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SELECTION FOR DROUGHT TOLERANCE IN DIFFERENT BOTANICAL VARIETIES FROM *CUCUMIS MELO* L.

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ABSTRACT

Drought stress is one of the most serious environmental limitations affecting the growth and productivity of vegetable plants. However, tolerant genotypes improve their physiological mechanisms to cope with this stress. The objective of the current study was to determine the effects of water stress on fifteen melon recombinant inbred lines (RILs) (5 RILs galia type and 3 RILs charentais type follow Cucumis melo var. cantaloupensis, 5 RILs ananas type follow Cucumis melo var. ananas and 2 RILs Egyptian melon type follow Cucumis melo var. egyptiacus). Two irrigation levels (full irrigation and 50% of full irrigation) were imposed after completing the formation of the first three true leaves to determine potential drought tolerance of these RILs during 2017 and 2018 early summer seasons at Kaha Vegetable Research Farm (KVRF), Kalubia Governorate. Leaf area, flowering, yield and its components, fruits number/plant and fruit quality were measured for each RIL under both of full irrigation and drought stress conditions. The RILs were classified as drought tolerant if they had very low reduction or increment rates under drought stress compared to full irrigation condition and vice versa. The experimental results showed that both of the RILs 3G (galia type) and 7Ch (charentais type) had a very low reduction or increment rates under drought stress compared to full irrigation condition in all measured traits. So, both of these RILs had a high drought tolerance, but the remaining RILs were classified as intolerant for drought stress. Data revealed that the RILs 3G (galia type) and 7Ch (charentais type) could be considered as a source for drought tolerance.

Key words: ***Muskmelon, Cucumis melo L., Drought tolerance, Water stress, Recombinant inbred lines.***

INTRODUCTION

Climatic disturbances due to global warming can cause huge reductions in yield and crop quality. Among the agricultural crops, the vegetables which are more vulnerable for climatic changes (Turkes 1999). Drought is the major environmental constraint to crop productivity. Due to the higher productivity of irrigated land than the rain-fed land, the saline area has still been increasing as a result of improper irrigation water management. Consequently, it is necessary to determine the horticultural traits of crop plants under drought stress in order to develop appropriate strategies to carry on food production under adverse environmental conditions (Zheng *et al* 2009).

In general, melon is known to be moderately resistant to drought. It has been shown that this stress causes several types of damage such as growth inhibition (Franco *et al* 1997, Mendlinger 1994, Dasgan and Koc 2009 and Kusvuran 2010), metabolic disturbances (Mavrogianopoulos *et al* 1999) and yield and quality losses (Del Amor *et al* 1999).

Likewise, leaf area decreases according to decreasing of irrigation. This relationship was observed for carambola (Marler *et al* 1994), cherry

(Kirnak and Demirtas 2002), peach and nectarine (Kaynas 1994) and pistachio (Kanber *et al* 1993).

Drought stress increases flowering and earliness, but reduces average fruit weight and yield in vegetable crops (Oliveira *et al* 1992 and Karipcin *et al* 2008). The total soluble solids content is an important parameter for drought. However, deficient irrigation increased total soluble solids content in strawberry and watermelon (Pomper and Breen 1997, Sezgin *et al* 1996 and Karipcin *et al* 2008).

Finally, biotic and abiotic stresses are the most important factors that severely limit plant growth and metabolism (Makbul *et al* 2011). Abiotic stress is the primary cause of crop loss through worldwide, reducing average yields for most major crop plants by more than 50% (Bray *et al* 2000). Moreover, when the usable areas on the earth are classified in view of stress factors, drought stress is one of the most widespread environmental stresses (Arora *et al* 2002 and Saruhan Güler *et al* 2012). However each stress factor produces its own specific effect on plants.

Thus, the aim of this work was to compare the changes in yield, yield components, growth parameters and fruit quality of melon RILs under drought stress compared to full irrigation to select the drought tolerant RILs in different botanical varieties and obtaining genetic resources tolerant to drought stress.

