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Veli PEKCAN*, Goksel EVCI, M. Ibrahim YILMAZ, A. Suna BALKAN NALCAIYI, Şeküre ÇULHA ERDAL, Nuran CICEK, Yasemin EKMEKCI, Yalcin KAYA [1]

DROUGHT EFFECTS ON YIELD TRAITS OF SOME SUNFLOWER INBRED LINES

SUMMARY

Sunflower (*Helianthus annuus* L.) is the most important oil crop in Turkey with the preference of sunflower oil mostly and an increasing of vegetable oil deficit (4.3 billion $ in 2014). Despite of larger planting potential, low labor use and the government support, sunflower planting areas could not reach to desired level. The most important reason for that sunflower production can vary depending on the years due to extreme heat and drought in the growth period affected seed yield severely (for instance, 30-35% yield loss in 2012) as a summer crop. The study was conducted to determine the drought tolerance of some male inbred lines developed lately in National Sunflower Project conducting by Trakya Agriculture Research Institute (TARI). Based on the results under controlled conditions, some inbred lines exhibited positive responses in the research and some important yields affected less in these lines. While some inbred lines got lost 60% of the control in seed yield, some of them influenced less from drought stress about 9-10%. Drought tolerance of male inbred lines against stress conditions changed between 50-100% in 1000 seed weight and 70-100% in oil yield. However, oil content of inbred lines was not adversely influenced from drought stress; conversely, most of their oil content was increased in stress conditions.

Key words: Sunflower, Drought, Drought tolerance, inbred lines

INTRODUCTION

Water stress is a major limiting factor for sunflower production in the many regions in the world especially when the frequency and amount of rainfall are often quite variable during sunflower growing season. These kinds of situations lead variability of water and nutrient uptakes with restricting plant growth and development then finally reduces crop yield and quality (Rauf and Sadaqat, 2008; Ahmed et al., 2009; Yankov and Tahsin, 2015). Therefore, breeding efforts to develop tolerant sunflower cultivars against drought stress is

[1] Veli Pekcan* (corresponding author: velipekcan@hotmail.com), Goksel Evci, M. Ibrahim Yilmaz, Trakya Agricultural Research Institute, PO Box: 16, 22100 Edirne, TURKEY, A. Suna Balkan Nalcaiyi, Şeküre Çulha Erdal, Nuran Cicek, Yasemin Ekmekci, Hacettepe University Science Faculty, Biology Dept, 06100 Ankara, TURKEY, Yalcin Kaya, Trakya University Engineering Faculty, Genetic and Bioengineering Dept, Edirne, TURKEY

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so important issue in the breeding programs recently due to global warming and also less profitability than other crops. Since sunflower production has pushed into marginal areas in recent years because it could not compete with other crops in the rotation such as wheat in rainfed areas and corn irrigated fields. Furthermore, it has been predicted that sunflower plants will suffer from drought more in the future than current conditions in these kinds of areas although it could absorb more water than other crops from soil with its deep roots (Razi and Asad, 1998).

To develop drought tolerant lines is not easy and complicated issue due to the lack of fast and practical screening techniques as well as the incapability to set up large drought stress condition in nature. However, some tolerant genes were determined in wild types and transferred into cultural ones (Kaya, 2014). On the other hand, especially in controlled conditions, sunflower genetic materials could be screened efficiently to generate tolerant lines to drought stress with simultaneous selection (Geetha et al., 2012; Soorninia et al., 2012).

The primary objectives of this study were evaluate the effect of drought stress on some yield traits of some yield traits of sunflower male inbred lines developed in National Sunflower project conducted by TARI under controlled conditions in Edirne, Turkey.

MATERIAL AND METHODS

The study was conducted in TARI research fields with fifty male inbred lines originated different genetic sources in 2014. Trials were conducted in controlled conditions with randomized complete block design with one row and three replications. Tunca commercial hybrid belonging Limagrain Co were used as control. In each row, there were five plants and the distance between rows was 70 cm and in rows was 30 cm. The climatic data of longer years and in 2014 was given Table 1. Based on climatic data, rainfall and humidity in 2014 is over longer year averages while average temperatures were the same.

Table 1. Some climatic data of longer years and in 2014 during sunflower growth period

Months	Max. Average Temp. (ºC)	Average Temp. (ºC)	Min Average Temp. (ºC)	Average Humidity (%)	Rainfall (mm)
Longer years Averages (1954-2013)					
May	24.7	18.2	11.6	64.4	52.0
June	29.1	22.5	15. 4	60.1	44.7
July	31.7	24.7	17.3	55.9	32.0
August	31.6	24.3	17.1	56.2	23.6
September	27.1	19.8	13.3	62.2	36.8
2014 year					
May	25.0	18.6	12.5	68.7	89.0
June	28.7	22.3	16.4	67.2	88.5
July	31.9	25.3	18.3	61.9	97.8
August	32.8	25.6	18.7	61.0	12.7
September	26.5	19.6	14.5	71.4	105.3

Trials were planted by hand in 29 May and plants were harvested and threshed by hand in 24 September. Seed and oil yield (g/plant), oil content (%) and 1000 seed weight (g) of sunflower male inbred lines were observed and measured in the study.

