	197	C	D	99.4	6	47.3	93,3		C	5
LG 5550 (K)	205	A	C	103.2	4	43.7	89,4	C	D	6
TE-TM 2012-4	186	D	E	93.7	8	46.3	86,0	D	E	7
TE-TM 2012-5	172		F	86.5	12	47.8	82,1	E	F	8
TE-TM 2012-3	186	D	E	93.9	7	43.9	81,6	E	F	9
EGE 436 A x TT 119 R	182	E	F	91.7	9	44.8	81,4	E	F	10
TE-TM 2012-2	177	E	F	88.9	11	44.7	78,8		F	11
LG 5580 (K)	180	E	F	90.5	10	42.9	77,0		F	12
CV (%)	7,38						7.35			
LSD (0.05)	14,26						6.55			

* 10% seed moisture.

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