MATERIALS AND METHODS

This research was conducted at Kaha Vegetable Research Farm (KVRF), Kalubia governorate. The experiment was carried out on a clay textured soil during 2017 and 2018 early summer seasons. The field was divided into two open areas, one of them was used to full irrigation treatment (control) and the other was used to 50% of full irrigation (drought stress treatment).

Plant material

Fifteen melon recombinant inbred lines (RILs) (5 RILs galia type and 3 RILs charentais type follow *Cucumis melo* var. *cantaloupensis*, 5 RILs ananas type follow *Cucumis melo* var. *ananas* and 2 RILs Egyptian melon type follow *Cucumis melo* var. *egyptiacus*) were obtained by the second author of the present study from former breeding program, which took ten years ago from the beginning of this work, and used in this study.

Methods

Seeds of these fifteen RILs were sown in two open areas using drip irrigation system and were arranged in experimental plots (EP). All plots received enough water until the true leaf development. After completing the formation of the first three true leaves, irrigation treatments were started. Drip irrigation management treatments of the 15 RILs were as follows: full irrigation was for one hour with drain 4 liter/hour for each plant twice a week (full irrigation was used as control) for the first open area, but drought stress treatment was 50 % of full irrigation, which was for half an hour with drain 2 liter/hour for each plant twice a week for second open area. A single drip irrigation tube for each bed with 4.0 L/h was placed over the soil surface. The drippers were used to supply uniform water distribution. All experimental plots were arranged in a factorial design with three replicates. Each replicate of each open area contained 15 experimental plots for 15 RILs. Each EP was represented by a single bed covered with black plastic mulch, 1.5 m width and 10 m length (EP area = 15 m^2) and the plants were spaced at 50 cm. Land preparation, fertilizer application and other field practices were carried out according to recommendations of the Egyptian Ministry of Agriculture. Also, the fertigation system was used to apply plants with fertilizers and all the fertilizer quantities were dissolved in the water and were injected inside the fertigation system according to irrigation treatments for each open area.

Measured traits

Ten traits were measured for each RIL under both of full irrigation and drought stress conditions as follows:

1. Leaf area index (LAI): The leaf area of each plant was determined after maturity of fruits by the area meter (LI-COR, model LI 3050A, USA) measured as an average of 3 randomly chosen plants per EP and the LAI was calculated by dividing average leaf area by the ground area occupied by the plant.

2. Flowering: Three plants were randomly chosen per EP to determine the number of days from seed sowing to appearance of the first andromonocious flower on the plant.

3. Yield: Early yield (EY) was yield of the first 3 pickings and total yield (TY) was weight of all fruits harvested at the yellow-netted ripe stage from each EP. Marketable yield (MY) was determined after excluding cracked, rotten and infected fruits with diseases and pests and was calculated as percentage from the total yield.

4. Fruits number/plant: It was measured as an average of the number of fruits/plant for five plants were chosen randomly from each EP.

5. Fruit quality: average fruit weight (AFW) and flesh thickness were determined as the mean of 10 fruits randomly chosen from each EP. The netting percentage was measured as a ratio of the netting covered fruit rind to full fruit rind as visual method and determined as the mean of 10 fruits randomly chosen from each EP. Total soluble solids (TSS) was determined in the third and fourth pickings of 5 yellow-ripe fruits/picking of each EP using a hand refractometer.

Statistical analysis

Obtained data were statistically analyzed and mean comparisons were based on the LSD test according to Gomez and Gomez (1984). Also, the Bartlett's test (using Chi-square test) of the variance of error for 15 RILs in both early summer seasons during 2017 and 2018 were homogeneous for all traits. So, the combined analysis of variance for the two early summer seasons during 2017 and 2018 was computed for all traits according to Koch and Sen (1968).