Drip irrigation was applied with covering rain shelters, drought stress conditions were set up like below in the experiment. Stress group 1 was set up in 23.06.2014, group 2 in 22.07.2014; group 3 was set up in 04.08.2014. Control: All plant water need were supplied by drip irrigation (when field capacity reduced until 50%); Stress group 1 (S_1): When plants were 50 cm, Stress group 2 (S_2): at bud development, Stress group 3 (S_3): at the milky stage.

RESULTS AND DISCUSSION

National Sunflower Project conducted by TARI in Edirne, Turkey produced and registered many inbred female and restorer (male) lines and F_1 hybrids, then it needs to determine of the level of drought tolerance these lines for growing widely in different environmental conditions. The seed yield was the most affected trait most among evaluated yield characteristics with followed by oil yield and 1000 seed weight based on study results. Oil content was not influenced almost from drought stress in these conditions most probably because of male lines having little and firm seeds with less husks.

Drought stress influenced hardly to seed yields of male lines until 70% yield losses especially at 1st stress application (Table 2 and Figure 1). 01001 R, TT 317 R, 10004-1 R, TT 119 R, 8129 R, 70352 R, 10004-2 R and 9947 R lines at stress 1; 70352 R, 01001 R, 9987 R, 9947 R, TT 214 R, 8129 R, TT 138 R and 9759 R lines at stress 2 and 8129 R, 9987 R, 10004-2 R, 9786 R, TT 119 R, 9487 R, 62301 R and 70352 R lines affected less at stress 3 from drought stress based on tolerance index of sunflower genotypes.

Similarly, oil yield of sunflower inbred lines also affected much until 65% (Table 3 and Figure 2). It is due to seed yield because oil content of lines almost not influenced (Table 5 and Figure 4). Less affected inbred lines on oil yield were TT 317 R, 01001 R, TT 205 R, 9868 R, 10004-1 R and 70352 R at 1st stress; 9987 R, 70352 R, 01001 R, TT 214 R and TT 119 R at 2nd stress and 9987 R, 9786 R, TT 119 R, 10004-2 R, 9868 R, TT 214 R, 70352 R, 9487 R, TT 205 R, 01001 R, 9947 R and 8129 R at 3rd stress conditions.

1000 seed weights were third affected trait and about based on study results (Table 4 and Figure 3). The number of 70352 R, CL 217 R, TT 135 R, 7887-1 R, 8129 R, K9 R SN 1 and 9786 R lines at 1st stress, TT 135 R, 8129 R, 70352 R, K9 R SN 1, 7887-1 R, TT 326 R and CL 217 R at 2nd stress and 7887-1 R, 7820 R, TT 207 R, TT 135 R, 9761 R and TT 216 R lines influenced less among other male inbred lines. On the other hand, there were no influence on yield and conversely there were some increases on oil contents of lines. However, there were few decreases at 2nd and 3rd stress conditions (Table 5 and Figure 4).

Table 2: The effect of drought stress on seed yield per plant (g/plant) in sunflower.

Yield Traits	#	Max	75% Quartile	Median	25% Quartile	Min	Mean	Std Dev.
Control	50	57,7	25,5	19,5	16,3	10,3	23,7	9,0
Stress 1	50	29,7	12,4	10,3	8,6	4,7	11,9	4,6
Tolerance Level (%)	50	66,7	55,3	51,5	44,6	31,9	50,5	7,8
Stress 2	50	33,7	17,4	13,0	9,6	5,7	15,0	5,7
Tolerance Level (%)	50	82,5	71,3	65,8	57,4	39,2	63,5	10,5
Stress 3	50	45,3	20,7	15,0	12,2	7,0	17,4	6,6
Tolerance Level (%)	50	90,3	81,7	76,0	70,3	37,3	75,1	9,8

Table 3: The effect of drought stress on oil yield per plant (g/plant) in sunflower.