The reduction and increment rates were estimated for all studied traits under drought stress as the deviation of each RIL mean in each trait under drought stress (50% irrigation) over the control (full irrigation) of the same RIL. So, if the reduction or increment rates were very low, this indicate a high tolerance to drought stress and *vice versa*.

RESULTS AND DISCUSSION

Obtained data of combined analysis on LAI and flowering date of perfect flowers of muskmelon RILs under drought stress compared to control and their reduction rates during 2017 and 2018 early summer seasons were presented in Table 1.

Table 1. Effect of drought stress on leaf area index and flowering date of perfect flowers of muskmelon RILs evaluated in the open field during 2017 and 2018 early summer seasons in a combined analysis across two years.

RILs	Leaf area index			Flowering date of perfect flowers (days)		
	Control	Drought	Reduction rate (%)	Control	Drought	Reduction rate (%)
1G	1.71	0.78	-54.19	46.33	40.33	-12.95
2G	0.96	0.43	-55.05	41.67	37.33	-10.40
3G	0.81	0.71	-11.98	46.00	45.17	-1.81
4G	1.07	0.50	-53.13	44.17	37.33	-15.47
5G	1.10	0.47	-57.58	48.67	42.00	-13.70
6Ch	1.05	0.54	-48.09	48.00	42.67	-11.11
7Ch	1.01	0.98	-2.98	43.33	41.33	-4.62
8Ch	0.93	0.51	-45.32	52.67	45.33	-13.92
9A	1.43	0.84	-41.63	40.00	35.67	-10.83
10A	1.63	0.43	-73.62	40.67	36.00	-11.48
11A	1.51	0.52	-65.49	44.33	38.67	-12.78
12A	1.16	0.36	-68.77	43.67	38.33	-12.21
13A	1.47	0.45	-69.61	41.00	36.67	-10.57
14M	2.11	1.01	-52.13	52.67	46.00	-12.66
15M	2.26	0.85	-62.33	49.67	43.67	-12.08
$LSD_{(0.05)}$	0.18			3.10		

Regarding LAI, data showed that the LAI reduced due to drought stress. So, although RIL 15M had the highest LAI without significant differences from RIL 14M under full irrigation condition, the two RILs gave high reduction rates under drought stress compared to control reaching to -62.33 and -52.13%, respectively. Besides, this indicated that both RILs didn't show drought tolerance for this trait. In contrast, although RILs 7Ch and 3G ranked sixth and tenth in LAI, respectively, under drought stress and full irrigation conditions, the two RILs had the lowest reduction rates under drought stress compared to control reaching to -2.98 and -11.98%, respectively. Consequently, both RILs (7Ch and 3G) might have high drought tolerance for this trait.

These results coincided with those of Kanber *et al* (1993), Kaynas (1994), Marler *et al* (1994) and Kirnak and Demirtas (2002) who reported that leaf area decreases according to decreasing of irrigation on different crops.

As for flowering date of perfect flowers, data showed that the flowering date of perfect flowers reduced as drought stress increased. So, although RIL 9A had the least value of flowering date of perfect flowers without significant differences from the most of RILs under drought stress, it gave high reduction rate under drought stress compared to control reaching to -10.83%. Also, this indicated that this RIL hadn't drought tolerance based on this trait. In contrast, although RILs 3G and 7Ch had intermediate values of flowering date of perfect flowers under drought stress and full irrigation conditions, they had the lowest reduction rates under drought stress compared to control reaching to -1.81 and -4.62%, respectively. So, this indicated that both RILs (3G and 7Ch) might have high drought tolerance based on this trait.

Similar trend have been observed on watermelon (Oliveira *et al* 1992 and Karipcin *et al* 2008).

Likewise, obtained data of combined analysis on early, total and marketable yield of muskmelon RILs under drought stress compared to control and their reduction and increment rates during 2017 and 2018 early summer seasons are presented in Table 2.

Referring to early yield, data showed that the early yield increased as drought stress increased. So, although RIL 10A produced the highest early yield under drought stress, it had high increment rate compared to control in this trait reaching to 48.57%. This indicated that RIL 10A hadn't drought tolerance based on this trait. The RIL 9A wasn't significantly different from RIL 10A under drought stress and the RIL 7Ch had low early yield either under drought stress or under full irrigation conditions. However, they gave moderate increment rate under drought stress compared to control reaching to15.11 and 20.00%, respectively. This indicated that RILs 9A and 7Ch had moderate drought tolerance based on this trait. In contrast, Although RIL 3G had intermediate early yield value either under drought stress or under full irrigation conditions, it had the lowest increment rate under drought stress compared to control reaching to 1.94%. So, this indicated that RIL 3G had a high drought tolerance based on this trait.

These results are in agreement with those of Oliveira *et al* (1992) and Karipcin *et al* (2008) who reported that drought stress accelerated flowering and earliness in vegetable crops.

Table 2. Effect of drought stress on early, total and marketable yield of muskmelon RILs evaluated in the open field during 2017 and 2018 early summer seasons in a combined analysis across two years.

RILs	Early yield (ton/feddan)			Total yield (ton/feddan)			Marketable yield (%)		
	Control	Drought	Increment rate (%)	Control	Drought	Reduction rate (%)	Control	Drought	Reduction rate (%)
1G	1.12	1.39	24.48	8.67	2.82	-67.5	90.33	72.33	-19.93
2G	0.65	1.02	57.44	9.33	6.97	-25.30	86.00	61.67	-28.29
3G	1.03	1.05	1.94	8.85	7.77	-12.24	88.33	83.33	-5.66
4G	1.06	1.32	24.14	7.52	1.58	-78.95	91.33	69.33	-24.09
5G	0.67	0.94	41.50	9.75	1.87	-80.85	90.00	66.67	-25.93
6Ch	0.45	0.83	83.70	10.48	4.66	-55.52	94.67	66.00	-30.28
7Ch	0.52	0.62	20.00	10.96	9.86	-10.04	90.33	86.00	-4.80
8Ch	0.20	0.36	81.36	9.74	2.68	-72.46	88.33	64.00	-27.55
9A	1.68	1.93	15.11	12.96	2.68	-67.21	89.67	61.00	-31.97
10A	1.40	2.08	48.57	11.47	4.00	-65.13	88.67	65.00	-26.69
11A	0.92	1.18	28.73	12.76	4.33	-66.07	90.33	66.33	-26.57
12A	0.84	1.27	50.20	11.51	3.13	-72.78	88.00	67.33	-23.48
13A	0.63	1.13	78.95	13.37	4.43	-66.86	83.00	54.33	-34.54
14M	1.30	1.64	26.15	17.02	5.50	-67.68	79.67	49.67	-37.66
15M	0.65	1.04	61.34	15.30	4.01	-73.82	79.33	54.33	-31.51
$LSD_{(0.05)}$	0.24			1.11			7.39		

With respect to total yield, data showed that the total yield was reduced as drought stress increased. So, although RIL 14M produced the highest total yield under full irrigation condition and was significantly different from all other studied RILs, it revealed high reduction rate under drought stress compared to control reaching to -67.68%. This indicated that

RIL 14M hadn't drought tolerance based on this trait. In contrast, although RILs 7Ch and 3G ranked fifth and ninth in total yield, respectively, under drought stress and full irrigation conditions, they had the lowest reduction rates under drought stress compared to control reaching to -10.04 and -12.24%, respectively. So, this indicated that both RILs (7Ch and 3G) had a high drought tolerance based on this trait.

Similar results have been reported on different vegetable crops by Oliveira *et al* (1992), Del Amor *et al* (1999), Bray *et al* (2000) and Karipcin *et al* (2008), who stated that the drought stress reduced yield and could be reached to 50% losses.