Yield Traits	#	Max	75% Quartile	Median	25% Quartile	Min	Mean	Std Dev.
Control	50	20,1	10,5	7,1	5,7	3,5	8,0	5,3
Stress 1	50	9,5	5,0	4,3	3,3	1,9	4,9	3,4
Tolerance Level (%)	50	79,4	65,9	57,8	51,4	36,6	57,5	9.7
Stress 2	50	10,3	6,6	4,9	3,8	1,8	5,8	3,8
Tolerance Level (%)	50	88,4	75,9	69,5	59,5	40,7	67,6	11,3
Stress 3	50	12,1	7,5	5,6	4,5	2,5	6,5	3,7
Tolerance Level (%)	50	98,3	84,3	78,8	70,3	37,8	77,3	10,8

Table 4: The effect of drought stress on 1000 seed weight (g) in sunflower.

Yield Traits	#	Max	75% Quartile	Median	25% Quartile	Min	Mean	Std Dev.
Control	50	115,4	42,5	34,9	29,0	24,0	39,9	17,9
Stress 1	50	85,7	27,2	23,6	17,7	14,2	25,9	12,2
Tolerance Level (%)	50	81,3	71,7	64,3	59,1	49,9	64,9	8,1
Stress 2	50	101,5	31,9	27,8	21,4	16,8	30,9	14,7
Tolerance Level (%)	50	90,1	83,9	78,3	70,8	57,1	77,4	8,5
Stress 3	50	110,9	38,4	30,8	26,6	19,8	35,1	16,0
Tolerance Level (%)	50	104,4	94,4	91,2	82,9	65,6	88,6	8,3

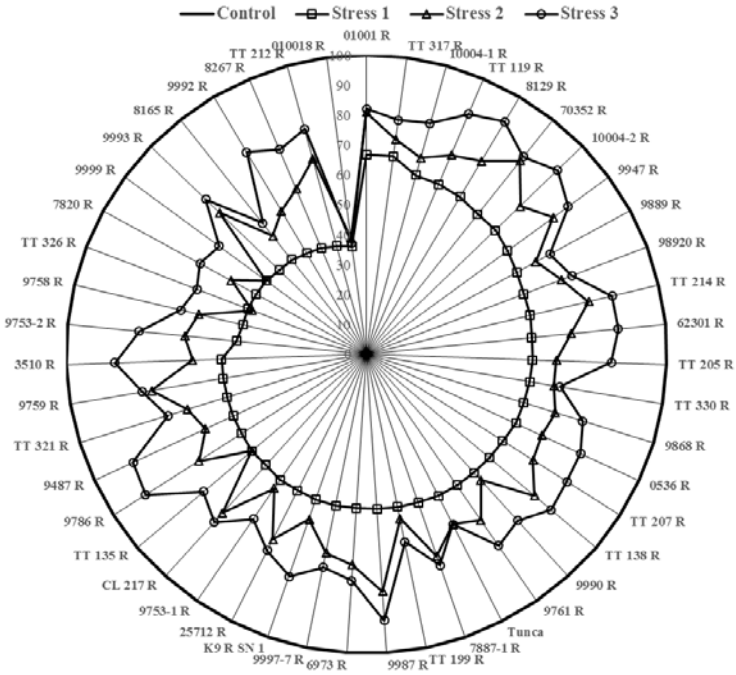

Figure 1: The effect of drought stress on seed yield per plant ((% of control) in sunflower

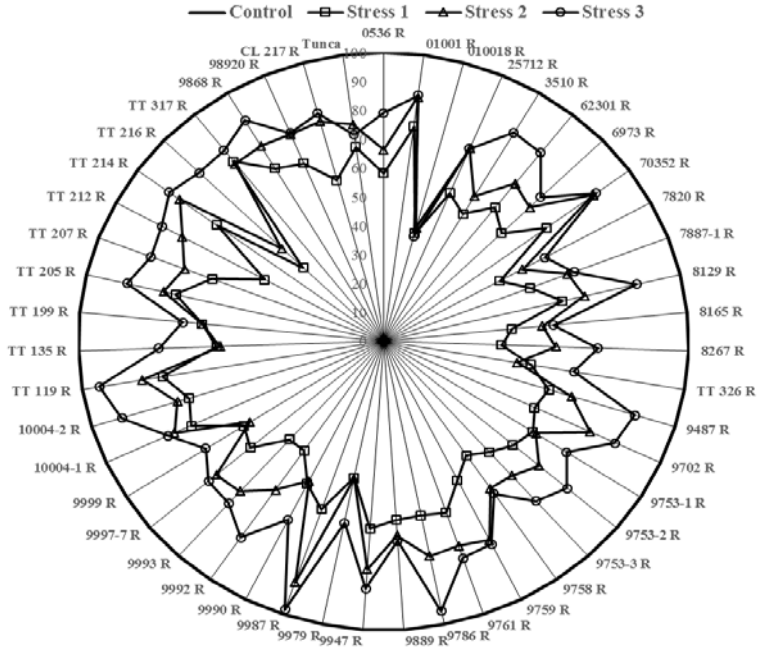

Figure 2: The effect of drought stress on oil yield per plant (% of control) in sunflower