Concerning marketable yield percentage, data showed that the marketable yield percentage was reduced as drought stress increased. So, although RIL 6Ch produced the highest marketable yield percentage under full irrigation condition and wasn't significantly different from most of other studied RILs under the same condition, it had high reduction rate under drought stress compared to control reaching to -30.28%. This indicated that RIL 6Ch hadn't drought tolerance based on this trait. In contrast, although RILs 7Ch and 3G ranked second and third in marketable yield percentage, respectively, under drought stress and full irrigation conditions, they had the lowest reduction rates under drought stress compared to control reaching to -4.80 and -5.66% for the two RILs, respectively. Thus, both RILs (7Ch and 3G) had a high drought tolerance based on this trait.

In addition, obtained data of combined analysis on fruits number/plant, average fruit weight and netting percentage of muskmelon RILs under drought stress compared to control and their reduction rates during 2017 and 2018 early summer seasons are presented in Table 3.

As for fruits number/plant, data showed that the fruits number/plant was reduced as drought stress increased. So, although RIL 4G produced the highest fruits number/plant under full irrigation condition and wasn't significantly different from most of other studied RILs under the same condition, it had the highest reduction rate under drought stress compared to control reaching to -83.33%. Thus, it could be concluded that RIL 4G hadn't drought tolerance based on this trait.

Table 3. Effect of drought stress on fruits number/plant, average fruit weight and netting percentage of muskmelon RILs evaluated in the open field during 2017 and 2018 early summer seasons in a combined analysis across two years.

RILs	Fruits number/plant			Average fruit weight (g)			Netting percentage (%)		
	Control	Drought	Reduction rate (%)	Control	Drought	Reduction rate (%)	Control	Drought	Reduction rate (%)
1G	3.33	1.33	-60.00	816.7	350.0	-57.14	100.00	73.33	-26.67
2G	3.67	1.33	-63.64	1016.7	500.0	-50.82	81.67	51.00	-37.55
3G	3.00	2.33	-22.22	852.3	786.7	-7.70	100.00	90.67	-9.33
4G	4.00	0.67	-83.33	480.3	238.3	-50.38	100.00	60.00	-40.00
5G	3.67	1.00	-72.73	468.3	333.3	-28.83	86.67	28.33	-67.31
6Ch	4.00	1.67	-58.33	585.0	460.0	-21.37	100.00	33.33	-66.67
7Ch	4.00	3.00	-25.00	596.7	550.0	-7.82	100.00	86.67	-13.33
8Ch	2.67	1.00	-62.50	792.3	510.0	-35.63	83.33	23.33	-72.00
9A	2.67	1.00	-62.50	1116.7	723.3	-35.22	80.00	16.67	-79.17
10A	3.67	1.33	-63.64	948.3	603.3	-36.38	91.67	26.67	-70.91
11A	3.00	1.33	-55.56	1060.0	604.0	-43.02	100.00	59.33	-40.67
12A	3.00	1.00	-66.67	933.3	620.0	-33.57	85.00	26.67	-68.63
13A	2.67	1.00	-62.50	1126.7	728.3	-35.36	100.00	45.00	-55.00
14M	2.00	1.00	-50.00	2283.3	1036.7	-54.60	65.00	30.00	-53.85
15M	2.33	0.67	-71.43	1585.0	850.0	-46.37	61.67	13.33	-78.38
$LSD_{(0.05)}$	0.98			136.01			10.01		

In contrast, the RILs 7Ch and 3G ranked first and second under full irrigation condition and second and fourth under drought stress, respectively, in fruits number/plant trait. Besides, they had the lowest reduction rates under drought stress compared to control reaching to -25.00 and -22.22%, respectively. So, this indicated that both RILs (7Ch and 3G) had a high drought tolerance based on this trait.

The reduction of fruits number/plant could be a reason for yield losses. So, these results and conclusions are in agreement with those of Bray *et al* (2000), who reported that abiotic stress is the primary cause of crop loss worldwide, reducing average yields for most of major crop plants by more than 50%.

Regarding average fruit weight, data showed that the average fruit weight was reduced as drought stress increased. So, although RIL 14M produced the highest average fruit weight under full irrigation condition and was significantly different from all other studied RILs under the same condition or under drought stress, it had a high reduction rate under drought stress compared to control reaching to -54.60%. It could be concluded that RIL 14M hadn't drought tolerance based on this trait. In contrast, although the RILs 7Ch and 3G ranked eighth and sixth, respectively, under full irrigation and drought stress conditions in average fruit weight trait, they had the lowest reduction rates under drought stress compared to control reaching to -7.82 and -7.70%, respectively. So, this indicated that both RILs (7Ch and 3G) had a high drought tolerance in this trait.

Similar conclusions have been reported on watermelon by Oliveira *et al* (1992) and Karipcin *et al* (2008).

Referring to netting percentage, data showed that the netting percentage was decreased as drought stress increased. In that respect, although RIL 6Ch produced the highest netting percentage under full irrigation condition and wasn't significantly different from most of other studied RILs under the same condition, it had a high reduction rate under drought stress compared to control reaching to -66.67%. This indicated that RIL 6Ch hadn't drought tolerance based on this trait. In contrast, both of RILs 7Ch and 3G ranked first and second under full irrigation and drought stress conditions, respectively, in netting percentage trait. Besides, they had the lowest reduction rates under drought stress compared to control reaching to -13.33 and -9.33%, respectively. So, this indicated that both RILs (7Ch and 3G) had a high drought tolerance based on this trait.

Similar trends have been reported on melon by Del Amor *et al* (1999), who reported that drought stress causes several types of damage such as quality losses.

Likewise, obtained data of combined analysis on fruit flesh thickness and TSS of muskmelon RILs under drought stress compared to control and their reduction rates during 2017 and 2018 early summer seasons are shown in Table 4.

Table 4. Effect of drought stress on fruit flesh thickness and TSS of muskmelon RILs evaluated in the open field during 2017 and 2018 early summer seasons in a combined analysis across two years.

RILs	Fruit flesh thickness (cm)			TSS (%)		
	Control	Drought	Reduction rate (%)	Control	Drought	Reduction rate (%)
1G	2.83	1.77	-37.65	11.53	9.47	-17.92
2G	2.63	1.70	-35.44	12.80	10.20	-20.31
3G	3.37	3.20	-4.95	13.53	14.00	3.45
4G	2.57	1.80	-29.87	11.47	9.20	-19.77
5G	2.93	1.77	-39.77	12.47	10.00	-19.79
6Ch	3.50	2.23	-36.19	10.47	8.67	-17.20
7Ch	3.77	3.37	-10.62	12.67	13.53	6.84
8Ch	2.97	2.03	-31.46	10.27	8.47	-17.53
9A	3.00	1.97	-34.44	9.00	6.93	-22.96
10A	3.43	2.47	-28.16	10.13	8.07	-20.39
11A	3.67	2.50	-31.82	11.13	9.40	-15.57
12A	3.93	2.77	-29.66	12.00	9.80	-18.33
13A	3.43	2.10	-38.83	11.47	9.40	-18.02
14M	2.57	1.73	-32.47	8.67	6.73	-22.31
15M	2.67	1.73	-35.00	9.53	7.27	-23.78
$LSD_{(0.05)}$	0.34			0.87		

Concerning fruit flesh thickness, data showed that the fruit flesh thickness was reduced as drought stress increased. So, although RIL 12A produced the highest fruit flesh thickness under full irrigation condition and wasn't significantly different from RILs 7Ch and 11A under the same condition, it had a high reduction rate under drought stress compared to control reaching to -29.66%. This indicated that RIL 12A hadn't drought tolerance based on this trait. In contrast, both of RILs 7Ch and 3G ranked first and third under full irrigation and third and fourth under drought stress conditions, respectively, in fruit flesh thickness trait, besides they had the lowest reduction rates under drought stress compared to control reaching to -4.95 and -10.62%, respectively. So, this indicated that both RILs (7Ch and 3G) had a high drought tolerance based on this trait.