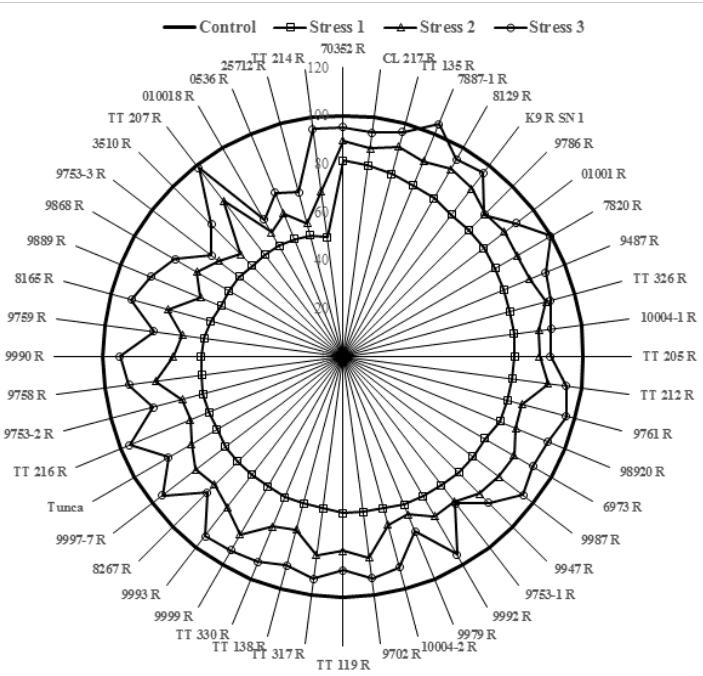

Figure 3: The effect of drought stress on 1000 seed weight (% of control) in sunflower

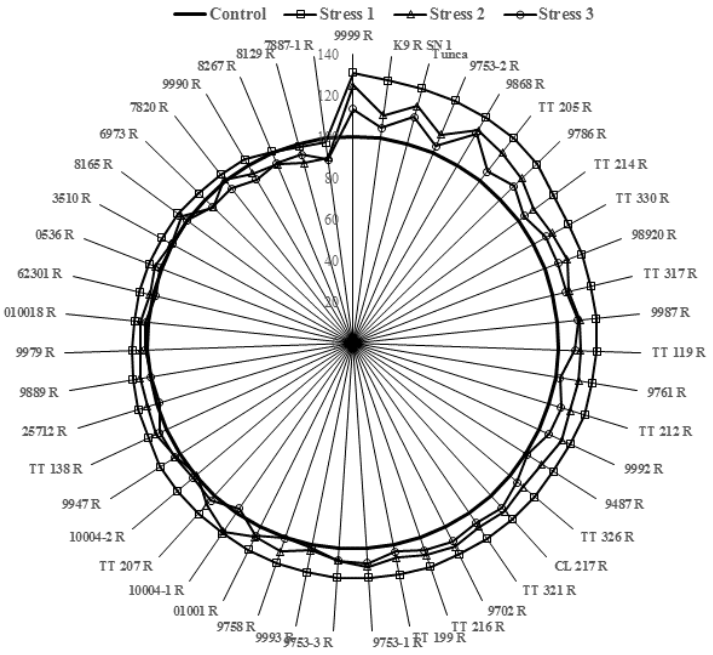

Figure 4: The effect of drought stress on oil content (% of control) in sunflower

Table 5: The effect of drought stress on oil content (%) in sunflower

Yield Traits	#	Max	75% Quartile	Median	25% Quartile	Min	Mean	Std Dev.
Control	50	47,9	41,1	36,2	32,8	14,4	36,2	6,9
Stress 1	50	52,0	45,5	41,2	37,9	18,3	40,8	6,3
Tolerance Level (%)	50	130,9	118,3	113,3	108,2	98,1	113,5	7,6
Stress 2	50	48,8	43,3	38,3	35,4	17,2	38,4	6,2
Tolerance Level (%)	50	124,8	110,7	106,7	103,2	90,3	106,5	6,6
Stress 3	50	48,5	41,8	37,8	34,2	17,0	37,2	6,2
Tolerance Level (%)	50	118,0	106,2	103,5	100,3	89,8	103,0	5,2

CONCLUSIONS

As conclusion, drought mostly influenced seed and oil yields of male inbred lines and 1000 seed weight followed these traits while there no decrease on oil contents controlled conditions. Selected drought tolerant lines could be used for the future breeding research to develop tolerant sunflower hybrids. 70352 R and 8129 R which slightly affected from drought stress may be recommended for this type purpose for future studies.

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