Referring to TSS, data showed that the TSS were decreased as drought stress increased in all RILs except RILs 3G and 7Ch. This may be due to the plants couldn't form carbohydrates under drought stress at intolerant RILs, but the plants could form carbohydrates under drought stress in tolerant RILs such as 3G and 7Ch. This result is contradiction with reported results by Pomper and Breen (1997), Sezgin *et al* (1996) and Karipcin *et al* (2008), who stated that the deficit irrigation increases total soluble solids content in strawberry and watermelon.

So, the RIL 3G under drought stress had the highest TSS value, but it wasn't significantly different from the same RIL under full irrigation condition and RIL 7Ch under drought stress. Also, RIL 7Ch ranked second under full irrigation condition. Thus, only the RILs 3G and 7Ch had low increment rates under drought stress compared to control reaching to -3.45 and -6.84%, respectively. So, this insure the superiorty of these two RILs (3G and 7Ch) under drought tolerance based on this trait as well as in previous traits.

In conclusion, the findings confirmed that all traits were decreased as drought stress increased except early yield trait. The drought tolerance of any genotype was increased as the reduction or increment rate for this genotype compared to control was reduced and *vice versa*. The RILs 3G (galia type) and 7Ch (charentais type) showed a high drought tolerance and could be used as a source for drought tolerance.

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الإنتخاب لتحمل الجفاف فى أصناف نباتية مختلفة من الشمام

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يعد الجفاف واحد من أكثر المعوقات البيئية الهامة التى تؤثر على نمو وإنتاجية نباتات الخضر. وحيث ان التراكيب الوراثية المتحملة تُحسن من ميكانيكيتهم الفسيولوجية للتغلب على هذا العائق، فقد قُدرت فى الدراسة الحالية تأثيرات الجفاف على خمسة عشر سلالة مرباه داخلياً من الشمام (خمسة سلالات تتبع مجموعة الجاليا، وثلاثة سلالات تتبع مجموعة الشارانتيه، وخمسة سلالات تتبع مجموعة الأناناس، وسلالتين تتبع مجموعة الشمام المصرى). وقد تم تطبيق مستويين من الرى (الرى الكامل، و٥٠% من الرى الكامل) وذلك بعد إكتمال تكوين أول ثلاث أوراق حقيقية لتقدير قوة التحمل للجفاف لهذه السلالات خلال العروات الصيفية المبكرة لعامى ٢٠١٧، و٢٠١٨ بمزرعة بحوث الخضر بقها – محافظة القليوبية. وتم قياس صفات مساحة سطح الورقة ، والتزهير، والمحصول ومكوناته، وعدد الثمار لكل نبات، وصفات جودة الثمار لكل سلالة تحت كلاً من ظروف الرى الكامل، وظروف العطش. صُنفت السلالات متحملة للجفاف، إذا كانت معدلات الإنخفاض أو الزياده تحت ظروف العطش مقارنة بظروف الرى الكامل منخفضة جداً، والعكس صحيح. أظهرت النتائج ان كلاً من السلالتين 3G (تتبع مجموعة الجاليا)، و 7Ch (تتبع مجموعة الشارانتيه) أعطت معدلات إنخفاض أو زيادة تحت ظروف العطش مقارنة بظروف الرى الكامل منخفضة جداً فى كل الصفات المقيسة. وقد أظهرت هاتين السلالتين قدرة واضحة على تحمل عالى للجفاف، ولكن كانت باقى السلالات غير متحملة للجفاف. وبناء على هذه النتائج تُوصى الدراسة بإستخدام كلاً من السلالتين 3G (تتبع مجموعة الجاليا)، و 7Ch (تتبع مجموعة الشارانتيه) كمصدر للتحمل للجفاف.

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